



2023 MASSACHUSETTS CLEAN ENERGY INDUSTRY REPORT

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Since 2010 MassCEC has:



Awarded **\$654M** in programs and investments and attracted **\$2.6B+** in private and federal capital



Supported **5,800+** college and vocational internships with **620+** employers, attracting **65%** women and minority interns



Awarded **\$170M** for technology innovation and company growth



Awarded **47,000+** projects, supporting **164MW+** of solar and **251MW+** of clean heating and cooling



Tested **55** wind turbine blades at the Wind Technology Testing Center, generating over **\$25M+** in revenue



Developed the **1st** purpose-built port in the U.S. for staging and deployment of offshore wind projects

ABOUT MASSCEC

The Massachusetts Clean Energy Center (MassCEC) is a state economic development agency dedicated to accelerating the growth of the clean energy sector across the Commonwealth while helping to meet clean energy, climate, and economic development goals. MassCEC works to spur job creation, deliver statewide environmental benefits, and secure long-term economic growth for the people of Massachusetts.

MassCEC is governed by a Board of Directors, which is chaired by Massachusetts Energy and Environmental Affairs Secretary Rebecca Tepper.

Areas of Focus

MassCEC fosters collaboration amongst the climate industry, state government, research universities, community-based organizations, and the financial sector to advance the state's clean energy economy. We partner with a diverse range of stakeholders, with a particular focus on clean transportation, high-performance buildings, net-zero grid, offshore wind, and clean energy workforce development.

MassCEC is committed to creating a diverse, equitable, and inclusive organization and clean energy industry where everyone is welcomed, supported, respected, and valued. Our workforce development programs incorporate principles of diversity, equity, inclusion, and environmental justice and support the training of our clean energy

workforce to achieve our climate goals. We are passionate about promoting the equitable distribution of clean energy health and economic benefits across the Commonwealth.

MassCEC has a proven track record of identifying and supporting promising clean energy solutions and innovations. Our technology-to-market grants and investments support climate-critical technologies that reduce emissions and have the potential to address our most challenging climate issues. We specialize in funding early-stage technology crucial for decarbonization, addressing gaps in traditional funding. Our initiatives include research and development grants, seed funding, grants for prototypes and first demonstrations, and catalyzing later-stage investments.

Market development is a central component of MassCEC's work, which includes accelerating the adoption of new commercially ready clean energy technologies, proving and scaling innovative business models, and developing and supporting critical clean energy infrastructure.

Massachusetts leads the growth of American offshore wind with two unique facilities. MassCEC owns and operates critical industry infrastructure—the Wind Technology Testing Center in Charlestown, the only facility of its kind in North America that conducts endurance testing for commercial-scale wind blades, and the New Bedford Marine Commerce Terminal, the only existing port in the United States purpose-built for the deployment of offshore wind.



EMILY REICHERT

NOTE FROM THE CEO

and striking a bold stance on offshore wind, Governor Healey and other leaders in state government are empowering Massachusetts to reach its climate targets.

It is clear there is a pressing need for a robust and well-trained clean energy workforce in Massachusetts. Presently, the state boasts 108,450 direct clean energy jobs, which further supports an additional 104,325 direct or induced jobs. In July, MassCEC unveiled an expansive Workforce Needs Assessment detailing the roadmap for clean energy workforce growth. To meet climate milestones, we must add 38,000 more workers to the industry by 2030. Building upon our robust workforce development programming, we can meet these challenges and bring valuable and rewarding careers to Massachusetts residents.

A highlight of our workforce programming was the August announcement of more than \$18 million

in grants to over 40 community-based organizations and industry partners to create meaningful pathways into clean energy careers. With a focus on equity and accessibility, these grants will offer training programs across the Commonwealth, providing the opportunity for sustainable, family-supporting careers in fields ranging from HVAC installation to wind turbine maintenance.

MassCEC is immensely proud of a new collaboration with partners in the Department of Elementary and Secondary Education. The newly established Clean Energy Innovation Career Pathway will introduce young students to these careers through experiential learning opportunities in the field, ensuring a workforce that meets future needs and inspires the next generation of clean energy experts.

Leading the offshore wind conversation this year was the ongoing construction of Vineyard Wind, the nation's first

commercial-scale offshore wind farm, built out of MassCEC's New Bedford Marine Commerce Terminal, the country's first purpose-built offshore wind port. This is a strong beginning to the Commonwealth's commercial offshore wind future.

Governor Healey's announcement of the fourth—and largest—offshore wind energy procurement propels Massachusetts into a period of substantial growth in the field. At 3,600 MW, this represents 25% of the Commonwealth's annual electricity demand and is the largest procurement for offshore wind energy generation in New England.

Massachusetts is already preparing for this growth with substantial commitments to offshore wind infrastructure, including over \$180 million in critical funding for upgrades

to facilities in New Bedford, transmission cable manufacturing in Somerset, and the establishment of the state's second offshore wind port in Salem, positioning the Commonwealth as leaders in the nation's clean energy transition.

MassCEC is exploring strategic avenues to support innovative clean energy and climate technologies. With the launch of MassCEC's first-ever venture fund, the 2030 Fund, MassCEC will invest \$50 million by 2030 in early-stage climatetech startups with promising and groundbreaking solutions. Alongside our tech-to-market grants, we are nurturing and accelerating local entrepreneurs, further solidifying Massachusetts' reputation as a global hub for climatetech innovation.

MassCEC continues to be at the forefront of the clean energy conversation. A new program to reduce embodied

carbon in building materials is primed to change how we build. MassCEC-supported demonstration projects are examining new ways to deliver heat, accessible options for residential clean energy upgrades, and pathways to decarbonizing existing homes. We are expanding our electric school bus and overall clean transportation programming, ensuring our children and communities breathe healthier air.

Our clean energy future is a bright one. Though the magnitude of change may appear daunting, MassCEC remains steadfast in its mission and belief that Massachusetts will meet its climate goals and deliver a sustainable, clean energy future. Together, alongside our fellow Massachusetts residents, we can have a profound impact on our environment, creating a brighter world for future generations.

This report illustrates that the Massachusetts clean energy industry is:

Home to over **108,000** direct clean energy workers, having grown **80%** since 2010

Powered by small businesses, with **58%** having ten or fewer employees

Growing fast, outpacing overall growth in the state:

Clean energy Gross State Product has grown over **63%** since 2012, outpacing statewide growth of **55%**

2023

MASSACHUSETTS CLEAN ENERGY INDUSTRY HIGHLIGHTS¹



212,775 total direct, indirect, and induced jobs and **\$33.1 billion** in total Gross State Product (GSP) supported by the clean energy industry



108,450 direct clean energy workers in MA



Clean energy jobs represent **2.8%** of jobs in MA



71% of clean energy workers are employed in the Energy Efficiency, Demand Management, and Clean Heating and Cooling Sector



MA has **4%** of all clean energy jobs in the U.S., while being home to only **2%** of the country's population



74% of clean energy jobs and businesses are located outside of Route 128



58% of all clean energy firms are small businesses (10 or fewer workers)



Clean Energy Companies represent more than **\$14 billion** in GSP



Industry GSP increased by **\$5.7 billion** since 2012, a **63%** increase that outpaced growth in MA overall GSP, which grew by **55%** over the same time



Clean energy jobs created by 2030 will have a median hourly wage of **\$36.58** (based on today's dollars)

7,315 clean energy businesses in 2023



Residential solar project through MassCEC's Mass Solar Loan Program

Sub-sectors that experienced the greatest rate of job growth between 2022 and 2023 reports²



Electric Vehicles
39% (+1,227 jobs)



Advanced & Recycled Building Materials
3.5% (+651 jobs)



Solar
3.2% (+506 jobs)

¹ Unless otherwise noted, the numbers represented in the 2023 Massachusetts Clean Energy Industry Highlights are as of December 2022.

² The 2023 Report shows sub-sector jobs growth in absolute numbers versus prior reports, which have shown percentage job growth.

Since 2010, the MA clean energy industry has experienced:

80%
job growth

— ADDING —

48,176
new workers



While COVID-19 led to a loss of 12,800 jobs by December 2020, the industry has begun to rebound, with over **7,200** jobs gained as of December 2022.

ECONOMIC CONTRIBUTION ANALYSIS

DECEMBER 2022

For the purpose of this report, only those workers who are directly supporting clean energy activities, such as conducting research, manufacturing products, performing installations, or repairing and maintaining clean energy systems, are included as clean energy workers. However, the impact of the industry is significantly greater than these “direct” jobs alone.³

The clean energy industry has a similar number of direct jobs as the College & University or Restaurant industries yet exceeds both industries' economic contribution in indirect and induced jobs and state GSP.

³ The economic contribution analysis in this report was calculated using IMPLAN modeling software. The study area was set as the State of Massachusetts, and the event year was set to 2021 since 2022 IMPLAN data was not yet available.

Based on this analysis, the **MASSACHUSETTS CLEAN ENERGY INDUSTRY** is responsible for a total economic contribution of:



212,775
combined direct, indirect,
and induced jobs



\$33.1 BILLION
in MA GSP



\$2.6 BILLION
in state and local taxes



\$4.4 BILLION
in federal taxes



The **108,450 DIRECT CLEAN ENERGY JOBS**

in Massachusetts supported an additional:

38,466 INDIRECT JOBS

(those outside of the clean energy sector that provide critical supply chain goods and services)

65,859 INDUCED JOBS

(those that result from increased spending in the economy)



MASSACHUSETTS IS A LEADER

#1 Highest clean energy median wage in the U.S. at **\$29.84**, which is **23%** above the MA statewide median wage by **Environmental Entrepreneurs** (2020)

#1 On the clean energy Community Power Scorecard for the **7th straight year** by the **Institute for Local Self-Reliance** (2023)

#1 and **#3** For utility-specific energy efficiency work by Eversource Massachusetts and National Grid Massachusetts respectively by the **American Council for an Energy-Efficient Economy** (2023)

#1 Top states for LEED-certified green building by the **U.S. Green Building Council** (2022)

In the Top Ranking

- For statewide energy efficiency work in the U.S for the 2nd year in a row by the **American Council for an Energy-Efficient Economy** (2022)
- For clean energy jobs as a percentage of total employment by the **U.S. Department of Energy** (2023)
- For clean energy storage jobs per capita by the **U.S. Department of Energy**

MassCEC Spotlight

MassCEC's Offshore Wind Leadership

MassCEC began supporting the development of the offshore wind industry over a decade ago, knowing its potential to help meet the Commonwealth's climate, energy, and economic development goals in Massachusetts. MassCEC has helped to reduce risk, increase market confidence, and support the economic development and workforce opportunities of the offshore wind industry.



Staging of offshore wind turbine components at MassCEC's New Bedford Marine Commerce Terminal

MassCEC's work has helped to address numerous challenges to growing the offshore wind industry, including:



Developing the first purpose-built port in the U.S.



Constructing the only commercial-scale wind blade testing facility in North America



Growing the pipeline of offshore wind workers and cultivating the supply chain in Massachusetts

The Commonwealth has conducted 3 offshore wind procurements to date totaling 3,200 MW of capacity, with the 4th procurement underway for up to 5,600 MW. The Vineyard Wind project, the first offshore wind project in the pipeline, is slated to be fully operational in 2024.

MassCEC's Offshore Wind Ports Challenge

Successful establishment of the offshore wind industry in Massachusetts will require the build-out of multiple highly specialized port facilities for deployment, manufacturing, and operations.

MassCEC leveraged significant private and other public investments in specific maritime port rehabilitation and redevelopment activities to advance the offshore wind sector and capture high-value supply chain and workforce opportunities for the Commonwealth.

Initial Results

\$180M investment

\$444M leveraged funds

7 Port Projects in 3 environmental justice communities

Broader Impacts

Significantly increases the regional capacity for offshore wind manufacturing, deployment, and operations & maintenance while increasing local employment and economic impact.



Massachusetts' Climate Goals

In 2017, Massachusetts enacted the Clean Energy Standard, which aims to fully decarbonize the state's electricity generation by 2050. Additionally, in 2021 and 2022, Massachusetts enacted comprehensive climate legislation to target reaching net zero greenhouse gas emissions by 2050 and supporting underserved populations.

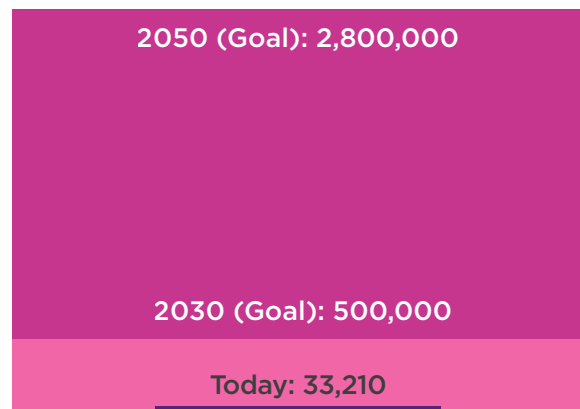
The Commonwealth has made progress in decarbonizing the electric grid, buildings, and vehicles, but more needs to be done to ensure the state meets its ambitious and critical goals.

MassCEC is poised to help tackle the most difficult challenges to achieving our climate goals, including testing and demonstrating new technologies and business models, supporting clean energy startups, supporting complex supply chains, engaging and informing consumers, and training a diverse and equitable workforce.

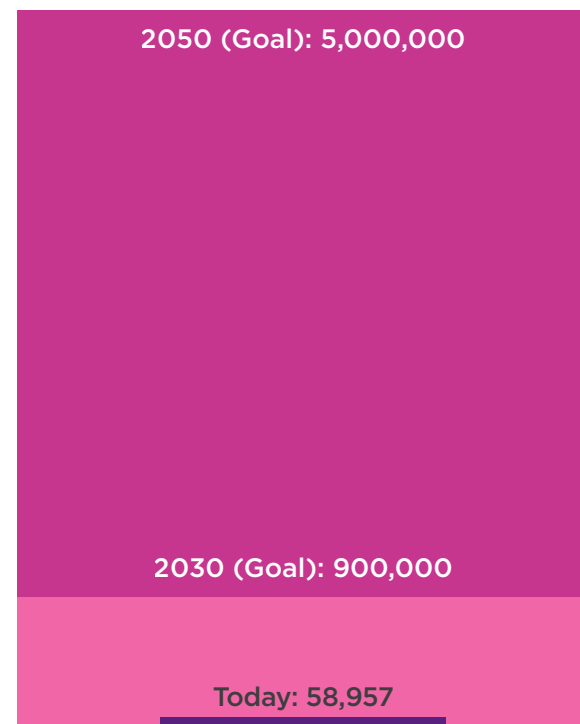


Staging of offshore wind turbine components at MassCEC's New Bedford Marine Commerce Terminal

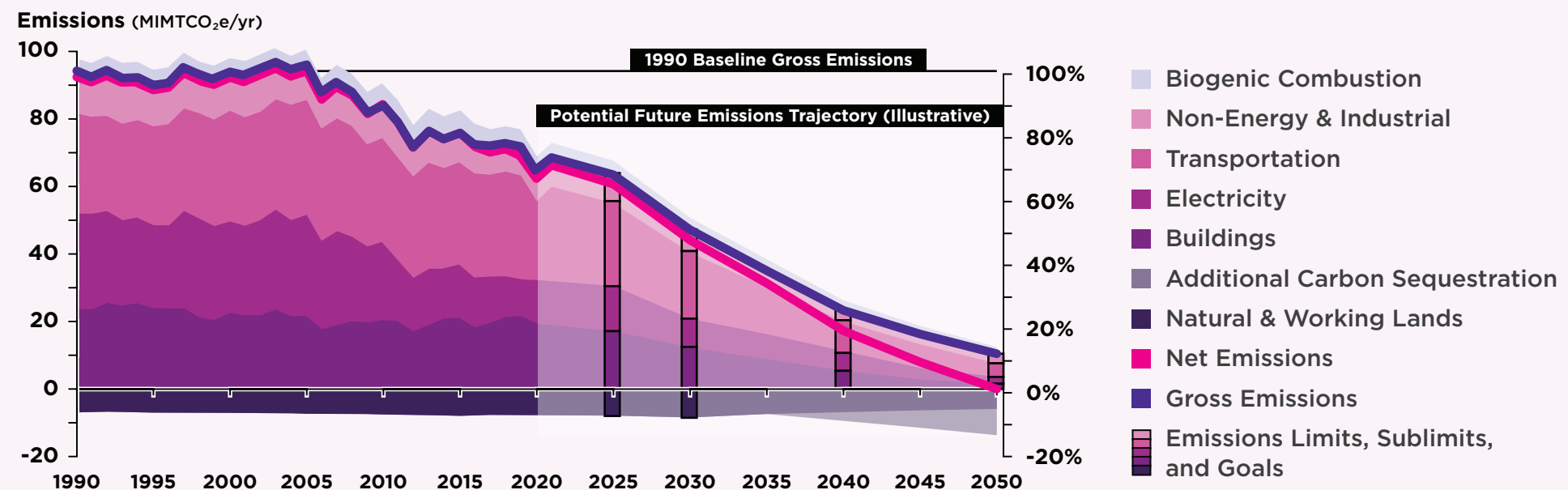
CUMULATIVE HEAT PUMPS INSTALLED (WITH INCENTIVES)⁴



CUMULATIVE BATTERY AND PLUG-IN HYBRID ELECTRIC VEHICLES⁴



MASSACHUSETTS GROSS EMISSIONS, 2050 CLEAN ENERGY CLIMATE PLAN



⁴Based on EEA's Clean Energy Climate Plan Implementation Tracker (<https://www.mass.gov/info-details/massachusetts-clean-energy-and-climate-metrics>). Data updated as of July 2023.

TOTAL CLEAN ENERGY JOBS⁵

Between 2010 and 2022, the clean energy industry in Massachusetts added a net **48,176** jobs, which accounts for **10%** of all net jobs created in the state during that same time. Though the COVID-19 pandemic continues to have a lasting impact on the Massachusetts' clean energy industry and the broader labor market, between the 2022 and 2023 reports, clean energy businesses added **4,160** jobs, representing a **4%** increase. This is comparable to the growth of the Massachusetts wholesale trade and education industries, which also grew by **4%** over the same time. The overall Massachusetts economy experienced job growth of **3%** over the same time period.

This report defines a clean energy worker as a person who spends some portion of their time working in renewable energy, energy efficiency, alternative transportation, or other carbon management technologies. In Massachusetts, **108,450** workers spend some portion of their time working in clean energy. Of those workers, **70%** spend the “majority” or “all of their time” working in clean energy, compared to an average of **63%** nationally.

⁵For the purpose of this report, only those workers who are directly supporting clean energy activities, such as conducting research, manufacturing products, performing installations, or repairing and maintaining clean energy systems, are included as clean energy workers. However, the impact of the industry is significantly greater than these “direct” jobs alone.

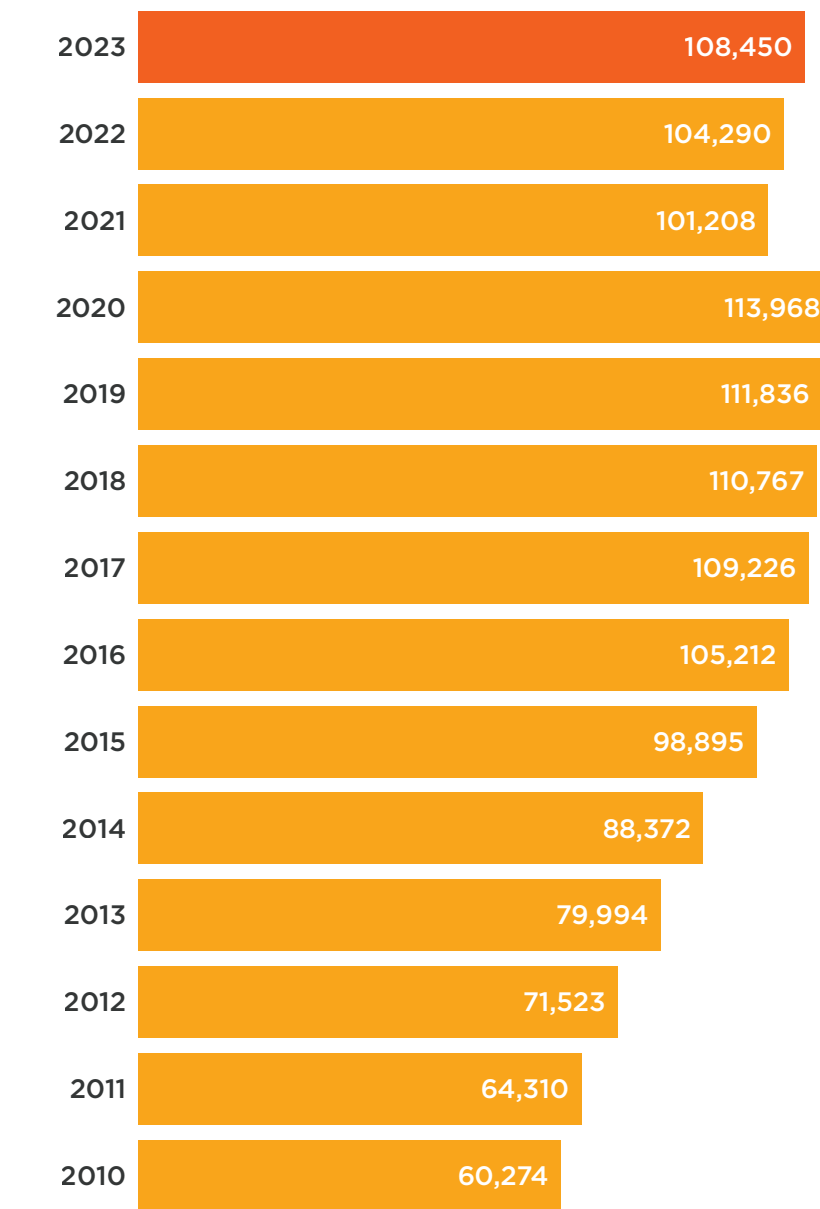
Clean energy employers are optimistic, estimating to hire roughly 5,900 additional employees in 2024. While actuals may vary from these estimates, it demonstrates clean energy companies' intent to expand their workforce to meet industry and consumer demand.⁶

⁶ Employer hiring estimates are based on current opinions regarding companies' short-term growth. Respondents consider a variety of factors, including current policy, economic conditions, and labor availability. It is more of a measure of optimism or pessimism than a detailed projection.



80%
growth
since
2010

TOTAL CLEAN ENERGY JOBS REPORT YEARS 2010-2023⁷



⁷ 2023 job numbers represented in this report are based on the 2023 USEER data collection effort and represent the net change in employment between December 2021 and December 2022.



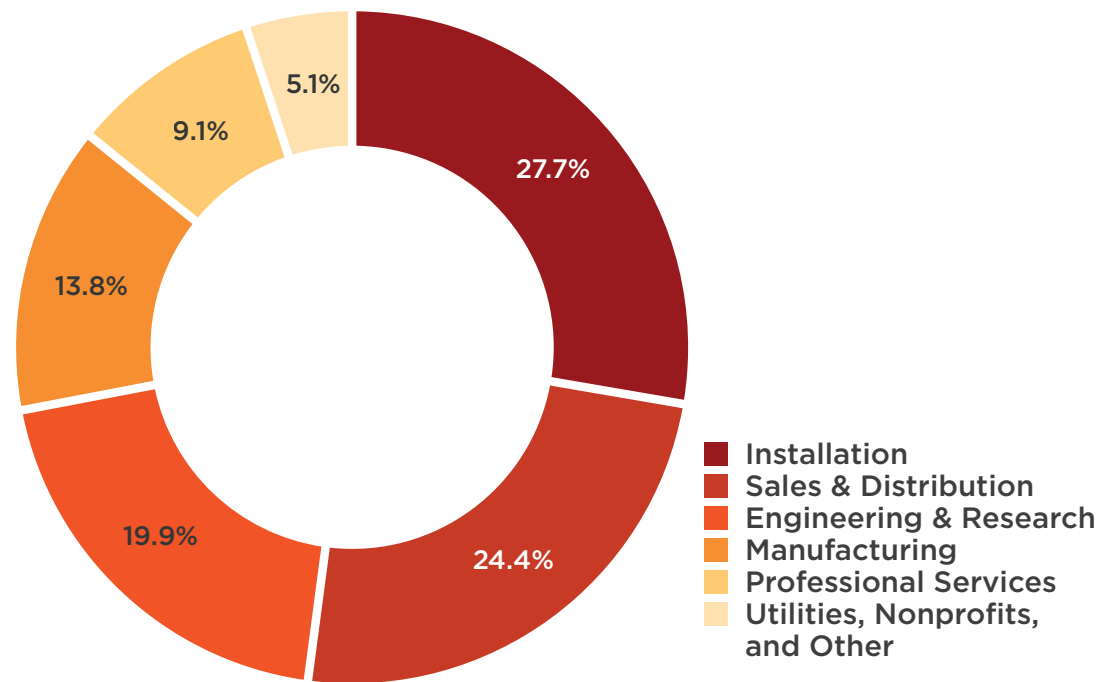
Photo courtesy of Multiscale Systems.

CLEAN ENERGY JOBS BY VALUE CHAIN⁸

All value chain segments continued to grow, adding jobs between the 2022 and 2023 reports. Businesses with a primary focus on Sales & Distribution experienced the greatest growth, adding **1,276** workers (**5%** growth).

Installation grew by **4%** (**1,005** workers), while the Professional Services sector grew by **7%** (**598** workers). Additionally, businesses with a primary focus on Engineering & Research saw a growth rate of **3%**, adding **559** new workers.

PERCENT OF 2023 CLEAN ENERGY JOBS BY VALUE CHAIN⁹



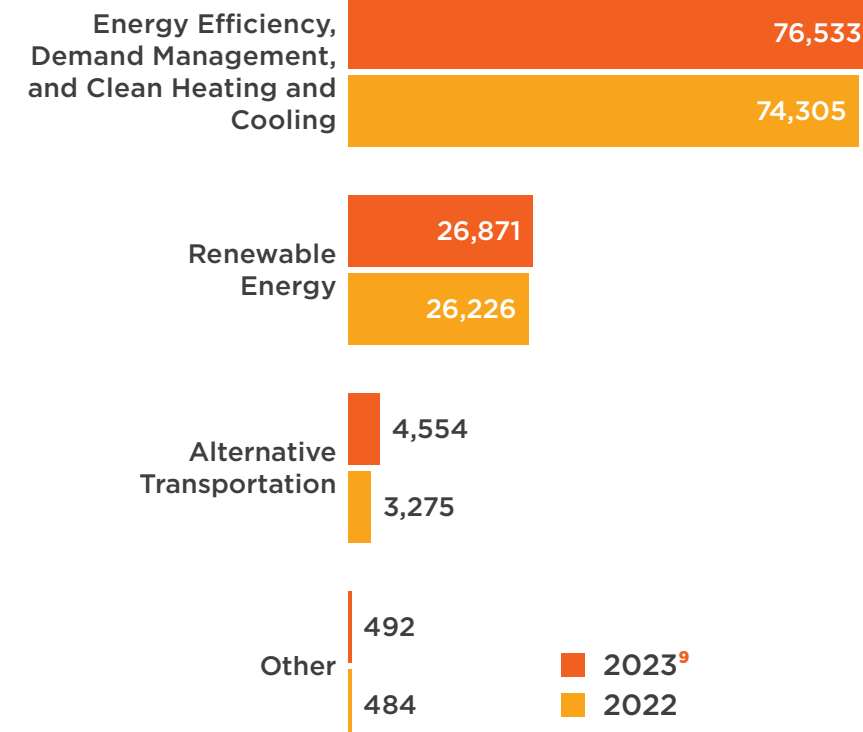
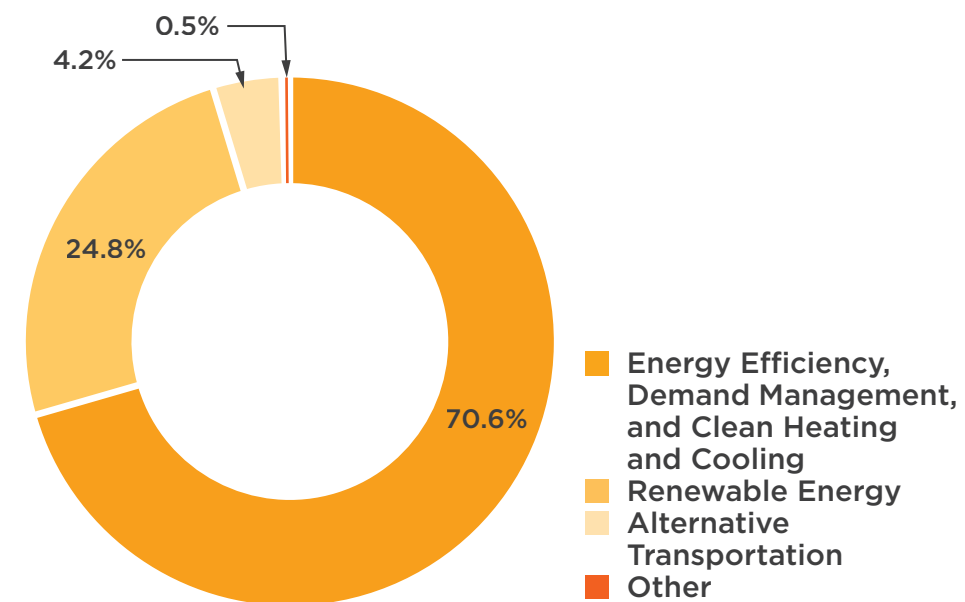
⁸ Definitions for all clean energy value chains, sectors, and sub-sectors can be found in the Glossary of this report.
⁹ 2023 job numbers represented in this report are based on the 2023 USEER data collection effort and represent the net change in employment between December 2021 and December 2022.

CLEAN ENERGY JOBS BY SECTOR⁸

Alternative Transportation saw the greatest growth rate at **39%**, adding **1,279** jobs. The growing number of electric vehicle jobs is driving significant growth in the Alternative Transportation sector, which has seen significant growth in Massachusetts and nationally over the last several years.

The Renewable Energy sector grew by **3%** and the Energy Efficiency, Demand Management, and Clean Heating and Cooling sector, which continues to have the largest number of absolute jobs, grew by **3%**.

PERCENT OF 2023 CLEAN ENERGY JOBS BY SECTOR⁹

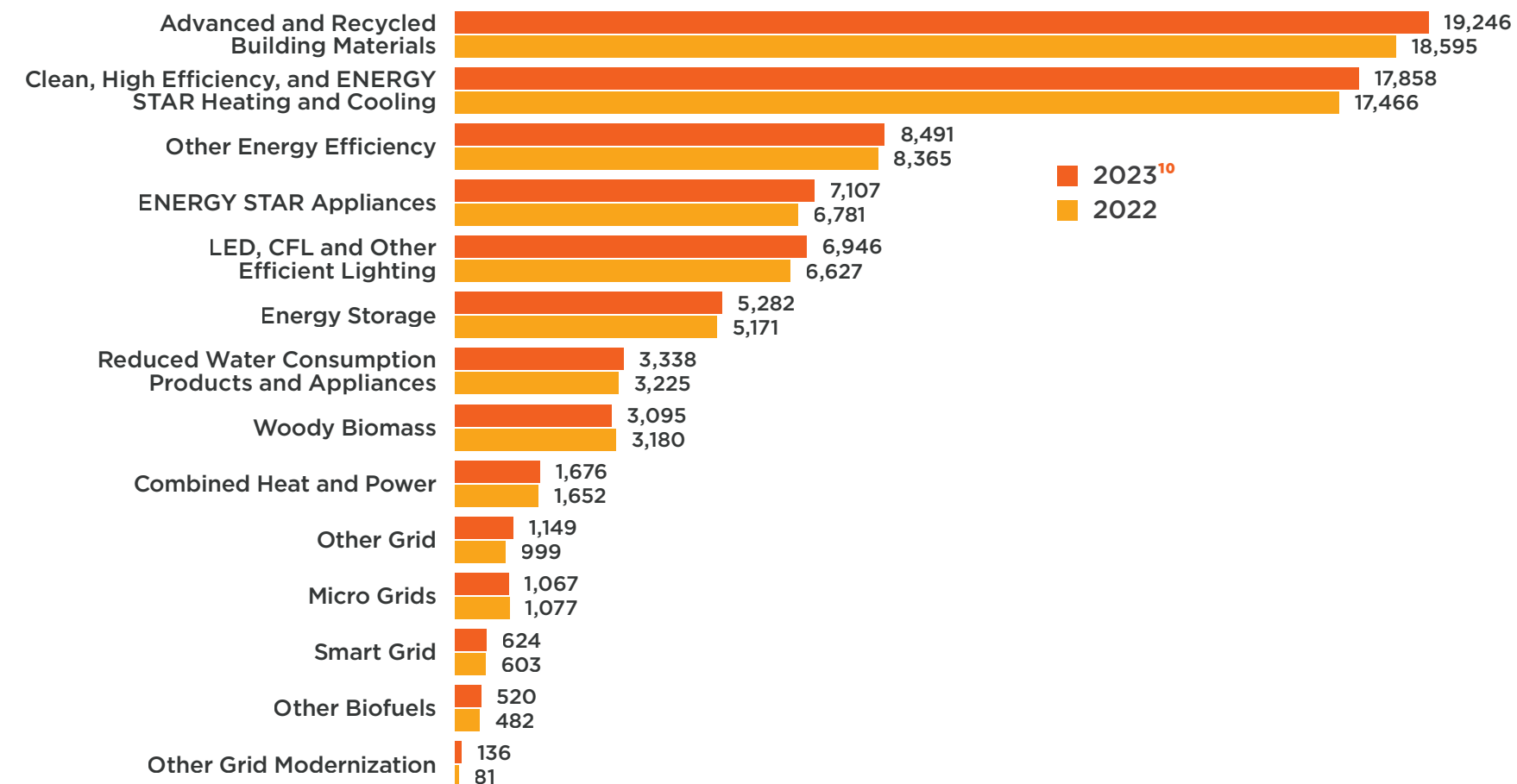


Courtesy of Alp Technologies

ENERGY EFFICIENCY, DEMAND MANAGEMENT, AND CLEAN HEATING AND COOLING JOBS

The Energy Efficiency, Demand Management, and Clean Heating and Cooling sector continues to make up the largest portion of clean energy jobs in Massachusetts. Within this sector, Advanced and Recycled Building Materials saw the most considerable increase between the 2022 and 2023 reports, at **651** jobs.

Clean, High Efficiency, and ENERGY STAR Heating and Cooling, which includes jobs related to the installation of air source heat pumps, saw the second largest increase of **392** jobs. While this is a growing sub-sector in Massachusetts, the state is far short of having enough workers to install the number of heat pumps needed to reach the state's 2030 Clean Energy and Climate Plan goal.



¹⁰ A2023 job numbers represented in this report are from the 2023 USEER data collection and represent the net change in employment between December 2021 and December 2022.


MassCEC Spotlight

DECARBONIZING MULTI-FAMILY BUILDINGS

Passive House building standards provide a framework for the construction of exceptionally energy-efficient, resilient, healthy, and comfortable buildings. In 2019 there were few Passive House buildings in Massachusetts, as they were believed to be overly complicated and expensive to build compared to those constructed using standard building practices. As a result, MassCEC developed the Passive House Design Challenge to demonstrate that multi-family affordable housing could be built to Passive House standards at a low- to no-cost premium. This program educated the industry and informed additional state programs, resulting in a significant increase in the number of Passive House buildings in the state.

MassCEC's Passive House Design Challenge

Program Results

 **540 units**
(8 multi-family affordable projects)

 **86 developer & architect collaborations**

 **2.4% average cost premium for Passive House**

 **\$1.8M awarded**

Broader Impacts

De-risked concept of PH, leading to dramatic increase in Passive House design and construction:



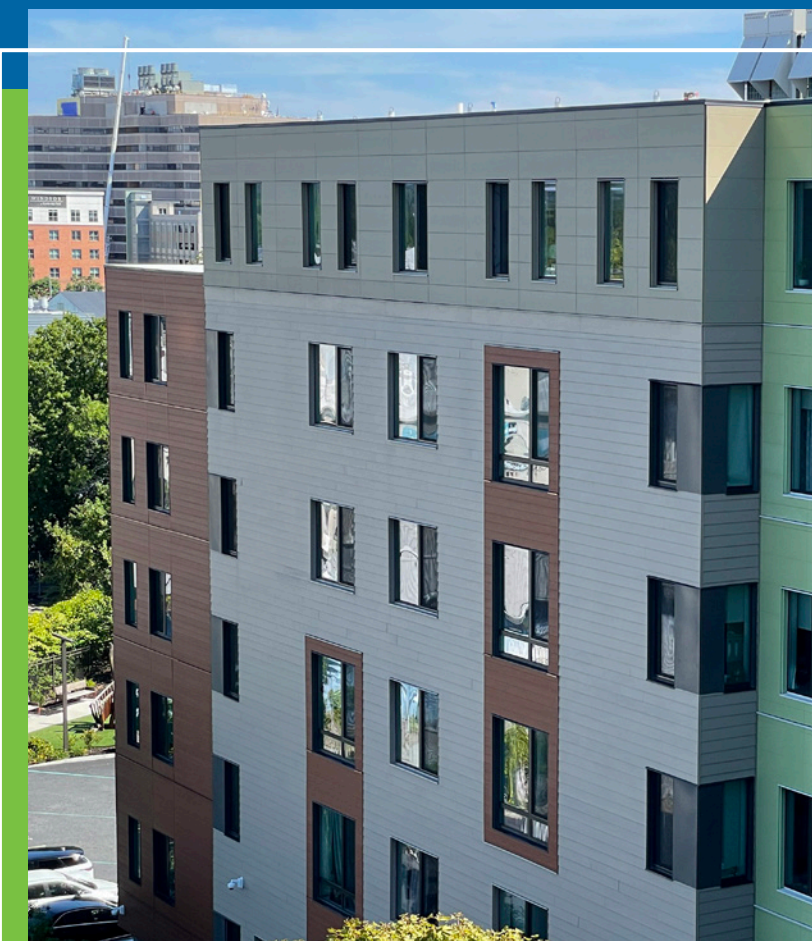
Informed Mass Save's Passive House incentives, with 10,000+ units in the pipeline



Resulted in addition of Passive House incentives to tax credit program



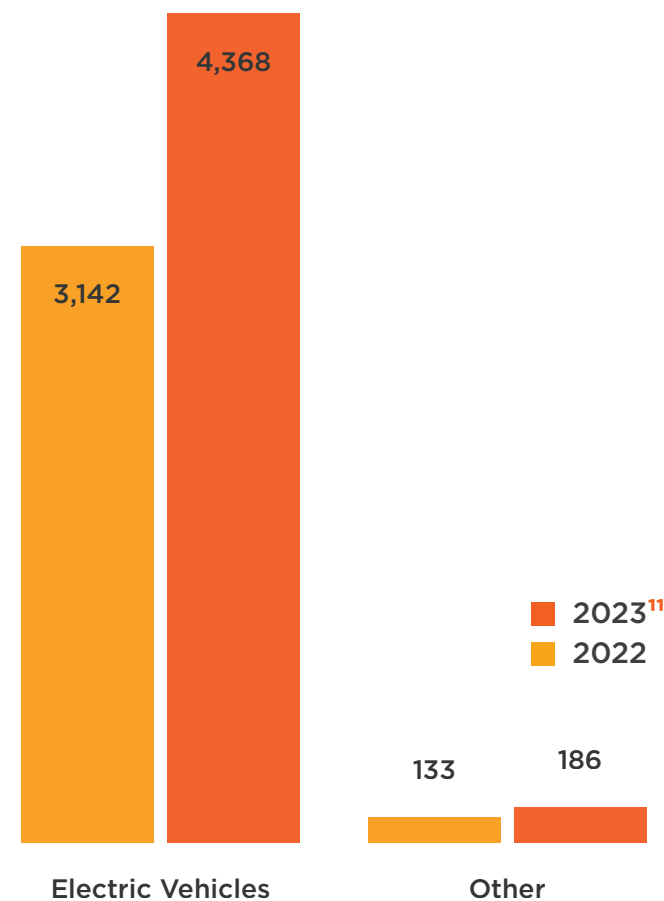
Informed Stretch Code to require Passive House for multi-family buildings



MassCEC supported Cambridge-Finch multi-family affordable housing built to Passive House standards.

ALTERNATIVE TRANSPORTATION JOBS

Massachusetts' Electric Vehicles workforce continues to grow, adding **1,227** jobs for a growth rate of **39%**. The state experienced a higher rate of Electric Vehicle job growth relative to the U.S. as a whole, which increased by only **27%** over the same time. The Commonwealth ranked **3rd** for the highest growth rate and **6th** for the total number of new Electric Vehicle jobs created in the United States.



¹¹ 2023 job numbers represented in this report are based on the 2023 USEER data collection effort and represent the net change in employment between December 2021 and December 2022.



An all-electric shuttle bus providing free transportation from the Forest Hills Orange Line station to the Franklin Park Zoo.

MassCEC Spotlight

ACCELERATING CLEAN TRANSPORTATION

In Massachusetts, transportation currently produces more greenhouse gas emissions than any other sector. Residents of disadvantaged communities are more likely to be exposed to poor air quality from transportation-related emission and often lack the resources to access cleaner transportation alternatives.

MassCEC developed the Accelerating Clean Transportation for All (ACT4All) Program to pilot equity-focused transportation programs and increase access for disadvantaged communities across Massachusetts. One program was focused on increasing e-bike use in pilots across the state.



MassCEC's ACT4ALL E-Bike Projects

Cape Light Compact

- Outreach to low-income adults in **10** environmental justice communities
- Distributing **405** point-of-sale e-bike incentives with co-pay from participants

MASSBIKE

- Distributing **203** e-bikes at no cost to low-income Worcester participants
- Over **1,200** applicants have applied for e-bikes
- Focusing on biker education and community events & rides

Metro Mobility

- Distributing **215** e-bikes in Greater Boston environmental justice communities & at affordable housing developments

Pioneer Valley Planning Commission

- Distributing **135** e-bikes at no cost to participants
- Outreach focused in **3** Gateway cities & within environmental justice populations

50K+
Miles Ridden
(Around the world and more!)

56%
of e-bike rides
replace car trips

414
Bikes Distributed

25+
Metric Tons of GHG
Emissions Avoided

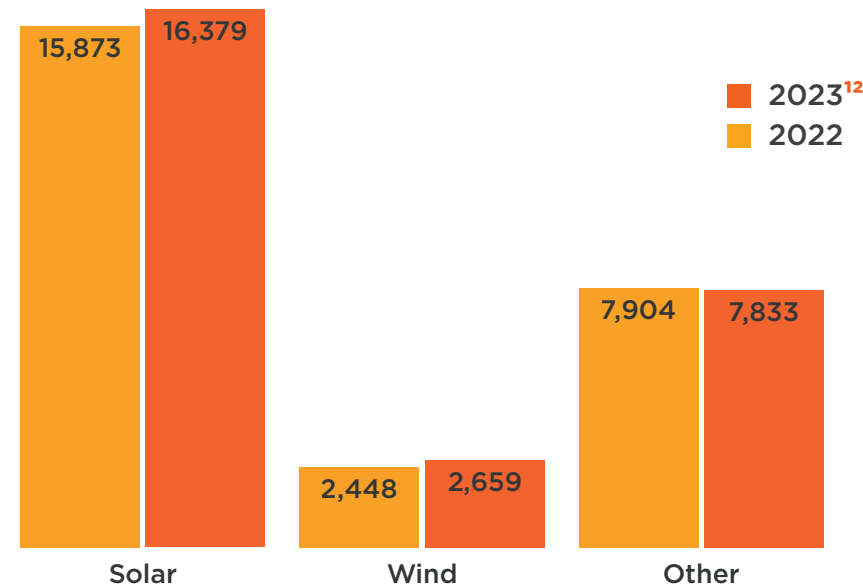


Photo courtesy of Nth Cycle

RENEWABLE ENERGY JOBS

Wind energy employment grew by **9%** between the 2022 and 2023 reports, adding **211** new jobs. This is higher than the nationwide growth in wind jobs of **5%** and slightly higher than New York's wind energy job growth of **8%**. Offshore wind-related jobs accounted for **10%** of the Wind jobs.

Massachusetts' solar industry grew by **3%** (**506** jobs), which is just slightly lower than the nationwide growth in solar jobs of **4%**.

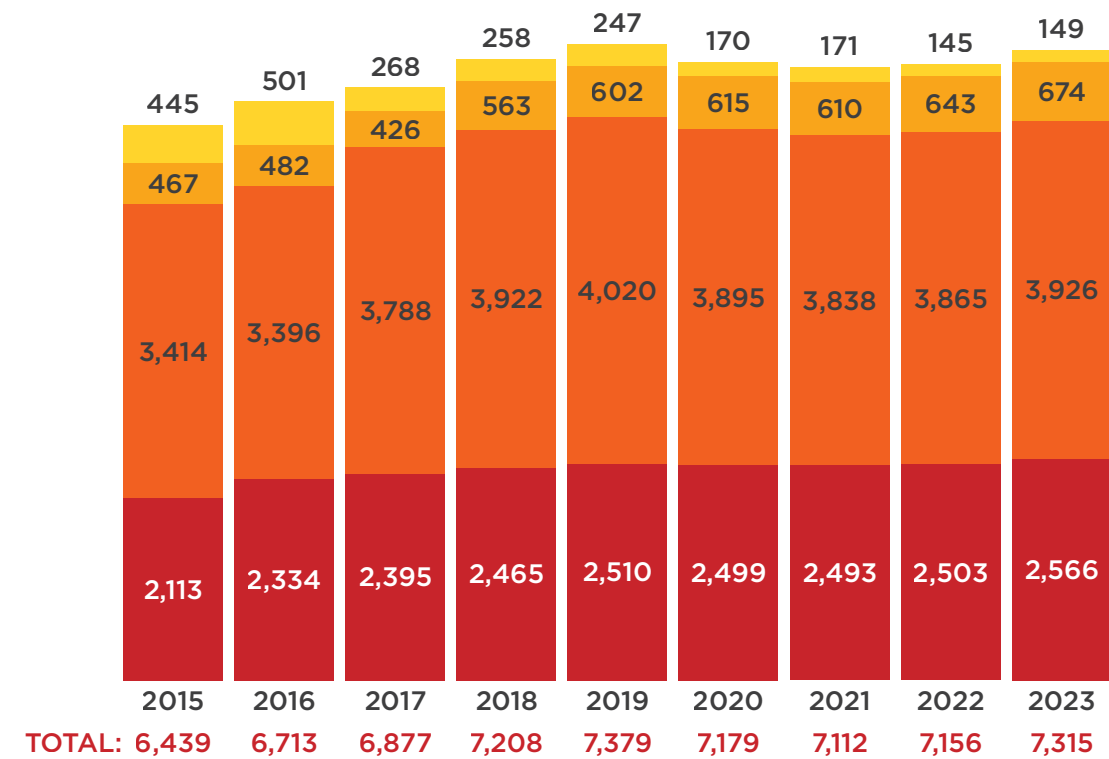


¹² 2023 job numbers represented in this report are based on the 2023 USEER data collection effort and represent the net change in employment between December 2021 and December 2022.

CLEAN ENERGY BUSINESSES

The overall number of clean energy businesses¹³ in Massachusetts increased by 159 (or 2%) relative to the year before, with the largest addition of Renewable Energy businesses, at 63. The trend has remained the same, with the majority (54%) of businesses focused on Energy Efficiency, Demand Management, and Clean Heating and Cooling.

Small businesses (1 to 10 employees) account for **58%** of all clean energy businesses, which is similar to the 2022 report. Mid-size businesses (11 to 49 employees) represent **27%** of clean energy businesses.



■ Alternative Transportation ■ Other
■ Energy Efficiency, Demand Management, and Clean Heating and Cooling ■ Renewable Energy

¹³ For the purpose of this report, a business is an establishment location. A clean energy business or firm with multiple locations would be counted multiple times in this analysis based on the number of unique locations.

7,315
clean energy
businesses in 2023

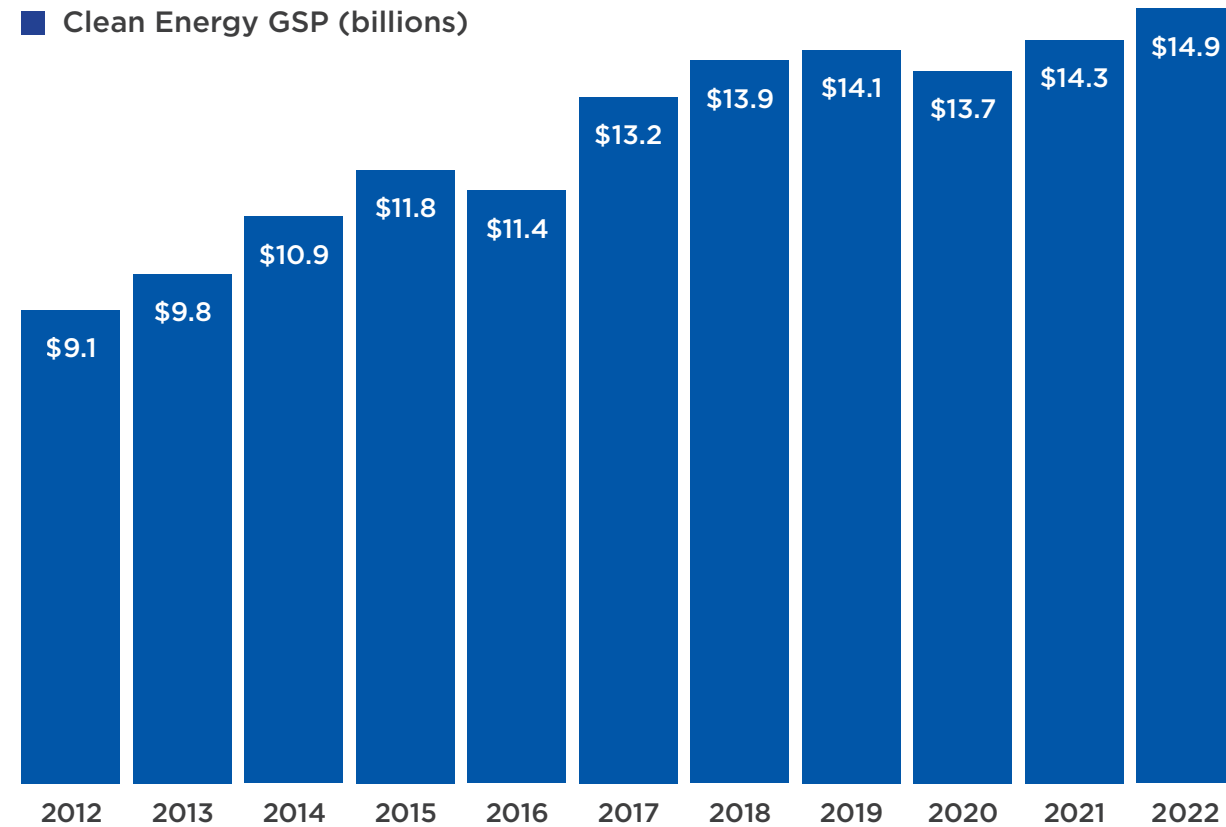


MassCEC supported Harbor Village multi-family housing, built to Passive House standards. Photo courtesy of Ken Carter, SunBug Solar.

CLEAN ENERGY GROSS STATE PRODUCT¹⁴

The direct clean energy jobs in the industry contributed **\$14.9 billion**, or roughly **2%**, to the Commonwealth's Gross State Product (GSP) in 2022. The industry's GSP increased by **63%** from 2012-2022. This outpaces overall growth in Massachusetts GSP, which grew by **55%** over the same time period. Clean energy GSP increased by **3.7%** (about **\$528 million**) between 2021 and 2022. This rate of growth is slightly less than Retail Trade, which grew by **4.6%** during the same time.

■ Clean Energy GSP (billions)

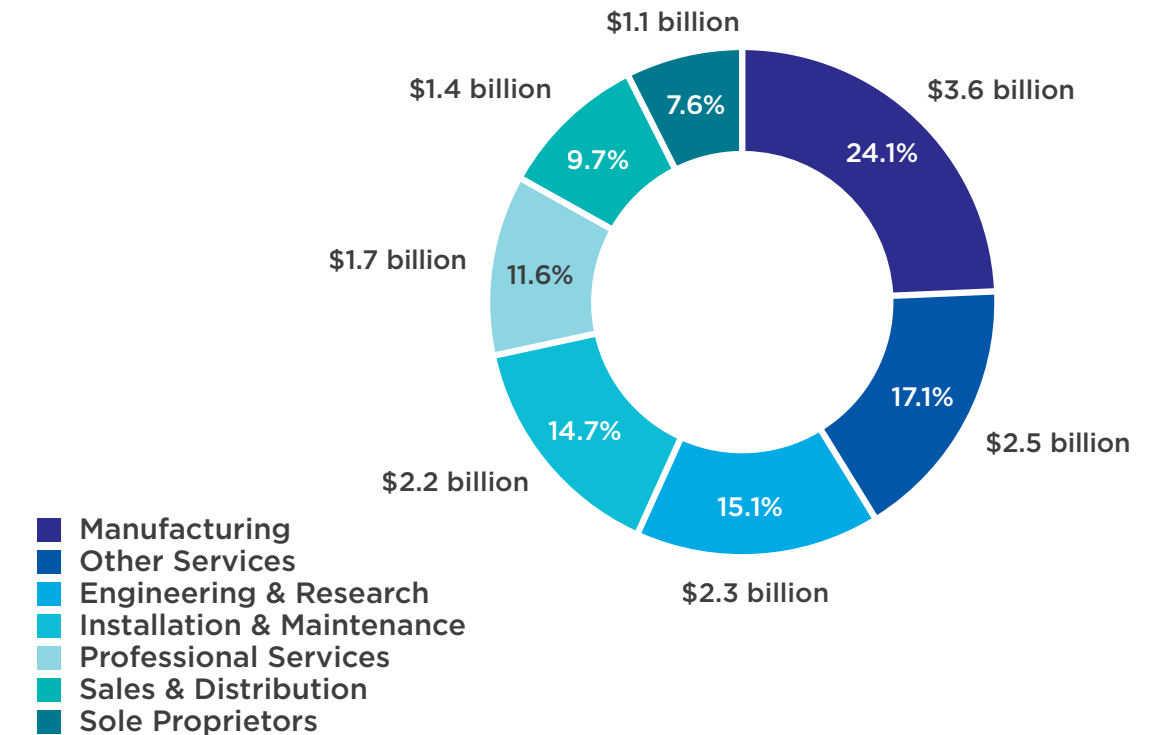


¹⁴ 2022 data is the most recent available. The clean energy GSP was derived from survey incidence rates and proportional revenue reporting, together with existing data from the Bureau of Economic Analysis, calculated by the NAICS code. Utility data and state government spending were included as direct inputs.

CLEAN ENERGY GROSS STATE PRODUCT BY VALUE CHAIN¹⁴

The contribution to the Massachusetts Clean Energy GSP by the Sales & Distribution sector grew by **10%**, and Manufacturing grew by **7%** between 2021 and 2022.

The Manufacturing sector continues to account for the largest contribution to clean energy GSP, at **24%**, or **\$3.6 billion**.

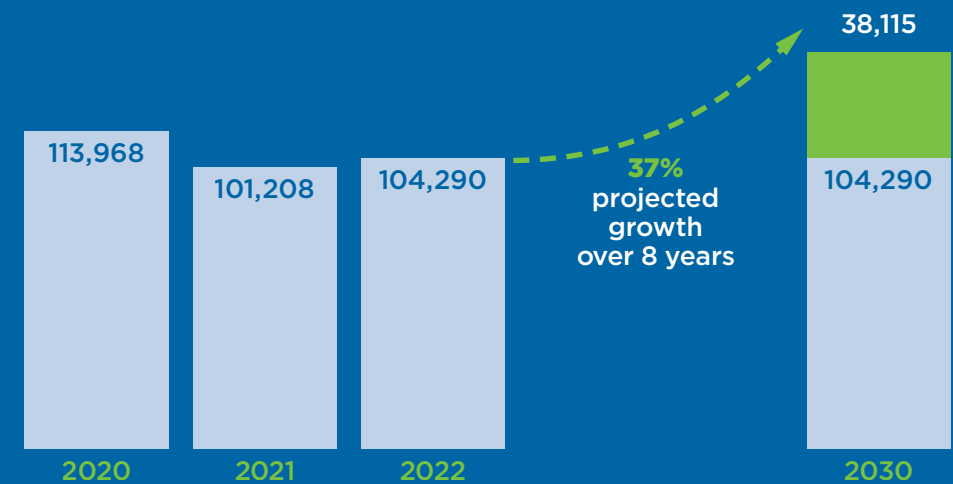


MassCEC Spotlight

MASSACHUSETTS CLEAN ENERGY WORKFORCE NEEDS ASSESSMENT

In July 2023, MassCEC released **Powering the Future: A Massachusetts Clean Energy Workforce Needs Assessment**. This report provides a comprehensive analysis of the clean energy workforce needed to meet the state's ambitious 2030 decarbonization goals, coupled with strategies to expand and diversify the clean energy workforce.

CLEAN ENERGY EMPLOYMENT (2022 - 2030)¹⁵



¹⁵Source: Powering the Future: A Massachusetts Clean Energy Workforce Needs Assessment, bit.ly/CleanEnergyWorkforce

Major findings of the report:

38,000+ additional clean energy workers are needed to meet the state's 2030 decarbonization goals (**37%** growth)

89% of employers report difficulty finding workers in this tight labor market

82% of clean energy jobs created by 2030 will be middle- to high-wage jobs, with a median hourly wage of **\$36.58** (based on today's dollar)

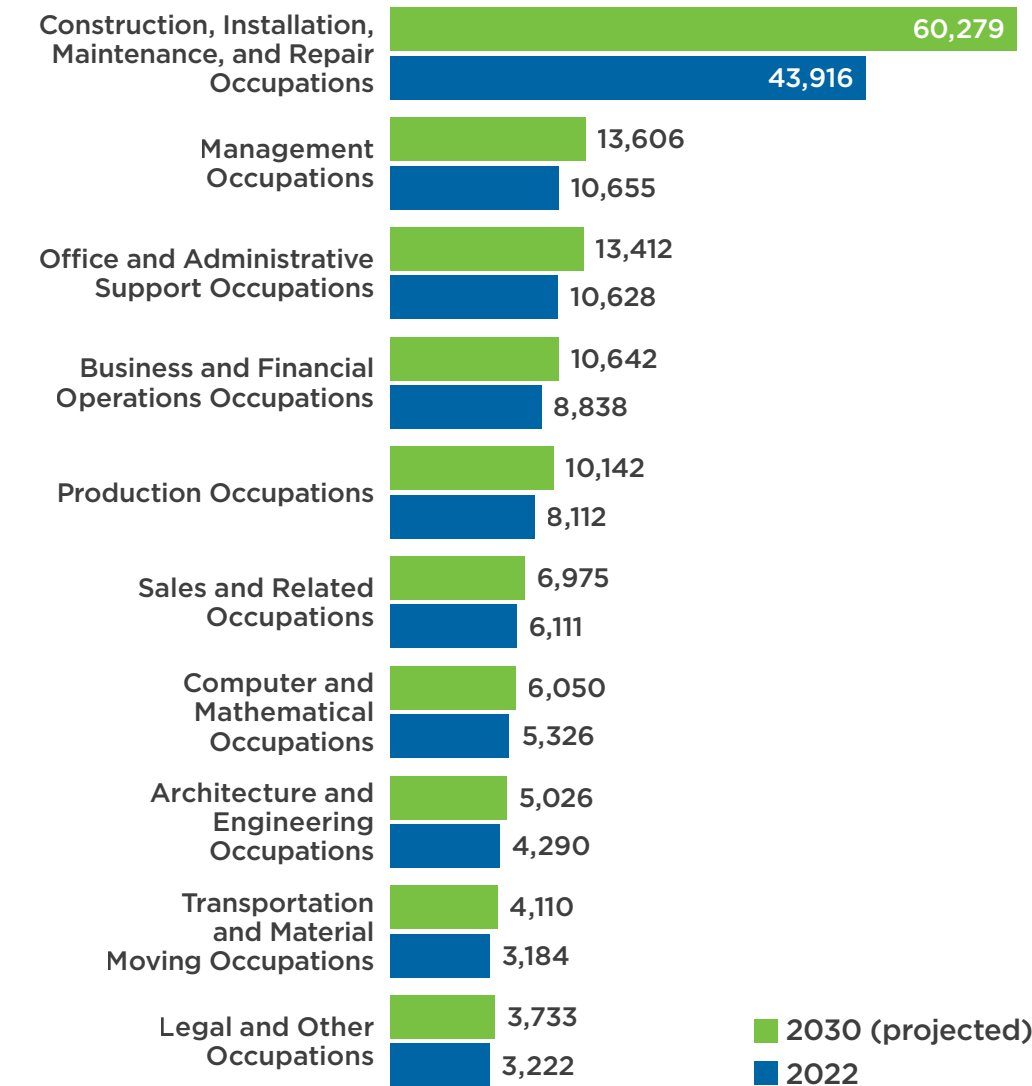
60% of all new clean energy jobs will be in the Energy Efficiency, Demand Management, and Clean Heating and Cooling sector

61% of new clean energy jobs are projects to be located outside of Route 128

Top Five Report Highlights and Recommendations

- #1** Expanding clean energy career awareness is a crucial first step to growing and diversifying the pipeline for tomorrow's climate-critical workers.
- #2** Scaling clean energy workforce training capacity will require leveraging existing systems and programs, prioritizing quality and effectiveness, and funding new or enhanced programs to address gaps and barriers.
- #3** A just transition that provides economic opportunity and advancement to historically marginalized populations is critical to meeting the demand for clean energy workers. This includes supporting opportunities for fossil fuel workers to transition into comparable clean energy roles.
- #4** Workforce development strategies must be tailored to regional considerations, including local occupations most in demand, infrastructure needs, and obstacles to transition.
- #5** While the report projects clean energy job growth across over 140 occupations, 65% of growth will be concentrated within 20 occupations. Some occupations will require considerable additional support to reduce the risk of a workforce bottleneck. At the same time, there will be opportunities for prospective workers of any interest to plug into the clean energy industry.

CURRENT AND PROJECTED CLEAN ENERGY EMPLOYMENT BY OCCUPATIONAL ROLE¹⁶



¹⁶ These categories are based on U.S. Bureau of Labor Statistics (BLS) Occupational groups. Descriptions of each group and associated occupations can be found at https://www.bls.gov/soc/2018/major_groups.htm. Construction, Installation, Maintenance and Repair Occupations is the combination of "Construction Occupations" and "Installation, Maintenance and Repair Occupations." These categories were combined due to the similarity in their skills and work tasks.

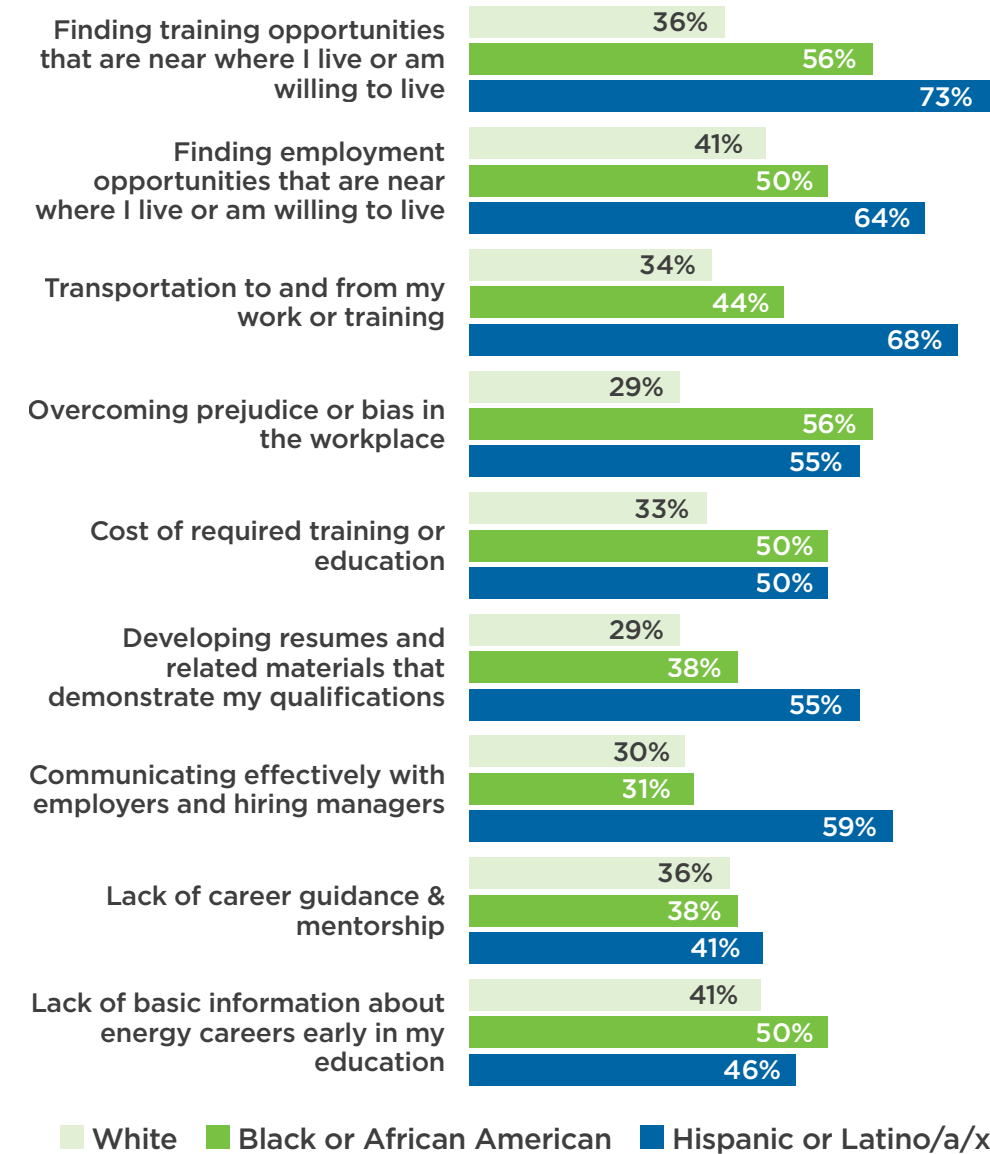
MASSACHUSETTS CLEAN ENERGY WORKFORCE NEEDS ASSESSMENT

The report found that while most clean energy workers surveyed faced some barriers to entry, female and non-white respondents were more likely to face barriers across multiple categories.

There are many approaches that can reduce barriers to entry into the clean energy industry for prospective workers. Among them, expanding access to accurate, engaging, and comprehensive information about clean energy career pathways is essential to driving career awareness, especially for underrepresented populations in the industry. Future investments in training capacity should focus on expanding access to training opportunities and enhancing outreach and support services. Efforts to engage clean energy businesses to deploy inclusive hiring practices and a welcoming and supportive work environment can support increasing worker retention and diversity in the industry.

Additionally, some persistent barriers, such as lack of reliable transportation, will require a whole government approach to effectively address.

BARRIERS TO ENTRY INTO CLEAN ENERGY BY RACE AND ETHNICITY¹⁷



¹⁷ Since respondents to this survey are workers who successfully entered the clean energy space, the results may contain a "survivorship bias." The barriers and intensity of those barriers may differ for populations who are, or could be, interested in clean energy careers but have not enter the industry.



The report includes a gap analysis of ten high-growth occupations, a regional gap analysis, best practices for clean energy workforce development, and a companion Excel data workbook.

Report link: bit.ly/CleanEnergyWorkforce

CLEAN ENERGY TALENT IS NEEDED

As of December 2022, **89%** of employers reported that it was “very difficult” or “somewhat difficult” to find qualified talent, an increase from **85%** just prior to the pandemic. The percentage of employers reporting that it was very difficult to find qualified talent was **35%** in December 2022.

According to surveyed employers, approximately **71%** of clean energy workers who were hired between December 2021 and December 2022 filled positions that required previous work experience. About **59%** of these job hires filled newly created positions. The education credential requirements for the filled positions ranged, but almost half (**49%**) required a bachelor’s degree or higher. Alternatively, according to a recent MassCEC report, between now and 2030, clean energy employers will require a range of new workers across 140+ occupations, many of which will require less than a 4-year degree for entry.¹⁸

¹⁸ Source: “Powering the Future: A Massachusetts Clean Energy Workforce Needs Assessment,” Massachusetts Clean Energy Center, July 2023, bit.ly/CleanEnergyWorkforce

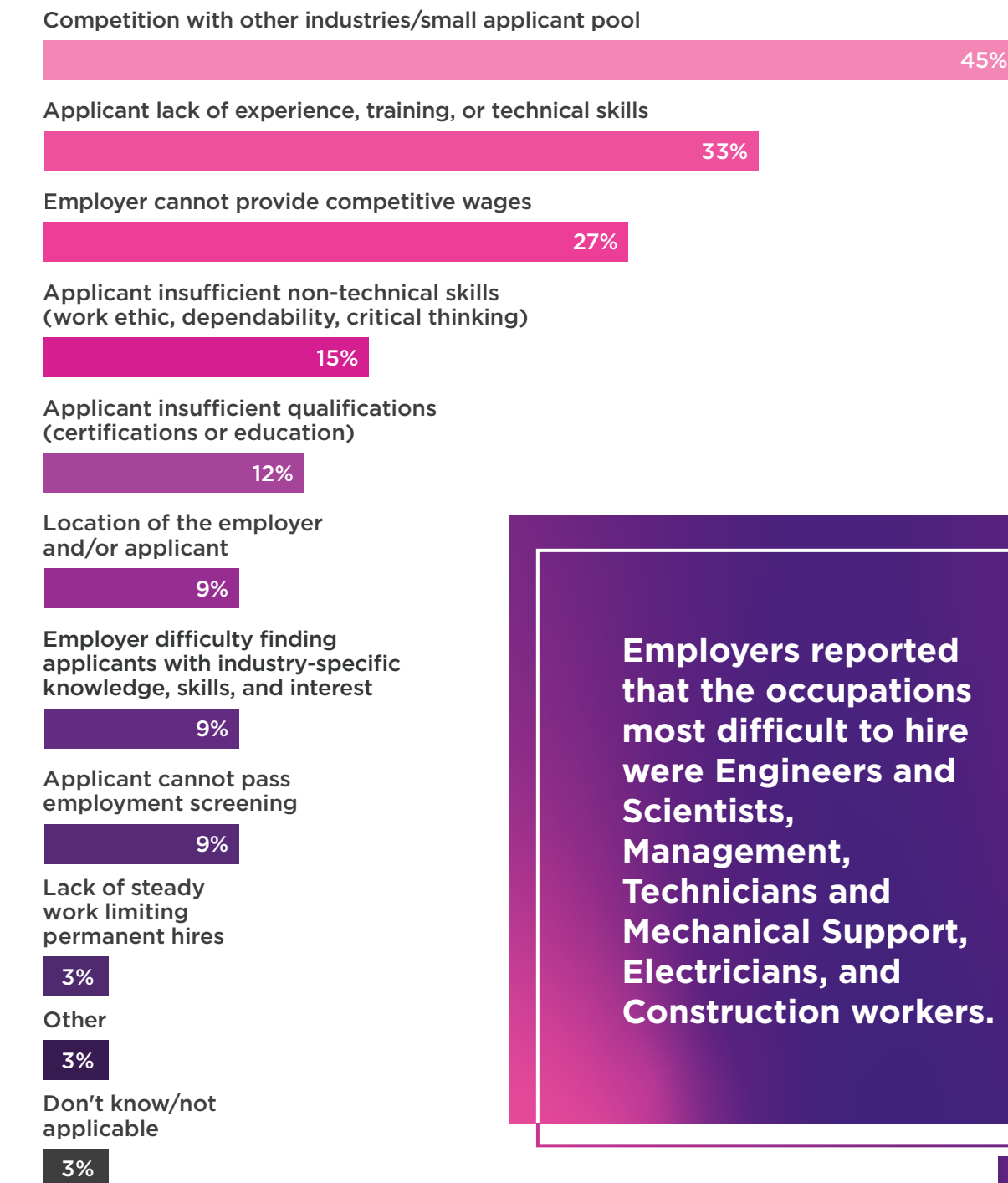


REASONS FOR HIRING CHALLENGES

The most common reason cited by clean energy employers (**45%**) for reported hiring difficulty was competition with other industries for potential hires or a small applicant pool. Additionally, **33%** of employers pointed to a lack of experience, training, or technical skills of applicants as a cause for their hiring challenges.

CAUSES FOR CLEAN ENERGY EMPLOYER HIRING DIFFICULTY

REPORT YEAR 2023



Employers reported that the occupations most difficult to hire were Engineers and Scientists, Management, Technicians and Mechanical Support, Electricians, and Construction workers.

MassCEC Spotlight

BUILDING THE CLEAN ENERGY WORKFORCE PIPELINE

To meet the Commonwealth's 2030 decarbonization goals, the Massachusetts clean energy workforce will need to grow by an additional 38,000 more workers.¹⁹ To support the growth of a robust, diverse clean energy workforce needed to meet this demand, MassCEC's Workforce Development programs:

- Increase awareness and effective skill preparation for critical clean energy occupations
- Support the creation, expansion, and enhancement of climate-critical training programs
- Create opportunities for workers and businesses to transition into the industry
- Expand the opportunity for registered apprenticeships and other on-the-job training opportunities
- Increase workforce diversity and eliminate barriers to entry
- Support women and minority businesses

MassCEC's Clean Energy Internship Program

Massachusetts clean energy businesses, many of which are small, need help accessing robust talent pipelines to remain competitive with more established industries with stronger career awareness. To address this challenge, MassCEC developed the Clean Energy Internship program to expand paid career exploration and on-the-job training opportunities among students while also providing clean energy employers with an active marketplace to discover talent and subsidize internships.

¹⁹ MassCEC's Massachusetts Clean Energy Workforce Needs Assessment: <https://www.masscec.com/resources/massachusetts-clean-energy-workforce-needs-assessment>

Program Results



5,800+ Internships Supported



620+ Unique Employers



65% of Participants are Women and Minorities



\$26.5M+ Awarded and \$6.8M+ Leveraged

Broader Impacts



1,030+ Interns Hired Permanently



Resource for employers to access and hire diverse candidates



Access to diversity, equity, and inclusion training



Collaborating to Expand Clean Energy Career Awareness

Expanding clean energy career awareness is crucial to growing and diversifying the pipeline for tomorrow's clean energy workforce. To help address this challenge, MassCEC partnered with the Massachusetts Executive Office of Education, the Executive Office of Energy and Environmental Affairs, and the Department of Elementary and Secondary Education to create a new Clean Energy Innovation Pathway to provide high school students with applied, hands-on learning opportunities in the clean energy sector. Participating students will have access to interactive curricular resources, opportunities for career pathway mapping, and experiential learning in the field.

Broader Impacts

For the launch year, six high schools across the Commonwealth will plan new Clean Energy Innovation Pathways to increase awareness of clean energy careers, support the next generation of climate leaders, and join the nearly 200 high schools across the Commonwealth using Innovation Career Pathways to introduce students to in-demand careers.

“MassCEC's Clean Energy Internship Program has a generational impact on clean energy careers and enables talented students to stay in Massachusetts.”

—Matthew Nordan, Managing Director at Azolla Ventures



CLEAN ENERGY WORKER DEMOGRAPHICS²⁰

The representation of workers by demographic group as a percentage of the clean energy workforce remained roughly unchanged from the 2022 to 2023 reports. There was a **7%** increase in female workers compared to a **3%** increase in male workers in absolute numbers over the same time period. Additionally, there was an **8%** increase in the number of workers over the age of 55. While there was a slight increase in the number of jobs in the majority of the other demographic groups, the number of American Indian or Alaskan Natives and Native Hawaiian or other Pacific Islanders decreased from the 2022 to 2023 reports.

The state is committed to supporting individuals in environmental justice neighborhoods and disadvantaged populations to get the education and training needed to access high-paying occupations in clean energy and enabling minority and women-owned business enterprises to access the resources needed to pivot and grow as employers in the clean energy industry.

²⁰ Data for age, race, ethnicity, and gender: <https://www.bls.gov/lau/table14full22.htm>. Population percentages for American Indian or Alaska Native, Native Hawaiian or other Pacific Islanders, or Two or more races were used due to lack of BLS data: www.jobseq.com. Veterans' employment: <https://www.bls.gov/news.release/vet.t06a.htm> & BLS QCEW 2022 Annual Employment for Massachusetts.

	2023 Clean Energy Employment	Percent of 2023 Clean Energy Workforce	Percent of 2023 Overall MA Workforce
Male	74,402	68.6%	51.4%
Female	34,048	31.4%	48.6%
Hispanic or Latino/a/x	17,130	15.8%	12.3%
Not Hispanic or Latino/a/x	91,320	84.2%	87.7%
White	80,322	74.1%	79.4%
Black or African American	8,660	8.0%	8.6%
Asian	9,056	8.4%	7.3%
American Indian or Alaska Native	1,174	1.1%	0.2%
Native Hawaiian or other Pacific Islanders	817	0.8%	0.0%
Two or more races	8,422	7.8%	4.4%
Veterans	9,956	9.2%	3.4%
Workers over the age of 55	15,981	14.7%	26.0%

CLEAN ENERGY WAGES

Of the projected clean energy jobs to be created between 2022 and 2030, **82%** will have wages that are greater than the statewide median hourly wage of \$27.22. The clean energy jobs created by 2030 will have a median hourly wage of **\$36.58**, based on today's dollars.²¹



Photo courtesy of Enel North America

WAGES FOR A SUBSET OF CLEAN ENERGY OCCUPATIONS IN MA, 2022²¹

	Average Entry-Level Hourly Wages	Median Hourly Wages	Average Experienced Hourly Wages	Average Hourly Wages
Massachusetts Average	\$17.76	\$28.14	\$46.96	\$37.22
Occupations:				
Carpenters	\$23.08	\$31.01	\$39.22	\$33.84
Construction Managers	\$41.46	\$59.43	\$74.49	\$63.48
Electrical Engineers	\$39.32	\$62.51	\$75.41	\$63.38
Electricians	\$24.19	\$38.67	\$48.14	\$40.15
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	\$24.56	\$34.68	\$40.11	\$34.93
Insulation Workers	\$19.98	\$28.19	\$35.27	\$29.84
Mechanical Engineers	\$35.59	\$50.50	\$62.53	\$53.55

²¹ Source: "Powering the Future: A Massachusetts Clean Energy Workforce Needs Assessment," Massachusetts Clean Energy Center, July 2023, bit.ly/CleanEnergyWorkforce

Demographic representation in many of the highest-paying clean energy occupations is not equal. The disproportionately high representation of people of color among some of the more physically demanding roles, such as insulation workers, contributes to the overall diversity of the clean energy workforce, but masks other instances of inequality. Women are underrepresented industry-wide, particularly in many high-growth occupations, such as Electricians, in which just over **2%** are women.

DEMOGRAPHIC REPRESENTATION FOR A SUBSET OF CLEAN ENERGY OCCUPATIONS IN MA, 2022²²

	Carpenters	Construction Managers	Electrical Engineers	Electricians	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	Insulation Workers	Mechanical Engineers
Female	3.5%	8.1%	7.2%	2.2%	2.3%	6.2%	7.6%
Male	96.5%	91.9%	92.8%	97.8%	97.7%	93.8%	92.4%
Hispanic or Latino/a/x	26.6%	7.4%	2.4%	14.4%	13.5%	36.4%	5.2%
White	87.2%	91.4%	72.8%	89.2%	86.1%	79.1%	80.3%
Black or African American	4.6%	3.3%	2.0%	6.1%	8.3%	17.2%	1.3%
American Indian or Alaska Native	0.4%	0.2%	0.0%	0.2%	0.1%	0.2%	0.1%
Asian	2.1%	2.5%	24.3%	2.2%	1.7%	0.0%	16.7%
Native Hawaiian or other Pacific Islanders	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Two or more races	5.7%	2.6%	0.8%	2.2%	3.8%	3.5%	1.7%
Workers over the age of 55	23.6%	31.5%	27.5%	22.6%	21.8%	16.4%	28.5%

²² Source: JobsEQ® www.jobseq.com. Accessed July 2023. Occupation Wages, Average Hourly in Massachusetts, 2022Q4 & Occupation Diversity, in Massachusetts, 2022Q4, based on place of residence estimates

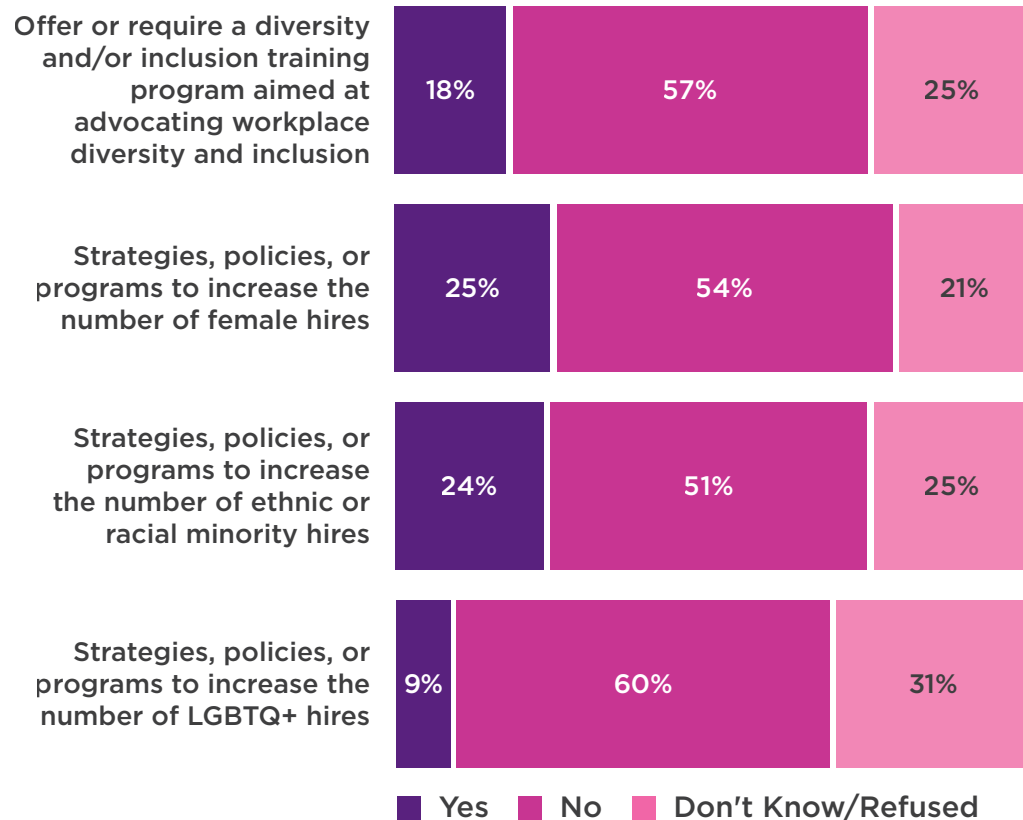


DIVERSITY CONSIDERATIONS

Of the organizations surveyed, **25%** have strategies, policies, or programs to increase the number of female hires, **24%** have the equivalent to increase the number of ethnic or racial minority hires, while only **9%** reported having the equivalent to increase the number of LGBTQ+ hires.

Employers utilize a variety of methods to increase diversity among workers, with targeting schools or conducting outreach being the most common strategy.

EMPLOYERS WITH STRATEGIES TO INCREASE DIVERSITY AMONG WORKERS REPORT YEAR 2023

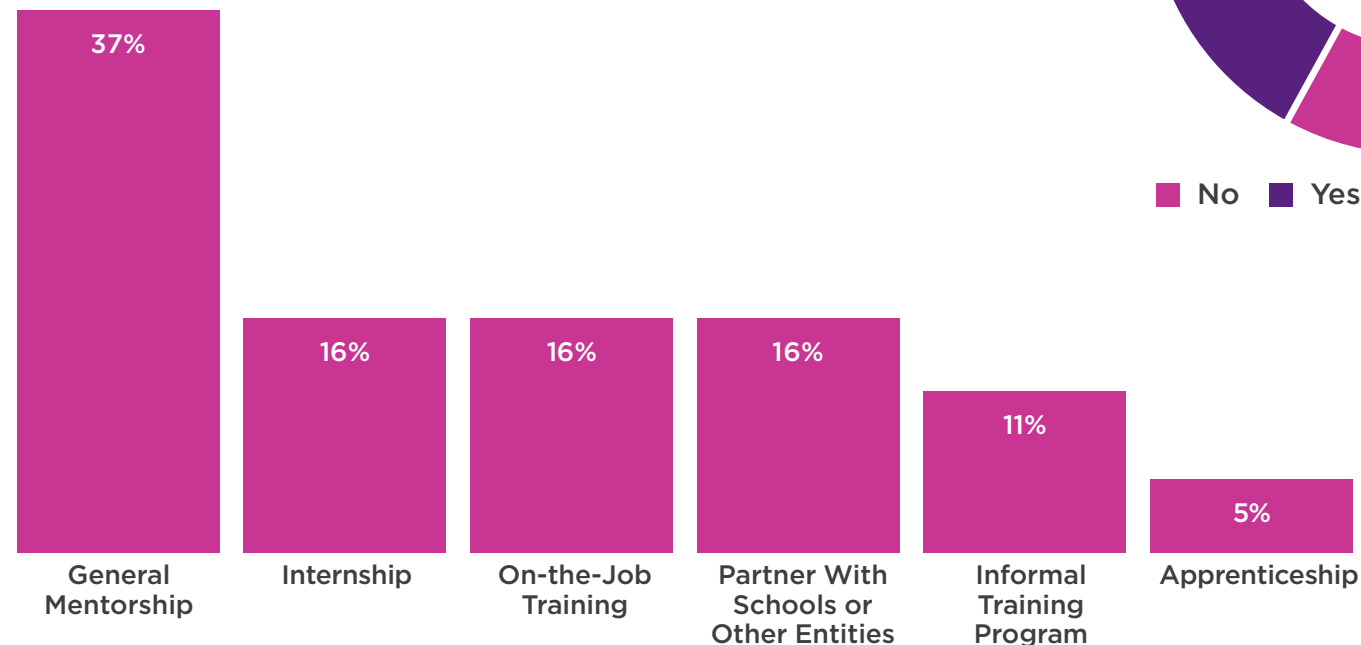


EMPLOYER SUPPORT PROGRAMS

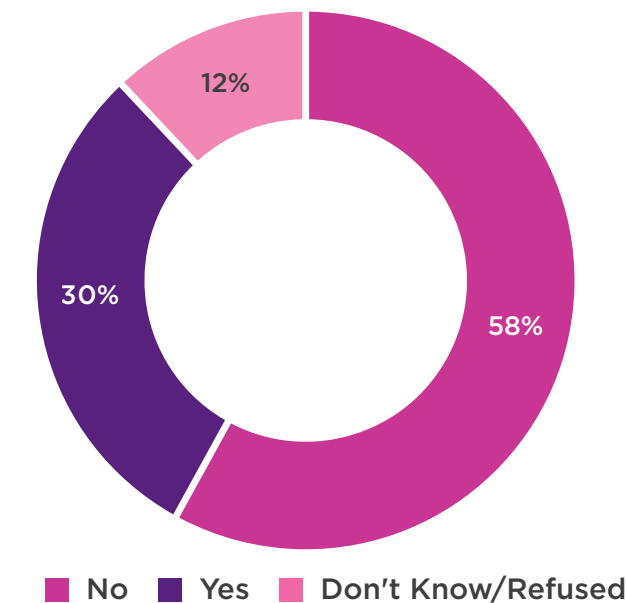
Only **30%** of clean energy businesses reported having formal or informal mentorship/sponsorship programs for employees. Of those businesses, the most common program to offer is a general mentorship program (**37%**), and the least common is an apprenticeship program (**5%**).

Increasing registered apprenticeships is important, as it is a proven model for improving access to careers and is supported financially at the state and federal level.²³

EMPLOYER MENTORSHIP OR SPONSORSHIP PROGRAMS REPORT YEAR 2023



PERCENTAGE OF EMPLOYERS WITH A MENTORSHIP OR SPONSORSHIP PROGRAM REPORT YEAR 2023



²³ <https://www.apprenticeship.gov/inflation-reduction-act-apprenticeship-resources>

MassCEC Spotlight

INCREASING EQUITY IN THE CLEAN ENERGY INDUSTRY

To achieve and sustain the Commonwealth’s climate goals, Massachusetts needs a robust, well-trained, and inclusive clean energy workforce. MassCEC’s Equity Workforce Planning, Capacity, Implementation, and Minority and Women Business Enterprise grants address the need for increased clean energy industry knowledge and provide quality technical assistance to environmental justice-serving organizations. The funding and corresponding support assist organizations in providing climate-critical training opportunities and wrap-around support services to increase placement and retention of residents in environmental justice neighborhoods, underrepresented populations, minority and women business enterprises, and former fossil fuel workers into clean energy career pipelines.

MassCEC Equity Workforce Planning, Capacity, and Implementation Grant Program

Initial Program Highlights



Awarded grants to train 700+ participants



37 Planning & Capacity Grants awarded



Awarded grants to provide support services to 350+ minority and women-owned business enterprises



\$18.3M Awarded

Broader Impacts



Connecting community organizations, training providers, and employers



Help minority & women business enterprises access new work



Leverage additional state and federal funding for community benefit

“MassCEC provided quality assistance during our planning phase, including immediate responses to our questions, helpful feedback on our training strategies, and assistance describing our plan to local and state leadership. This type of technical assistance is particularly important as we work to plan training, and place our tight labor market supply into the clean energy sector.”

— Mary Sarris, Executive Director, MassHire North Shore Workforce Board, MassCEC Equity Workforce Planning Grantee



In addition to workforce development programs, MassCEC takes a broader approach to increasing equitable access to the benefits of clean energy. Low-income Massachusetts households spend a disproportionately high percentage of their income on energy, and renters, low-income, and non-English-speaking households are less likely to use energy efficiency incentives. Similarly, solar adoption lags for renters and minority communities. And yet, all residents need and deserve to be part of our collective clean energy future. MassCEC’s EmPower Massachusetts Program offers multiple stages of investment in communities and community-based organizations to explore, develop, and implement program models or projects that provide access to the benefits of clean energy for previously underserved populations.

MassCEC’s EmPower Massachusetts Program

Initial Program Results



68 Community campaigns supported



157 Community organization partners



\$5M+ Awarded

Broader Impacts



Crowd-sources new and innovative ideas from groups deeply familiar with their local communities then implements initiatives to increase access to the benefits of clean energy for underserved populations.

CLEAN ENERGY INVESTMENTS

A robust innovation network is a key driver of the Massachusetts clean energy industry. Innovation support can take numerous forms, including ecosystem support, grants, and direct company investments.

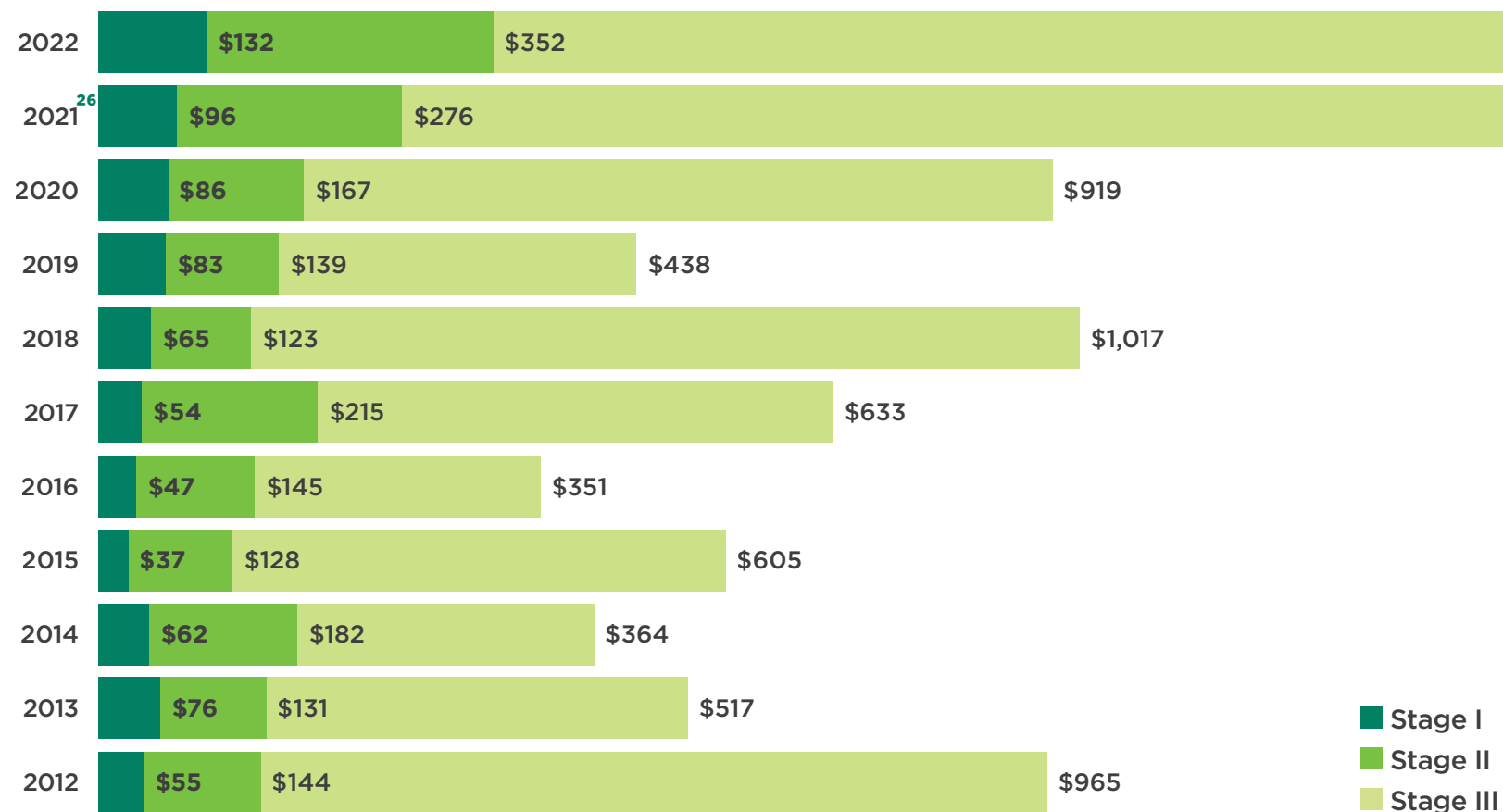
Investments in clean energy companies can fall into three key segments:²⁴

Stage I: Research & Prototyping – Companies at the ideation, theoretical research, and prototype development stage.

Stage II: Demonstration & Acceleration – Companies at the product testing, system evaluation, and market research stage.

Stage III: Commercialization & Growth – Companies that are expanding manufacturing capacity and identifying early-stage customers.

Total Massachusetts Clean Energy Investments (millions)²⁵



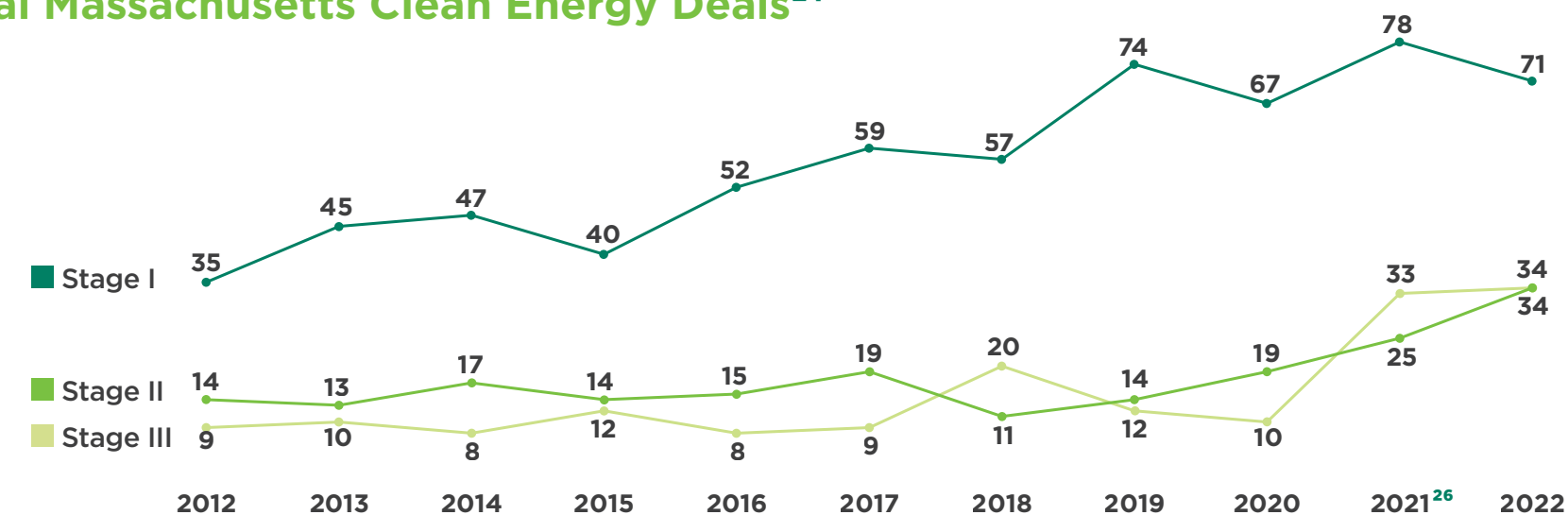
²⁴ The numbers of deals and amounts invested in each of these segments may vary from previous years' reports, owing to changes in methodology and delays before investments become public.

²⁵ PitchBook Data, Inc. These data have not been reviewed by PitchBook analysts.

²⁶ \$1.8 billion Series B investment was excluded from 2021 data as a significant outlier that would otherwise have obscured the picture.

The picture is mixed for Massachusetts climate venture capital, with an overall flattening after the rapid growth of 2021 and a fall in the number of Stage I deals. While the local ecosystem has proved more resilient than the venture capital market more broadly, there may be early signs of an investor retreat, especially from risky early-stage ventures, with firms committing more capital to Stage II deals in more established companies. Anecdotal evidence suggests that this trend has continued into 2023.

Total Massachusetts Clean Energy Deals²⁴



MassCEC Spotlight

MASSCEC INVESTMENTS PORTFOLIO

Seed and early-stage clean energy companies face funding gaps that threaten their path to reaching the market. MassCEC provides debt and equity investments in the most promising early-stage companies, signaling to the public and private market that Massachusetts is committed to the commercialization of clean energy technologies and business models. These investments support clean energy companies as they de-risk technology, reach early commercial milestones, and attract growth funding.



Boston Materials developed a patented Z-axis Fiber technology that enables

lightweight, high-performance materials with significant energy-efficiency benefits for the automotive, aerospace, and electronics markets. Alongside innovation and workforce development grants, MassCEC made an early investment in Boston Materials through the BRIDGES program in 2020. The company has gone on to raise larger sums from venture capital and strategic investors, including a \$12M Series A round in November 2022. It is expanding its manufacturing facility and headquarters in Billerica as it aims for commercial production.



VIA SEPARATIONS

Via Separations provides high-performance graphene oxide membranes that enable more

efficient industrial processes. Via Separations has been a grantee of MassCEC's innovation and workforce programs and received an initial MassCEC investment in April 2019 as part of a Series A fundraising round. MassCEC's support enabled the company to leverage additional funding, and two years later, Via raised a \$32M Series B round. In 2022, Via was one of the clean energy companies selected by the US Department of Energy for their SCALEUP Grant and was awarded just under \$10M. Via plans to deploy a new membrane module for industrial manufacturing, targeting a 90% reduction in energy costs.

MassCEC's clean energy company investments have yielded



\$1.3B
Leveraged Capital



62M+
Metric Tons
CO2e Avoided



500+
Jobs Created

MassCEC Spotlight

MASSCEC SUPPORT FOR INNOVATION

Innovation in the clean energy industry is crucial for Massachusetts to meet its climate goals faster and more cost-effectively. MassCEC's role in supporting innovation is countercyclical and more stable than the venture capital sector, helping to accelerate the rate of innovation. Additionally, MassCEC's efforts stimulate more private sector spending in innovation while also bridging critical funding gaps.

MassCEC provides funding and mentorship to climatetech startups, researchers, incubators, and accelerators.

Goals

- Stimulate the commercialization of early-stage, promising, clean energy technologies.
- Support technological innovation
- Foster a just energy transition by supporting diverse founders
- Provide critical and timely funding and mentorship during company formation and technology development
- Attract early-stage clean energy startups to Massachusetts
- Enable accelerators and incubators to provide the clean energy industry with valuable and complementary resources to MassCEC

Since 2010 MassCEC's Technology Development and Innovation Program has facilitated:



89%
Startup awardees still in business



6,148
New hires



\$42.5M
Awarded



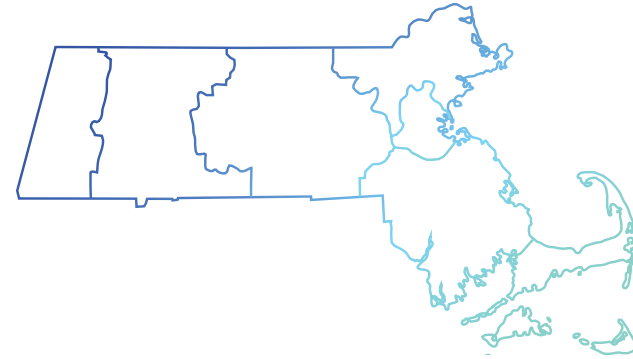
\$194M
Leveraged



405
Awards

REGIONAL ANALYSIS

The Berkshire, Cape Cod, and Central Mass Workforce Skills Cabinet (WSC) regions all saw **5%** growth in clean energy jobs between the 2022 and 2023 report. Additionally, the Berkshire WSC region experienced a **7%** growth in clean energy businesses over the same time period.²⁷



Clean Energy Jobs And Businesses In Massachusetts Workforce Skills Cabinet Regions

		2022 Report	2023 Report	2022-2023 Report Change	Percent of Total Clean Energy Jobs/Businesses in 2023	Percent of Total Jobs/Businesses in Region
Berkshire	Employment	2,982	3,129	4.9%	2.9%	5.0%
	Businesses	214	229	7.0%	3.1%	4.0%
Cape Cod	Employment	5,309	5,579	5.1%	5.1%	4.5%
	Businesses	444	456	2.7%	6.2%	3.5%
Central Mass	Employment	17,073	17,987	5.4%	16.6%	4.8%
	Businesses	1,254	1,274	1.6%	17.4%	4.4%
Greater Boston	Employment	37,071	38,448	3.7%	35.5%	2.2%
	Businesses	2,199	2,242	2.0%	30.6%	2.1%
Northeast	Employment	10,608	11,001	3.7%	10.1%	2.4%
	Businesses	709	718	1.3%	9.8%	1.9%
Pioneer Valley	Employment	9,583	9,870	3.0%	9.1%	3.2%
	Businesses	727	748	2.9%	10.2%	2.6%
Southeast	Employment	21,664	22,436	3.6%	20.7%	3.8%
	Businesses	1,609	1,648	2.4%	22.5%	3.4%

²⁷ Source: JobsEQ® www.jobseq.com. Accessed July 2023. Data Explorer, Industry Data, 4-quarter moving average employment in Massachusetts, 2021 & 2022. Establishment data is only available at the county level, and the WSC regions are determined by zip code. Some counties fall within multiple WSC regions, so establishment data from the county level is allocated proportionally between the multiple WSC regions based on employment data per region at the zip code level.

STATE-BY-STATE COMPARISON

Massachusetts continues to be a leader in clean energy jobs relative to other states in several categories. The Commonwealth ranks **2nd** for total number of clean energy jobs as a percentage of total employment in the state.

STATE CLEAN ENERGY JOB RANKINGS, REPORT YEAR 2023²⁸

TOTAL STATE CLEAN ENERGY JOBS

1	California	501,314
2	Texas	232,731
3	Florida	157,025
4	New York	157,010
5	Illinois	113,811
6	Massachusetts	108,450
7	Michigan	100,966
8	North Carolina	98,914
9	Ohio	98,375
10	Virginia	90,083

TOTAL CLEAN ENERGY JOBS PER CAPITA

1	Vermont	2.2%
2	District of Columbia	2.1%
3	Massachusetts	1.6%
4	Wyoming	1.4%
5	Utah	1.3%
6	Rhode Island	1.3%
7	Maryland	1.3%
8	California	1.3%
9	South Dakota	1.3%
10	Oregon	1.3%

TOTAL CLEAN ENERGY JOBS AS A PERCENTAGE OF TOTAL STATE EMPLOYMENT

1	Vermont	4.7%
2	Massachusetts	3.0%
3	Maryland	3.0%
4	Wyoming	2.9%
5	Rhode Island	2.9%
6	California	2.8%
7	Oregon	2.7%
8	Delaware	2.6%
9	Utah	2.5%
10	South Dakota	2.5%

²⁸ These employment values were calculated based on the Massachusetts clean energy definition, which may vary from the definitions of other states or organizations. For example, Massachusetts does not include traditional hydropower, traditional HVAC, or corn ethanol in its clean energy definition, while other states and organizations may. This was done for consistency so that employment values could be compared across states.

METHODOLOGY

The Massachusetts 2023 Clean Energy Industry Report uses publicly available data from the 2023 U.S. Energy and Employment Report (USEER)²⁹ on Massachusetts energy employment produced by BW Research Partnership on behalf of the Department of Energy (DOE). These public data are refined and customized for Massachusetts based on additional analyses conducted by BW Research Partnership on behalf of the Massachusetts Clean Energy Center.

The 2023 USEER survey in Massachusetts was administered by telephone, with approximately 29,400 outbound calls in Massachusetts, as well as by web, with more than 12,600 emails sent to potential participants across the state.

In total, **1,147** business establishments in Massachusetts participated in the survey effort, with **402** providing full responses to the survey. These responses were used to develop incidence rates among industries as well as to apportion employment across various industry categories in ways currently not provided by state and federal labor market information agencies. The margin of error is +/- 4.87 percent at a **95** percent confidence level.

See the full Expanded Methodology for more details on the 2023 Massachusetts Clean Energy Industry Report.³⁰

²⁹ The full 2023 USEER report can be found at: <https://www.energy.gov/policy/us-energy-employment-jobs-report-useer>

³⁰ The online version of the 2023 Clean Energy Industry Report and the Expanded Methodology can be found at: <http://masscec.com/reports/industry-2023/#methodology>



MassCEC's New Bedford Marine Commerce Terminal (NBMCT) in New Bedford, MA

GLOSSARY

Activity

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

Alternative Transportation

Alternative Transportation includes non-fossil fuel-related vehicles. This includes electric passenger or freight cars, trucks, or buses that use electric drive systems and electric motors for propulsion.

Clean Energy

Clean Energy is defined as any technology that either reduces or eliminates greenhouse gas emissions from the generation, distribution, and consumption of electricity and fuels. The major sectors of the clean energy industry include Renewable Energy Generation; Energy Efficiency, Demand Management, and Clean Heating and Cooling; and Alternative Transportation.

Clean Energy Business or Establishment

For the purpose of this report, a clean energy business or establishment is a business location in Massachusetts with at least one employee involved with an activity related to the clean energy industry.

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, and/or Electric or Hybrid Vehicles.

Clean Heating and Cooling

Refers to businesses that are involved with heating, ventilation, and air conditioning (HVAC) from renewable energy sources

or perform work that increases the energy efficiency of HVAC systems.

Includes the following:

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, 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, Biofuels, and Renewable Combined Heat and Power

Production of electricity and usable heat from renewable sources. Also called cogeneration.

Clean, High Efficiency, and ENERGY STAR Heating and Cooling

Includes the following:

ENERGY STAR/High AFUE HVAC

HVAC that meets the international ENERGY STAR standard for energy-efficient consumer products originated in the United States or has a high Average Fuel Utilization Efficiency (AFUE) rating of 90 or greater or 15 SEER or greater.

Renewable Heating and Cooling

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

Clean Energy Worker

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

Combined Heat and Power (CHP)

Generates electricity and useful thermal energy in a single, integrated system. Heat that is normally wasted in conventional power generation is recovered as useful energy.

Efficiency and Demand Management

Goods and services that reduce electricity demand, including energy efficiency upgrades to existing buildings (retrofitting and retrocommissioning) and installation of ENERGY STAR Appliances

Includes the following:

Energy Storage

Devices or physical media that store energy. (See expanded Energy Storage definition.)

Advanced and Recycled Building Materials

Includes doors, windows, air sealing, floor, wall, or piping insulation, and any additional building envelope materials that represent advances in efficiency over traditional materials.

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 power companies with the ability 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 supply network, including smart computing and software, which detects and reacts to local changes in electricity usage.

Micro Grid

A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid.

Other Grid

This sub-technology includes all other clean grid activity where employers were unable to assign work to a single sub-technology. This includes firms that conduct clean grid activity across multiple sub-technologies.

Other Grid Modernization

Other modernization of the nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth.

Water and Wastewater Technologies related to Conserving Energy

Products related to reducing energy for water purification, distribution, or treatment.

Electric Vehicles

A vehicle that uses one or more electric motors for propulsion with no onboard generator or non-electric motor.

ENERGY STAR Appliances

Appliances that meet the international ENERGY STAR standard for energy-efficient consumer products originated in the United States.

GLOSSARY

Energy Storage

Includes the following:

Pumped Hydro Storage

Hydroelectric energy storage used by electric power systems for load balancing. The method stores energy in the form of gravitational potential energy of water pumped from a lower-elevation reservoir to a higher elevation.

Battery Storage

A cell or connected group of cells used to convert chemical energy into electrical energy by reversible chemical reactions and may be recharged by passing a current through it in the direction opposite to that of its discharge.

Mechanical Storage

Includes technologies like flywheels and compressed air, which use kinetic or gravitational forces to store energy.

Thermal Storage

Temporary storage of energy for later use when heating or cooling is needed.

Firm

A business organization, such as a corporation, company, or partnership. A firm can have multiple establishment locations.

Gross State Product (GSP)

Gross State Product is a measurement of a state's output. It is the sum of value added from all industries in the state. In this report, clean energy is captured as a portion of the total Gross State Product.

LED, CFL, and Other Efficient Lighting

Energy-efficient lighting sources.

Other Alternative Transportation

Includes jobs in transportation technologies, such as biodiesel for on-road vehicles.

Other Biofuels

Other fuel derived directly from living matter.

Other Energy Efficiency

Includes variable speed pumps; other design services not specific to a detailed technology; software not specific to a detailed technology, energy auditing, rating, monitoring, metering, and leak detection; policy and nonprofit work not specific to a detailed technology; consulting not specific to a detailed technology, LEED certification, or phase-change material; and all other activities not specific to a detailed technology.

Other Renewable Energy

Includes geothermal, bioenergy or biomass, low-impact hydro, and other electric power generation detailed technologies that are not defined by the categories presented or cannot be assigned to a single category.

Other Sector

Consists of all jobs that could not be classified into one specific clean energy technology sector because the work overlaps with multiple categories. An example of this could be greenhouse gas management or accounting.

Other Services

Includes categories like business organizations, utilities, nonprofits, and select government organizations that are directly involved in clean energy.

Reduced Water Consumption Products and Appliances

Includes technologies such as high-efficiency washing machines, faucet aerators, and low-flow shower heads.

Renewable Energy

Any businesses that are involved in the manufacturing, sale, installation, or research and development of renewable electricity generation technologies.

Solar

Technologies that generate electric power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect.

Sub-Technology

For the purpose 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 purpose of this report, technology refers to the primary application or end use of an establishment's produced goods or services.

Value Chain Segments

Include the following:

Engineering & Research

Engineering & Research includes all engineering and scientific research firms engaged in clean energy projects and technology development.

Installation

Installation is comprised of firms engaged in residential, commercial, and industrial building construction, contracting, electrical, insulation and weatherization, or plumbing and heating, air conditioning, and ventilation work.

Manufacturing

Refers to heating and air conditioning equipment manufacturing, engine and compressor manufacturing, semiconductor manufacturing, and energy-efficient products, appliance or lighting manufacturing, as well as motor vehicle and parts manufacturing and, solar panel and wind assembly.

Professional Services

Any sort of financial, legal, architectural, mathematical, or scientific services that support clean energy technology development and deployment.

Sales & Distribution

Sales & Distribution includes mostly wholesale trade as well as some warehousing and distribution activity. For clean energy, this value chain category includes motor vehicles and parts wholesalers, electrical equipment, and household appliance wholesalers, plumbing and heating equipment and supplies wholesalers, and other wholesale related to clean energy products, component parts, and technologies.

Utilities, Nonprofits, and Other

This segment is largely comprised of automotive repair and maintenance but also includes organizational and non-profit work, such as environmental and conservation organizations, business associations, and advocacy organizations, as well as electric power generation and distribution utilities.

Wind

Technologies that convert the wind's kinetic energy into electrical power.

Woody Biomass

Fuel developed from the by-product of management, restoration, and hazardous fuel reduction treatments, as well as the product of natural disasters, including trees and woody plants (limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment).



MassCEC's Wind Technology
Testing Center in Charlestown, MA

Scan the QR code to read the interactive report, or visit
<http://masscec.com/reports/industry-2023>



**Massachusetts Clean
Energy Center**

294 Washington Street
Suite 1150
Boston, MA 02108

617-315-9300
masscec.com