

STRENGTHENING Maine's Clean Energy Economy



GOVERNOR'S OFFICE OF
**Policy Innovation
and the Future**

GOVERNOR'S
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Page 10: Wind turbines in Dixfield, Maine | Maine Drone Imaging



TABLE OF CONTENTS

Introduction..... 2

Executive Summary..... 4

Maine’s Clean Energy Economy 6

Workforce Opportunities 8

COVID-19 Impact and Recovery 10

Strategies for Strengthening Maine’s Clean Energy Economy..... 15

Conclusion 27

Appendix A: Maine Clean Energy Economy Workforce Survey 28

Citations 34



INTRODUCTION

Maine’s clean energy economy is poised for robust growth, which will generate stable, high-quality jobs for Maine people. Following a series of actions taken by Governor Janet Mills, with bipartisan support from the Maine Legislature, new renewable energy projects are being built across the state and increased energy efficiency investments are reducing costs for consumers and businesses.

Nationally, clean energy jobs have been the growth engine of the overall energy economy . In 2019, clean energy jobs (3.36 million) outnumbered fossil fuel employment (1.19 million) by nearly 3 to 1 across the United States. Nationally, more Americans worked in clean energy fields in 2019 than as K – 12 educators. Median US hourly wages for clean energy jobs are about 25 percent higher than the median wage, and clean energy careers offer a higher prevalence of health insurance and retirement benefits.

Though COVID-19 has caused some clean energy jobs losses, signs of recovery in this sector are already being seen in Maine, as evidenced by the historic procurement of renewable energy by the state earlier this year. The procurement to support the state’s ambitious Renewable Portfolio Standard supported 17 projects around the state, which will create hundreds of jobs and millions of dollars of new investment, while also signaling the great market potential Maine has for attracting and developing clean energy projects.

At the same time, new energy sector innovation--from forest products to offshore energy technology--is advancing in both the private sector and in our state university labs. Forecasts anticipate global financial institutions doubling planned investments in renewable energy in the coming decade with estimates of \$1 trillion in cumulative private capital investments being mobilized in this sector by 2030.

While the imperative to reduce emissions and slow climate change drives the need to rapidly develop the clean energy sector, the economic challenges in Maine stemming from the COVID-19 pandemic offer an opportunity to support good jobs in this fast-growing sector. New energy jobs can employ laid-off workers now, especially with the support of training programs to help connect workers with needed skills. Maine is projected to lose overall employment in the next ten years due to demographic trends and the clean energy industry can help attract younger workers - both from within the state and outside of Maine.

Ensuring adequate education and training is vital to building a skilled clean energy workforce. Creating pathways to career opportunities – through STEAM education, Career and Technical Education centers, and through Maine’s Community Colleges and University System, is essential to preparing workers for high-quality, family sustaining jobs in this sector.

This report seeks to catalog the current state of the industry and outline the opportunities for Maine to advance the state’s clean energy opportunities of the future. By committing to a set of targeted investments, policies, and workforce training strategies that match the state’s ambitious clean energy goals, Maine can realize significant short and long-term benefits for the people, businesses, and communities of our state.



A handwritten signature in black ink that reads "DL Burgess".

Dan Burgess, Director
Governor’s Energy Office



A handwritten signature in black ink that reads "H Pingree".

Hannah Pingree, Director
Governor’s Office of Policy Innovation and the Future

EXECUTIVE SUMMARY

Climate change and COVID-19 are creating challenges that are immediate, consequential, and have expansive social and economic implications. The current momentum and future potential of the clean energy sector is an opportunity to respond to these crises now and to realize a future that combats climate change and strengthens our economy for years to come.

The Governor's Energy Office (GEO) and Governor's Office of Policy Innovation and the Future (GOPIF) have developed this report to identify pathways and strategies for, and to pursue, the advancement of Maine's clean energy economy as required by statute.¹ Maine's 10-year economic plan² highlights the opportunity to grow Maine's clean energy economy with positive impacts reaching across sectors. The strategies outlined in this Clean Energy Economy Transition Plan, in combination with the forthcoming Maine Climate Council's Climate Action Plan, provide specific strategies to leverage Maine's clean energy resources and energy efficiency opportunities to recover and grow Maine's economy.

Strategies to advance Maine's clean energy sector, and to realize that growth potential in economic recovery efforts, are outlined throughout this report in the following four categories.

- **Policy and Program Development**
- **Workforce Development and Recruitment**
- **Cleantech Innovation**
- **Equity and Just Transition**

The Plan advises several specific actions within each category. For policy and program development, the plan advises the following to advance the clean energy industry:

- **Continue to create and implement clean energy policies that are clear and consistent, provide certainty for ongoing development, and specifically focus on creating quality jobs;**
- **Monitor programs and adjust as needed in order to effectively and efficiently accomplish the State's clean energy and climate goals;**
- **Utilize and expand incentives, grants, and financing options for renewable energy and energy efficiency projects.**

Workforce is the key component of Maine's transition to a clean energy economy, as highlighted by Maine's 10-year economic strategy.³ By supporting educational and training paths for Maine people to find new careers, and attracting a talented, diverse workforce to Maine, the clean energy industry has the potential to create new, sustained opportunities in sectors such as solar, wind, bioproducts and energy efficiency that are poised for major growth in the coming decade. To attract and develop this workforce, this plan advises the following:

- **Support and promote Science, Technology, Engineering, Arts, and Math (STEAM), Career and Technical Education (CTE) and Maine Community Colleges to provide pathways for Maine youth and residents to find fulfilling and quality job opportunities;**
- **Promote and encourage training opportunities and industry participation as an avenue for skilled jobs in Maine to benefit participants as well as employers;**

- **Prompt industry to provide their own training or associated apprenticeship programs and job opportunities in coordination with existing training programs and needs;**
- **Support existing programs and incentives, identify gaps and develop new programs, as needed, to create opportunities that assist and incentivize Maine workforce in growing the clean energy sector;**
- **Attract companies and workers looking to start or locate a company, conduct market research, develop innovative solutions, work for or partner with Maine companies, and create jobs through a diverse marketing plan to grow the state's economy and support workforce needs;**
- **Launch a workforce initiative (led by the GEO and in partnership with the private sector) that: (a) creates an online database and resource for connecting job opportunities in clean energy with potential hires in order to streamline the job search process, and identifies training and educational opportunities, and (b) establishes ongoing stakeholder coordination between industry and educational and training organizations to understand and support future workforce needs.**

Maine must also support the innovation ecosystem, encouraging investment dollars to go towards climate and clean energy focused products and services, for which this plan advises the following:

- **Increase investment in cleantech innovation and continue to expand Maine's entrepreneurial ecosystem to develop and commercialize innovative products and services that will provide cost-effective clean energy solutions;**
- **Encourage private and public investment dollars to go towards products and services that advance the state's climate and clean energy goals and provide state support for companies pursuing funding opportunities;**
- **Invest in broadband expansion in order to support business success and growth, as well as to provide the platform for innovative clean energy and grid management solutions;**
- **Achieve the state's goal of 95% broadband deployment by 2025 and strive to serve 99% of the state by 2030, at the latest, with high-speed access.⁴**

These efforts must also ensure equity of job opportunities, affordable energy, and public health benefits across the state, as well as just transition considerations for those who may face adverse impacts throughout this transition, for which this plan advises the following:

- **Include equity and cost considerations in the support and development of energy programs, particularly those targeted at low to moderate income households, to aid in decreasing overall energy burdens and shift towards low-carbon heat and energy sources;**
- **Support policy solutions that ensure fair distribution of benefits within the state and access to those associated benefits across all communities;**
- **Identify opportunities to create programs that will assist energy companies in transitioning to the clean energy economy of the future.**

MAINE'S CLEAN ENERGY ECONOMY

The clean energy economy, in broad terms, includes economic development and sustained operations that support clean energy, energy efficiency, and climate mitigation and adaptation goals that generate economic benefits, support high-quality job development, and protect the environment.

In June 2019, Governor Mills signed legislation into law⁵ increasing the state's Renewable Portfolio Standard (RPS) from 40 percent to 80 percent by 2030 and setting a goal of 100 percent renewable electricity by 2050. Maine's new RPS obligation is considered one of the most ambitious in the country and certainly reflects the most ambitious 2030 target in New England.

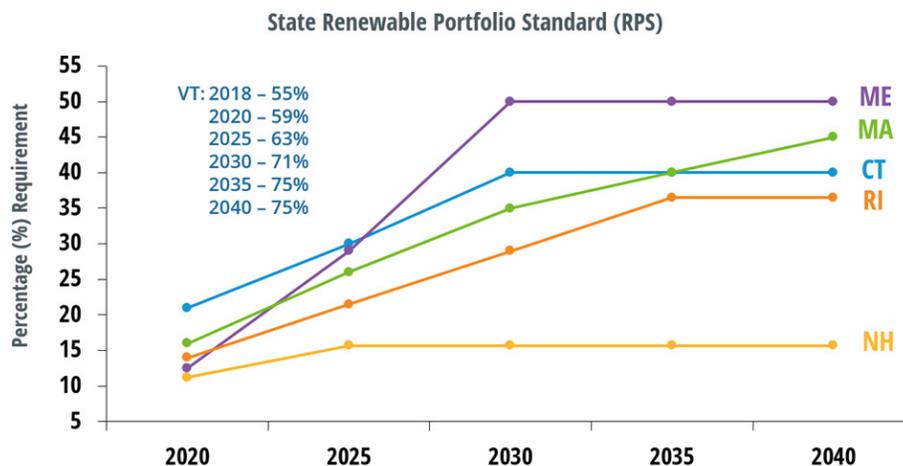


Figure 1. ISO New England: Class I⁶ Renewable Portfolio Standards in New England⁷

Per this legislation, the Maine Public Utilities Commission (PUC) is required to procure 14 percent of Maine's electrical load via long-term 20-year contracts for renewable energy resources. The first of these contract selections were announced in September 2020, with more than 500 MW of renewable resources selected at highly competitive prices, leading the way for renewable energy to lower energy cost burdens for Maine ratepayers. Lower energy costs can also provide opportunities for business success, growth, and attraction to Maine. This renewable generation, and the subsequent transmission and distribution investments needed to interconnect them to the grid, are also required to provide significant economic benefits to the state. In addition, Maine has developed programs for small- to medium renewable generation, support for strategic electrification of heating and transportation, and energy efficiency programs for all consumers – including specific programs for low- to moderate-income households.

The clean energy sector also includes the supporting supply chain. Wind turbines must be designed and manufactured, transported, installed, maintained, and operated. Wood pellets and other biofuels require the full spectrum of the forest products supply chain. Energy efficiency services reach across contractors, manufacturing, construction, and installation. Each link in the chain is an opportunity to create jobs and grow Maine's economy, especially with in-state manufacturing of key components.

As an example, offshore wind energy is a significant supply chain development opportunity in Maine. Maine has some of the strongest offshore wind speeds in the country but will need to rely on floating platforms given the water depths of the Outer Continental Shelf in the Gulf of Maine. The research and development of the New England Aqua Ventus, the floating offshore wind demonstration project using pioneering floating technology from the University of Maine, is poised to be the first of its kind in the country with recognition and financial support from the U.S. Department of Energy. This patented technology provides significant opportunities for supply chain development.

The University of Maine and the Advanced Structures and Composites Center, in partnership with construction and construction services company Cianbro, designed, developed, and tested versions of a patented floating concrete semi-submersible hull.⁸ In August 2020 it was announced that two large and experienced international clean energy companies – Diamond Offshore Wind, a subsidiary of the Mitsubishi Corporation, and RWE Renewables, the second-largest company in offshore wind globally – would invest \$100 million in partnership to help develop the floating offshore wind technology demonstration project off the coast of Maine.⁹ This innovative technology presents significant opportunity.

Another example is in the biomass and forest products sector. Around 89% of Maine is forested (17 million acres) and the forest industry harvests 13 million tons of wood each year.¹⁰ This work in forest products sustains 33,500 jobs, with workforce spread across Maine, particularly focused in rural areas. The forest products industry has shifted from more than just traditional wood products to include new innovative forest products such as high-performance fibers, natural chemicals, and biofuels.¹¹

This diversification of the forest products sector provides opportunities for continued participation in various aspects of Maine’s clean energy and energy efficiency initiatives, as well as stronger long-term economic stability.¹² Some new wood-based products can improve energy efficiency and sustainability by creating building materials that sequester carbon (such as cross-laminated timber), alternative biofuel heating sources, and insulation that make buildings more energy efficient.

The opportunity to contribute to the regional, and even global, supply chain and grow Maine’s economy is apparent as other New England states and countries commit to advancing their own clean energy and climate goals. Maine should embrace these opportunities and coordinate with regional and national partners to advance development and growth within our clean energy sector. The greatest supply chain benefits will come when the greatest number of components within that supply chain can be produced in Maine. While many steps will relate to projects specifically being developed in the state, a well-developed supply chain will provide opportunities for products and services to be part of a national and even international market.

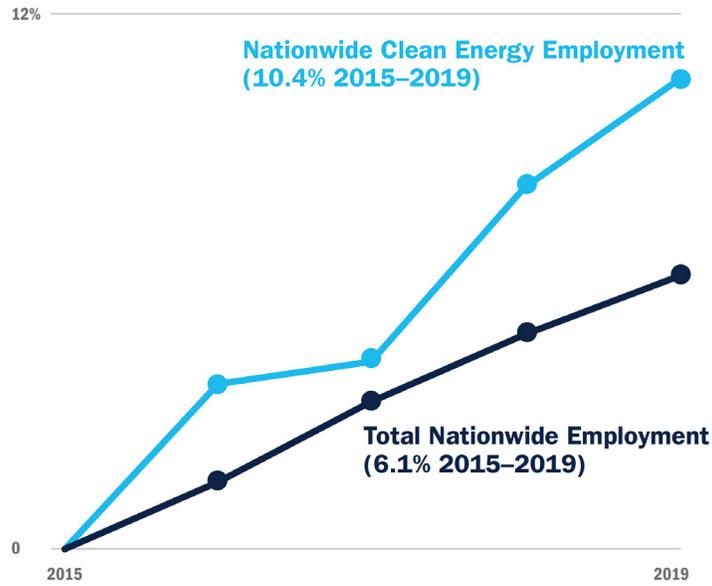
Ensuring there is an adequate workforce to benefit from the development of these projects and their supply chains is therefore essential to expanding the full range of benefits for Maine people.

Workforce Opportunities

Clean energy development is having a transformational effect on the global economy. Advanced energy revenues by the private sector were \$1.4 trillion worldwide in 2014, which is comparable to revenues of the global apparel industry and double the revenues of the global airline industry. This performance employed over 9.8 million people in the world’s energy industry in 2016, with the estimated ability to create more than 14 million additional jobs by 2030.¹³

Prior to COVID-19; national job numbers indicated nearly 3.4 million Americans worked in clean energy occupations, which is more than the number of people working in real estate, banking, or agriculture in the United States, and three times the number of existing fossil fuel jobs.¹⁴

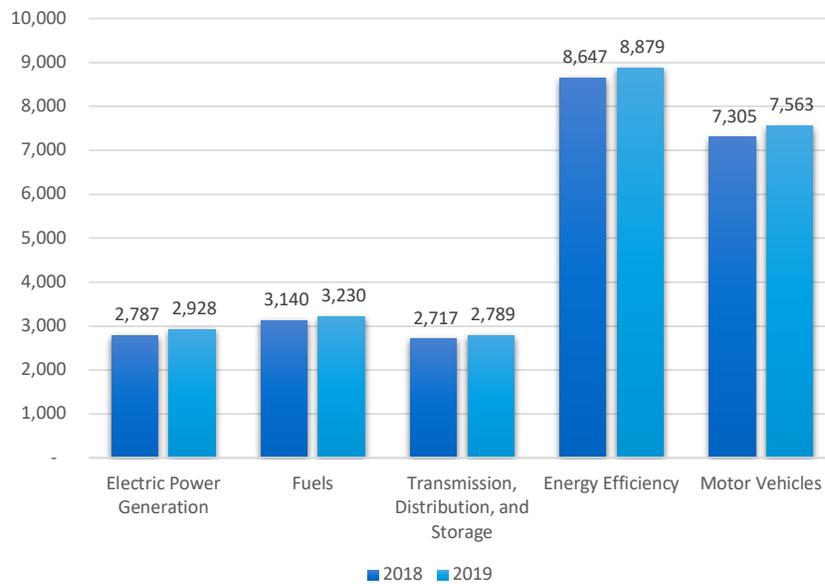
In the U.S., and also in Maine, the most significant proportion of clean energy employment is in energy efficiency. Prior to COVID-19, nearly 2.3 million people worked in energy efficiency jobs in the United States, which was slightly more than the total number of restaurant servers across the country (2.25 million). Additionally, 10% of those employed in energy efficiency are military veterans.¹⁵



Source: E2¹⁶

In Maine, nearly 8,900 people are employed in energy efficiency jobs, which is roughly the same as the total number of people employed in traditional energy jobs including electric power generation, fuels, and transmission, distribution and storage combined.¹⁷ From 2018 to 2019 in Maine, all sub-sectors within the energy industry experienced job growth. During that timeframe, 37.5 percent of Maine’s energy-related employers hired new employees.¹⁸

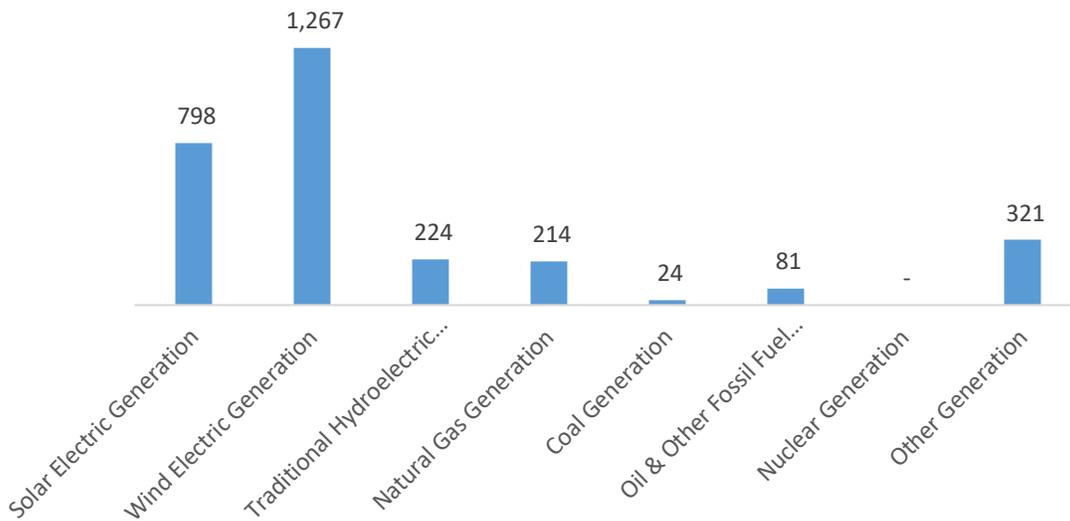
Employment by Major Energy Technology Application



Source: 2020 USEER¹⁹, Maine State Report

In Maine, prior to the pandemic, there were nearly 18,000 people employed in the overall energy sector, including traditional fuels, across electric power generation, fuels, transmission and distribution, storage, and energy efficiency. Of the nearly 18,000 total energy sector employees, around 14,000 would fall within the clean energy sector, including transmission, distribution and storage, as well as energy efficiency.²⁰ In examining the electric power generation sector in Maine, wind has the highest employment with 1,267 jobs, followed by solar with 798 jobs. In comparison, natural gas, coal, oil and other fossil fuel electric power generation represent 319 jobs combined.²¹ Within the broad category of fuels, the majority of jobs (1,823 total jobs) are within the oil and other petroleum sectors, which is followed by woody biomass and other fuels (1,176 total jobs).²²

Electric Power Generation Employment by Detailed Technology Application



Source: 2020 USEER²³, Maine State Report

In 2019, job numbers indicated that there were 8,946 traditional energy workers employed throughout the state (excluding energy efficiency). Of these workers: 2,928 were in electric power generation, 3,230 are in fuels, and 2,789 are in transmission, distribution, and storage.²⁴ Given the lag in job tracking data and that new renewable energy policies are still being implemented in Maine, a significant additional positive workforce and economic impact from those policies is anticipated.

COVID-19 Impact and Recovery

Like many others, this sector has suffered during the pandemic. Clean energy companies are still working within the confines of social distancing and new health and safety requirements, adding back 12,500 jobs nationally in September 2020. As of October 2020, however, there were still just under half a million (477,900) clean energy workers out of work, a nearly 14% decrease compared to the start of the year. Maine is estimated to have clean energy job losses of about 1,700, which is a 13% decline from pre-COVID employment.²⁵

The clean energy sector is now widely viewed as central to economic recovery strategy. The International Renewable Energy Agency explains how recovery efforts and stimulus packages can be greatly improved through renewable energy projects.

"Post-pandemic stimulus packages would be greatly enhanced by these clean, easily scalable, cost-effective energy solutions. Scaling up renewables can boost struggling economies. It can save money for consumers, pique the appetites of investors and create numerous high-quality new jobs. Renewables align recovery measures with climate resilience, sustainable development and other medium- and long-term policy goals. Cutting carbon dioxide (CO2) emissions in line with the Paris Agreement remains as crucial as ever in the wake of COVID-19, while also offering tremendous potential to put millions of people back to work. The same energy infrastructure needed to meet today's needs can also pave the way for a far better future. Investment in renewables equates with investing in health, sustainability and inclusive prosperity. Moreover, the more we deploy these technologies, the more their costs will fall."²⁶



Sectors within the clean energy economy including renewable energy, energy efficiency, transmission and distribution, and grid modernization are particularly poised for quick and high-quality job growth. Jobs in these sectors often involve working outdoors, increasing their ability to exist in a socially distant manner, or in large or vacant building stock, adding to the economy during the pandemic.²⁷

One example of this type of work performed during the COVID-19 pandemic in Maine is the LED light installations in Maine's building stock as a result of expanded initiatives from Efficiency Maine Trust. As of July 2020, more than 50 Maine public schools participated in an extended Efficiency Maine Trust incentive program to upgraded lighting to efficient LEDs and reduce electricity consumption. This program is creating savings for public schools, but also provided work for electrical contractors and the relevant supply chain during a challenging economic period.²⁸

More than 50 Maine schools, such as Stearns Junior-Senior High School in Millinocket pictured here, participated in the Efficiency Maine's School Lighting Retrofit Initiative this year to secure cost savings and efficiency through LED lighting conversions.



At the St. John Valley Technology Center in Frenchville, upgraded lighting in its entryways, hallways, and gyms. The school contributed \$20,000 and Efficiency Maine provided \$13,000 in incentives to help save the school nearly \$7,000 annually, resulting in a return on investment in fewer than three years.

Kevin Lavoie, the Director of St. John Valley Technology Center said, "There's no question, improving lighting enhances the ability of students to learn. We're reducing our carbon footprint because LED lighting is more energy efficient. This program also has reduced the tax burden on our community and has created jobs for Maine's workforce. That's a triple win as far as we're concerned. In addition, we're especially pleased we could complete the project this summer."²⁹

Buoyed by aggressive federal support following the recession in 2008, the clean energy sector experienced significant growth and lasting momentum. With \$90 billion in federal investment as part of the 2009 American Recovery and Reinvestment Act (ARRA), 1 million clean energy jobs were created; 100,000 wind, solar and other clean energy projects were initiated; and 1 million homes were weatherized across the U.S. Other measurable benefits included emission reductions, consumer energy savings, improved environmental indicators, and increased national energy security. Federal funding to grow Maine's clean energy sector and respond to the economic challenges of COVID-19 should be encouraged and pursued.

While there is clear precedent for the clean energy sector to respond following a period of economic turmoil, the sector's momentum prior to COVID-19 also underscores its poise for return to growth. A national analysis released in April 2020 found the U.S. clean energy sector was adding jobs at a rate 70% faster than other economic sectors between 2015-2019.³⁰

Poised for Growth

Maine's clean energy sector has long been seen as having high growth potential. In 2014, evaluations of Maine's technology-related drivers identified clean energy as particularly well-positioned for growth within Maine, and for Maine to become a regional leader in the sector.³¹ The subsectors below are areas of strong economic and job growth potential within the clean energy sector, but should not be considered a full representation of the spectrum of opportunities available to Maine from the broader clean energy economy.

Solar: States with strong solar policy support, particularly in New England, have experienced immense solar job creation. Massachusetts had 10,400 solar jobs in 2019, for instance, ranking 6th in per capita solar jobs across the United States. Vermont's solar industry has grown and ranks 3rd in solar jobs per capita. Nationally, solar jobs grew five times faster than overall U.S. job growth between 2014 and 2019. Development of solar projects resulted in new job creation, representing 68% of solar job hires, with competitive wages nationally even for entry-level positions.³²

Solar development, both utility scale and smaller distributed energy generation, present economic development opportunities. These projects can provide various benefits to their host communities, provide energy cost savings, develop community solar projects with cost savings to project subscribers, and create cost savings to taxpayers through municipal or state projects.



Sundog Solar's Tremont Landfill Solar Array

In September 2020, the Maine PUC announced the renewable energy project selections for the first round of procurements to meet requirements of Maine's RPS. Of the 546 megawatts (MW) of procured capacity in the first round, the large majority (483 MW) is new solar development, with the remaining coming from wind, biomass, and hydro. These projects are together committed to providing Maine with the following economic benefits: more than 450 full-time equivalent jobs during construction and more than 30 full-time equivalent jobs in every year of the operations phase; initial capital spending of more than \$145 million; additional spending of \$3 million annually and tax payments averaging \$4.7 million annually over the 20-year contract term.³³

Wind: As is highlighted in Maine’s 10-year economic development strategy, offshore wind energy represents a significant opportunity for job creation and economic development in Maine. A recent analysis from the American Jobs Project that examined the opportunities and related impacts of developing Maine’s offshore wind industry found that the offshore wind industry in the state could support an annual average of 2,144 jobs through 2030.³⁴ Fully harnessing Maine’s employment potential from offshore wind will require a proactive approach that takes advantage of our existing assets and strategically invests in new opportunities, all of which must be done with consideration and input from existing ocean users.

As mentioned previously, Maine has some of the best wind speeds in the country and is home to already cutting-edge research and development through academic networks that have developed significant technological advancements, particularly through University of Maine’s New England Aqua Ventus offshore wind floating platform technology. Offshore wind development presents a strong economic and job opportunity for the state when pursued in concert with existing marine uses.



University of Maine’s VoltturnUS 1:8, a small-scale prototype of Aqua Ventus, deployed off Castine, Maine in 2013

Maine’s abundant onshore wind resources and history of successful projects across the state also has strong potential for further growth. Home to the most onshore wind in New England, there continue to be commercial proposals for new wind farms. These projects, if sited thoughtfully and with community input, could provide cost-effective clean energy as well as workforce opportunities throughout the development cycle of these projects.

Bioproducts: In addition to strategic electrification, there are opportunities for low-carbon fuel sources to be included in Maine’s energy profile. Maine produces low-carbon fuel sources through biofuels and wood heating resources. When produced sustainably, pellet fuels and similar wood heating sources can play a part in Maine’s low-carbon energy future while supporting the residual wood products market. Additionally, research is currently being done and some initial products have been created utilizing wood products and other bio-based materials to make biofuels.³⁵

One example of efforts in R&D is the University of Maine’s Forest Bioproducts Research Institute which has “marshalled a broad array of scientists as well as business partnerships and research partnerships to create fossil fuel reduction solutions focused on sustainable forest management and the creation of innovative bioproducts.” Their research includes finding uses for wood, as well as algae, leftover from processing plants as a source of biofuels. This research has led to the creation of a biofuel for use in military jets as well as drop-in fuels for fuel tanks and pipelines.³⁶

Infrastructure: Energy infrastructure development also presents an opportunity for economic growth and job creation. A recent national report on infrastructure estimates that America will need to invest \$30 billion to \$90 billion in order to upgrade the national transmission system to properly utilize renewable energy generation and repair aging equipment to avoid future electric grid disruptions.³⁷ A similar opportunity exists in Maine as the state moves forward with decarbonizing the state’s electricity sector and advancing strategic electrification of the heating and transportation sector.

While estimates vary on the exact scope of the electric grid expansion that’s needed and by when, there is agreement the existing transmission and distribution system requires expansion and modernizing. Similarly, commercial scale wind development will need to build new transmission systems, particularly for offshore wind farms, as well as shore-side upgrades for energy to enter the regional grid. This is a clear opportunity for job creation in occupations such as engineering, construction, project management, environmental and regulatory consultants, transportation, and marine services. One example is the New England Clean Energy Connect (NECEC) transmission line, which is estimated to create more than 1,600 jobs during its construction phase.³⁸

Investments in energy infrastructure, such as improvements and expansion of the transmission and distribution system, can also improve the reliability and resiliency of the grid. As more frequent and intense storms occur as a result of climate change, more resilient infrastructure is essential as Mainers’ reliance on the electric grid increases for heating and transportation use.

Energy Efficiency: A significant number of Maine’s energy workforce is within the energy efficiency sector. An ongoing need to continue to weatherize Maine’s old housing and building stock, primarily through Efficiency Maine Trust (EMT) and MaineHousing programs, will drive a continued need for energy efficiency workforce and the associated supply chain. In combination with supportive energy efficiency policies and goals, this sector is primed for continued growth. According to EMT, there are close to 550 registered heat pump vendors as of October 2020. To demonstrate the growth potential, around 80 new vendors have been added between July and October, averaging an increase of one new vendor per workday. Many of these companies are hiring, showing great potential for a growing workforce.³⁹



Source: Efficiency Maine Trust

Workforce: The clean energy workforce is comprised of a broad spectrum of occupations. In the U.S., clean energy jobs are estimated to involve 320 unique areas, in fields such as electric grid construction, operation and maintenance, manufacturing, construction, and services in support of energy efficiency, and science, engineering, planning, policy and regulatory roles related to energy and environmental management. Compensation for these positions exceeded average national wages and are more comparatively financially equitable.⁴⁰ These higher-paying jobs tend to have lower educational requirements, though they generally require greater scientific knowledge and technical skills and training than the average job in the U.S. About half of the clean energy economy workers attain no more than a high school diploma but can earn higher wages than those with similar education levels working in other industries.⁴¹

Efforts to target the creation of these high-quality jobs must be encouraged, through strategies that pair job quality standards with clean energy investments. Some of these may include prevailing wages, project labor agreements, safety and health protections, community benefit agreements, registered apprenticeship utilization, and local hire provisions. Domestic content requirements can also assist in building local supply chain opportunities. These, and other related requirements, should be considered when developing clean energy projects and relevant policies.

Based on 2019 survey results from the 2020 U.S. Energy & Employment Report, Maine companies projected a 7.4% increase in electric power generation employment in 2020 which equates to about 216 new jobs. Additionally, Maine companies projected adding over 400 new energy efficiency jobs in 2020.⁴² While these numbers were projections prior to the COVID-19 pandemic, there remains demonstrated demand and workforce needs in the energy sector. Continued policy and program support could result in even greater workforce opportunities in cities, towns and tribal communities and are considered critical to supporting the growth of the industry subsectors listed above.

Growing this workforce should also include efforts to ensure greater diversity and more equitable opportunities within the clean energy sector. The composition of this workforce tends to be primarily older, white, and male, resulting in a less diverse workforce compared to occupations nationally. While about half of the overall national workforce are women, for example, fewer than 20 percent of clean energy production and energy efficiency workers are women.⁴³ Close examination of the diversity of Maine's current clean energy workforce, beyond just gender, is needed to ensure greater diversity and equity in the field.

Federal Support: Federal policies and funding are important supports for state efforts to grow the clean energy industry. A leading example is the solar investment tax credit (ITC), which was enacted in 2006. The ITC, a tax credit for solar systems on residential and commercial properties, has contributed to significant growth of the solar industry nationally and in Maine. While the ITC was extended in 2015, the value of the credit has decreased annually since 2019.⁴⁴ The success of the ITC, among other incentives such as the Production Tax Credit and tax credits for qualifying electric vehicles, have demonstrated the immense impact of federal support on the clean energy industry, and the essential nature of federal policies that provide stability and investment opportunity.

Federal funding for energy innovation is equally essential because it leads to matching private sector investment to spur growth and commercialization of new technology. The U.S. Department of Energy (DOE), Advanced Research Projects Agency-Energy (ARPA-E) has invested \$1.8 billion in transformational energy technology projects since 2009, which has leveraged more than \$2.6 billion in private funding. In Maine, Introspective Systems has received \$3.5 million of DOE and other federal financial support to develop distributed grid management software. This has resulted in full-time job creation, local project development, and global attention to the innovation happening in Maine.⁴⁵

As Maine and the nation continue to address the economic challenges caused by COVID-19, the significant opportunity for federal stimulus to strengthen the clean energy sector, resulting in economic and workforce benefits, must be a foremost consideration.

Clean Energy Economy Workforce Survey: In a clean energy economy workforce survey conducted by the GEO and GOPIF, many companies indicated expected workforce and business growth as a result of Maine’s supportive clean energy policies and programs. Respondents also strongly indicated a number of challenges associated with meeting that growing workforce need. The most noted challenge was a lack of workforce with necessary skills within the state. Suggested solutions that could be pursued by the State to address workforce challenges included coordination of training programs with industry needs, better outreach and promotion of current programs, promotion of STEAM education and the trades as avenues for employment, and attraction of more out-of-state workers. **Additional survey analysis is provided in Appendix A.**

STRATEGIES FOR STRENGTHENING MAINE'S CLEAN ENERGY ECONOMY

I: Policy and Program Development

- **Continue to create and implement clean energy policies that are clear and consistent, provide certainty for ongoing development, and specifically focus on creating quality jobs.**
- **Monitor programs and adjust as needed in order to effectively and efficiently accomplish the State's clean energy and climate goals.**
- **Utilize and expand incentives, grants, and financing options for renewable energy and energy efficiency projects.**

Consistent, supportive clean energy policies are the foundation for sustained industry growth. To support the industry interest and investment from recently enacted clean energy and energy efficiency policies and programs, Maine must continue to provide certainty for development and supportive practices to achieve maximum economic and social benefits.

In addition to providing the foundation for clean energy sector development, policies and programs must be specifically targeted towards creating high-quality jobs within the clean energy sector to bring the greatest economic benefit to the state. Strategies for ensuring high-road job quality development in cities, towns and tribal communities across the state, as outlined in the above workforce opportunity, should be considered when creating these policies and programs and developing clean energy projects.

In addition to supportive policy, incentives, grants and financing options must also be available to support clean energy projects. Capital costs are a challenge for developing projects and growing a company, therefore creating financial avenues and program incentives to drive and support growth is a vital component of creating a vibrant clean energy sector. This support can help save businesses and organizations money over the long-term, while increasing renewable energy technology adoption, energy efficiency services, and support the state's overall goals.

"Given the widespread support for renewable energy in the legislative and executive branches, we believe the signs point toward more opportunities for the clean energy industry in the near- to medium-terms."

—Workforce Survey Respondent

II: Workforce Development and Recruitment

- **Support and promote Science, Technology, Engineering, Arts, and Math (STEAM), Career and Technical Education (CTE) and Maine Community Colleges to provide pathways for Maine youth and residents to find fulfilling and quality job opportunities.**

STEAM: While jobs within the clean energy economy are diverse in their focus and educational requirements, many clean energy and environmental jobs require an education within the STEAM fields. Providing funding for proper STEAM education from K-12 and beyond is important to keeping students engaged in these fields. Young

students interested in pursuing a study in STEAM fields could grow up to fill clean energy jobs in Maine, which would help to build Maine's economy and provide Maine graduates with in-state employment opportunities so they can avoid having to go elsewhere to make a living in their field.

CTE: In addition to pursuing higher education in STEAM fields, some students may be interested in pursuing a trade occupation, many of which apply to work within clean energy. According to the Maine Department of Education, Career and Technical Education (CTE) is one educational tool to provide Maine students with “the opportunity for relevant and challenging applied learning to enhance their occupational, personal, and academic success while preparing them to meet the needs of the Maine workforce.”⁴⁶

CTE in Maine offers in-depth training as well as middle and high school exploration into career pathways for all students. Training an educated workforce is key to developing a successful and productive community and economy. CTE, through its career clusters, multiple pathways and programs, empowers students to develop the attributes and skills necessary to become successful citizens, workers and leaders.⁴⁷

Clean energy and energy efficiency training offered through CTE programs tend to be in construction, plumbing and heating, electricity, and electrical technology. While the graduation rate for students concentrating in CTE programs in 2015 was 90.2%, nearly three points higher than the state average of 87.5%, only 14% of high school students take at least one CTE program, and only 6% concentrate in CTE during high school.⁴⁸

Recognizing the importance of the CTE programs, including in training and preparing a workforce for the clean energy economy, as well as the low enrollment rates in Maine, Educate Maine published a guide to increase enrollment in the CTE programs in Maine by 200%. This guide includes strategies such as: update the public perception of today's CTE; expand private employer partnerships with CTE and make them feasible for more small businesses; reinforce the strength of college and CTE partnerships; remove policy and regulatory barriers to CTE participation; dramatically expand CTE pre-apprenticeship offerings.⁴⁹

It is vitally important to the future of Maine's clean energy sector to encourage and market the trades as a pathway to careers in Maine. Low enrollment in these educational programs is contributing to the challenges of meeting in-state workforce needs for many of the industries within the clean energy and energy efficiency sectors. The ability of students to learn a trade through CTE and community college programs, for example, should be marketed as a high-value option for Maine people. As students are encouraged to pursue training and education in the trades, there must be alignment with job opportunities in the state to ensure those pathways to employment are clear and attainable.

“The high school level vocational career paths should include renewable energy opportunities”

—Workforce Survey Respondent

“The State might consider more early-career support for youth in high school and trade schools focused on energy careers and training.”

—Workforce Survey Respondent

MCCS: The Maine Community College System can provide education and training to individuals that provides a pathway to a skilled labor career in Maine. Growth in clean energy will result in significant workforce needs, as is already being seen, and educational and training pathways are vital to building workforce to meet the need, including key electrical positions for renewable energy generation projects, and transmission and distribution installation and maintenance. Training pathways to viable careers attracts additional workforce to the state, which will be a necessity for a successful clean energy economy.

The Maine Community College System has established Maine Quality Centers, created by the Legislature “to meet the workforce education and training needs of new and expanding businesses in the state and provide new employment and career advancement opportunities for Maine people.” Within this program, Maine companies can receive grants to fund customized new-hire or incumbent worker training that is provided to students by the Maine Community College System.

Since its creation in 1994, over 275 new or expanding Maine businesses have been served by the program, with training provided to 18,923 Maine people specifically for new positions, and provided avenues for incumbent workers to upgrade their skills. The program offers four different training avenues: new-hire training, incumbent worker training, college initiated projects, and the Put Maine to Work program.⁵⁰

There are a number of programs that are provided by the Community Colleges in Maine to prepare students for clean energy related employment options. These programs will need continued support in order to provide avenues for clean energy job training, particularly as workforce needs increase during the transition to a clean energy economy.



Source: Maine Community College System

Maine’s Community College System offers clean energy job programs, such as the Wind Power Technology Certificate Program at Northern Maine Community College. The program offers training in electrical, electronic, and mechanical aspects of wind power to prepare a wind industry workforce, with a focus on wind turbine maintenance and electrical power production. This program is the only wind power technology training program in the Northeast and prepares workers for local and global job opportunities such as wind farm operators, turbine manufacturers, and contractors providing maintenance and turbine support.⁵¹

Kennebec Valley Community College (KVCC) now offers an Electrical Line worker Technology program to provide electrical power installation and maintenance training for utility employment, an Energy Services and Technology program to train students in mechanical services/plumbing and engineering technology, and a Sustainable Construction program that provides technical knowledge and skills for employment in construction including carpentry, project management, design, building inspection, and renewable energy installation.⁵²

- **Promote and encourage training opportunities and industry participation as an avenue for skilled jobs in Maine to benefit participants as well as employers.**
- **Prompt industry to provide their own training or associated apprenticeship programs and job opportunities in coordination with existing training programs and needs.**

In addition to educational pathways, training opportunities also pave the way for existing and new workers to enter clean energy occupations. Training opportunities can be vital for professional growth of new workers, as well as incumbent workers who are looking to advance their careers or shift into a new career. Many jobs associated with clean energy prioritize on-the-job training in addition to or in place of classroom educational experience.

As one example, the Maine Energy Marketers Association (MEMA) Technical Education Center (MTEC) offers hands-on training and certification for jobs in heating, ventilation, air conditioning, and refrigeration industries (HVAC-R). The training program is supported by over 300 companies in Maine and is advised by business owners and professionals currently working in the industry.⁵³ While courses are offered on a range of energy sources, the heat pump program in particular provides a pathway for employment in the clean energy sector.

The diverse training requirements for the vast array of positions that will be required throughout the sector presents a challenge in ensuring and meeting the program need. As much as possible, training programs must be developed in coordination with industry with feedback regarding the specific skills that they seek. This is crucial to ensure the effective use of resources and that the skills provided to job seekers aligns with the demand for skilled workers in the industry.

Another example of a training program in the state that helps in providing career opportunities within the clean energy and energy efficiency sectors is the Maine Apprenticeship Program, which assists in setting up structured but flexible training programs designed to meet the specific needs of Maine employers through on-the-job learning and related classroom instruction.

The programs, which can be sponsored by entities such as employers, associations, or labor groups, consists of a combination of 2,000 hours of on-the-job training and 144 hours of classroom instruction.

According to MAP, a sponsor must “provide a safe on-the-job learning environment, expose and allow the apprentice to learn and practice all of the skills prescribed in the standards, and provide incremental wage increases as the apprentice gains proficiency and completes course requirements.” The sponsors receive support from the MAP including assistance in developing programs, identifying related instruction providers, and financial assistance up to 50% of the cost of the classroom instruction.⁵⁴

Entities that participate in the program are supported in their development of an industry-recognized training program that is specific to the needs of the employer. The program has been found to reduce employee turnover and increase productivity, quality, safety, and worker versatility with an average return on investment of \$1.47 for every \$1 invested.⁵⁵ Companies are connected to a resource that provides updates on best practices, new approaches, and resources for workforce skill development that is often developed in collaboration with industry input.

MAP was established in 1941 and is still continuing to grow, with 44% increase in number of apprentices served and a 16% increase in number of registered sponsors between 2018 and 2019.⁵⁶ The largest sector within the MAP is construction with 41% of the apprentices, which is a vitally important part of developing renewable energy generation resources, so apprentices would thus have ready opportunity to work in clean energy related jobs.⁵⁷

- **Support existing programs and incentives, identify gaps, and develop new programs, as needed, to create opportunities that assist and incentivize Maine workforce in growing the clean energy sector.**
- **Attract companies and workers looking to start or locate a company, conduct market research, develop innovative solutions, work for or partner with Maine companies, and create jobs through a diverse marketing plan to grow the state's economy and support workforce needs**

Other workforce programs in addition to education and training should continue to be supported, and new programs established as needed, in order to assist and incentivize Maine workforce in support of the transition to a clean energy economy. These programs could include ways to encourage participation in clean energy sector jobs, business growth and new job creation in relevant sectors, out-of-state workers to move to Maine to fill workforce needs, or other similar actions. Maine is well positioned to both train and attract skilled workers. An overview of some current programs and incentives are provided below.

Opportunity Maine Tax Credit: This program reimburses student loan payments for college graduates who live and work in Maine through the form of an income tax credit. Eligibility requirements include living, working, and paying taxes in Maine and having an accredited associate, bachelors, or graduate degree, with additional benefits for STEAM degrees. This program can provide up to \$924 per year for an associate degree, \$4,404 per year for a bachelor's degree, and \$4,056 a year for a graduate degree.⁵⁸

New Mainers Resource Center (NMRC): The New Mainers Resource Center is a Portland Adult Education program serving immigrants, refugees and employers in the Greater Portland area. The organization provides skilled professionals programs, employment and case management, intensive classes focused on job readiness skills, networking opportunities, workshops and other services designed to help New Mainers of all professions overcome barriers to entering the workforce. NMRC participants can also take advantage of other classes and programs offered at Portland Adult Education and by community partners. Their vision is to grow Maine's economy by fully utilizing the skills of foreign trained professionals; to help employers hire and retain qualified workers for a skilled and diverse workforce; and to help Maine's immigrants and refugees overcome barriers and re-enter their professions. In 2018 398 new and returning program participants contacted NMRC for assistance and 576 people participated in NMRC programs designed to overcome barriers and engage with employers.⁵⁹

Welcome Home Program: Governor Mills recently launched the 'Welcome Home' program in February 2020, which is intended to create a data driven approach to marketing Maine and attracting talented people to our state. While this program has had to be put on hold during the COVID-19 pandemic, there is great potential to attract new workers to live and work remotely in Maine, with added economic benefits to the state.

Live and Work in Maine: Live and Work in Maine is a private-sector initiative designed to increase awareness about career opportunities that exist in Maine and promote Maine’s quality of life. One goal of this initiative is to ensure the private sector, government, community organizations, and Maine people are working together towards the shared goal of building a strong workforce.⁶⁰

Maine CareerCenter: CareerCenter is a resource through the State of Maine Department of Labor that provides a variety of employment and training services at no charge for Maine workers and businesses including access to computers, interactive workshops, job fairs, training and education, and support services such as child care assistance, transportation, and tuition.⁶¹

Maine JobLink: Maine JobLink is an online database to help match job seekers with employment opportunities. Those looking for jobs can post their resume for employment opportunities, and employers can post job opportunities, all at no charge.⁶²

Maine Competitive Skills Scholarship Program (CSSP): The CSSP provides eligible individuals with access to postsecondary education, training for industry-recognized credentials, and support that can help lead to skilled, well-compensated jobs with anticipated high employment demand.

Maine can also work to attract companies looking to start a business, conduct research, develop innovative solutions, and grow jobs through a diverse marketing plan. As is highlighted by Maine’s Economic Development Strategy, “Many of the new jobs that will be created in the next ten years don’t exist today. And, of the existing jobs that will remain, many will be transformed by technology. The challenge is to identify which combination of global trends and Maine strengths will offer the creative space for the high-paying jobs of the future to be realized.”⁶³

Maine presents a balance of open space, ocean, and mountains to support an active lifestyle. But it also has some of the most creative, artistic centers that have been around for generations. It has a highly regarded food culture that is constantly expanding and diversifying. Highlighting all aspects of Maine life to attract a more diverse workforce across the state will only bring a more diverse set of ideas, food, culture, inspiration, and lead to a more diverse economy and innovation ecosystem. It is key that potential new residents understand the full scope of possibilities provided through Maine employment in order to attract a talented workforce to the state.

- **Launch a workforce initiative (led by the GEO and in partnership with the private sector) that: (a) creates an online database and resource for connecting job opportunities in clean energy with potential hires in order to streamline the job search process, and (b) establishes ongoing stakeholder coordination between industry and educational and training organizations to understand and support future workforce needs.**

A 2020 National Association of State Energy Officials (NASEO) report recognizes the important role that state energy offices can play in supporting innovation within the clean energy sector. The report identifies that innovation plays a key role in ensuring states are able to meet climate and clean energy targets in a way that are affordable, improves resiliency, and supports economic and workforce growth.

Innovative solutions and technologies will help to create cost savings, improve performance, and deploy larger-scale clean energy technologies, as well as change the way consumption and generation needs interact with the grid, advancing and modernizing grid management practices to reach those cost and climate goals.⁶⁴ In a recent report, NASEO Executive Director, David Terry, noted:

“As the United States continues to grapple with the economic impacts of the coronavirus pandemic, states can set a long-term direction for recovery and growth by continuing to invest in technology innovation, STEAM, and workforce initiatives. [State Energy Offices’] work in policymaking, regulatory intervention, grant-making, program design, and stakeholder convening offers a major opportunity to connect emerging technologies and their innovators with on-the-ground realities about markets, public priorities, and regulations.”⁶⁵

The GEO should work to fulfill this innovation support role through the creation of a public-private partnership that establishes ongoing stakeholder engagement between the clean energy industry and support, educational, and training organizations to better understand future workforce needs and help to establish programs that create avenues to train and educate workers to fill those positions, creating an ongoing workforce pipeline to meet expected growth needs.

Additionally, the GEO can lead the development of an online database for job seekers and employers in the clean energy industry to streamline the job search process while meeting workforce needs of clean energy employers, in coordination with existing state job resources. This database could also include relevant training and educational opportunities in the state. Similar proposals were included in the workforce survey responses, one such respondent noted that

“A clearinghouse for training resources...to help local employers and workers learn about and access existing resources, and further resources of the same nature would be helpful.” - Workforce Survey Respondent

This partnership may also help to identify additional opportunities to extend support for the cleantech innovation ecosystem in the state. This may include identifying and encouraging Maine company participation in startup support accelerator and incubator programs, mentor support programs, startup competitions, and financing opportunities.

As discussed below, many such organizations currently exist in Maine, such as the Maine Technology Institute, TechPlace, Maine Center for Entrepreneurs, Greenlight Maine, Startup Maine, Coastal Enterprises Inc., E2Tech, and others. Creating the platform to easily find those resources, in addition to the training and educational programs previously mentioned, and funnel job seekers to job opportunities can streamline efforts to build a vibrant and robust clean energy economy. Additionally, this presents an opportunity to coordinate with other states to replicate their successes. Greentown Labs in Massachusetts is an example of a successful cleantech innovation resource that has a history of cleantech companies flourishing out of their programs and support.⁶⁶

III: Cleantech Innovation

- Increase investment in cleantech innovation and continue to expand Maine's entrepreneurial ecosystem to develop and commercialize innovative products and services that will provide cost-effective clean energy solutions.

Clean energy technologies have advanced immensely over the last few decades. Solar technologies have decreased drastically in cost from the time they first began to be developed. Overnight capital costs⁶⁷ required to build a new onshore wind plant have decreased 38 percent between 2010 and 2018; in comparison, overnight capital costs to build a new natural gas combined-cycle power plant has only decreased by 2 percent over the same timeframe.⁶⁸ Additionally the costs to generate onshore wind and solar PV have fallen between 3-16% yearly since 2010, which is faster than many other consumer goods and products.⁶⁹ New energy innovations in bioproducts, tidal and river hydrokinetics, and grid management also have significant potential.

In Maine, the initial demonstration project of the 10-12 MW New England Aqua Ventus offshore floating turbine has been estimated to provide \$37.4 million to \$51.9 million in economic benefits over three years of the project, as well as 341 to 475 full- and part-time jobs with \$13.6-18.9 million in labor income, with additional benefits for continued operations. The University of Maine has also provided estimates of the larger scale economic benefits that can come from a scaling up of production and development of this technology to a 500 MW project.⁷⁰ Further benefits may also become available through participation in international and regional markets as offshore wind continues to grow globally.

The University of Maine's Advanced Structures and Composites Center (ASCC), which housed the research and development of the New England Aqua Ventus, offers numerous other world-leading technologies and research. The ASCC continues to develop innovative products and services in bioproducts, wood composites, infrastructure and bridges, offshore energy, and marine monitoring. The University of Maine is leading research in the technical and economic feasibility of cross-laminated timber (CLT) manufacturing in the state, which presents opportunities for carbon sequestering, sustainable building materials. The ASCC also houses the world's largest 3D printer, providing cutting-edge research and development opportunities that can lead to new jobs and economic growth.⁷¹

Advancements in areas such as clean energy storage technologies, microgrids, demand management, and renewable energy generation technologies are continuing. Maine is also already creating and implementing innovative energy solutions such as an anaerobic digester to generate power from biogas⁷², potential power-to-gas pilot projects, microgrids on Maine islands⁷³, advancements of integrated hydrokinetics from river and tidal currents⁷⁴ and advanced independent home energy solutions.⁷⁵



ORPC RivGen Power System being built at Brunswick Landing, Maine (Source ORPC)

TechPlace is a technology accelerator and manufacturing business incubator at Brunswick Landing that offers shared workspaces, small office spaces, manufacturing spaces, machine and wood shops, composites and paint facilities, and a bioproduction lab for start-up and early-stage companies. It provides an opportunity for entrepreneurial networking, expansion and development of innovative products and services, building and testing prototypes, and growing a technology or manufacturing company.⁷⁶ As of 2019, TechPlace has housed 38 early-stage startups with an overall employment impact of over 100 people.⁷⁷

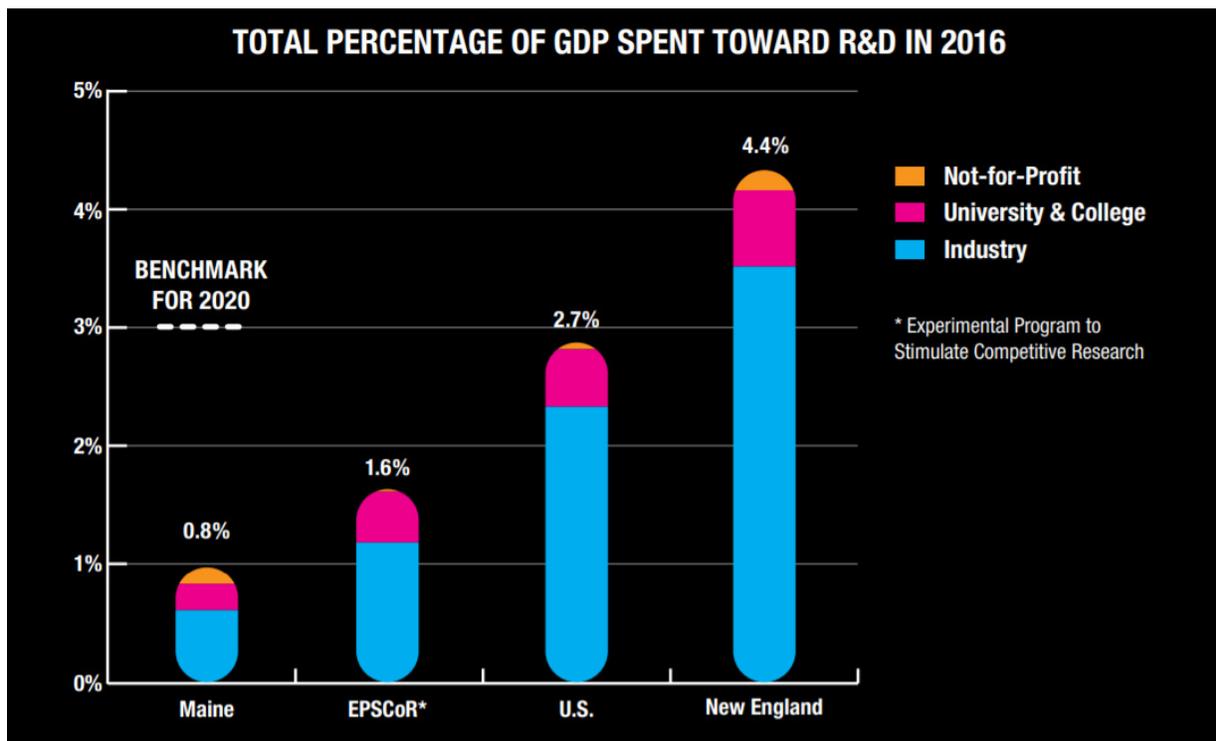
A number of clean energy companies have grown at TechPlace. In April 2019, Ocean Renewable Power Company unveiled its first commercial RivGen Power System, built at Brunswick Landing. That device was shipped to Alaska to provide clean electricity for the remote village of Igiugig, to reduce the community's dependence on diesel fuel and thus reducing their costs and carbon dioxide and particulate emissions. The company has received global recognition for its innovative clean energy solution, and has been supported by investors, crowdfunding, and by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.⁷⁸

As innovative ideas develop into commercialized products and services, it is imperative to provide the necessary resources and opportunities for development. For example, the state should not shy away from pilot projects, but find ways to support them cost-effectively as new technologies take time and money to evolve. Investing in the success of a new technology can lead to the development of advanced products and services that can be part of global clean energy solutions and reduce energy costs in the long-term as well seed greater competitiveness for the state. There are benefits in leading clean energy innovation and having the opportunity to market that new technology outside of the state, growing the pool of customers that will contribute to the Maine economy and helping to grow new jobs. Assistance must be focused beyond just initial research and development to ensure successful growth through the commercialization phase. The transition to commercialization can be immensely challenging for new companies but is vital to reaping the full initial investment and economic benefits.

Maine should support innovation, research and development (R&D), pilot programs, and the cleantech ecosystem overall, while balancing the benefits with potential cost implications for taxpayers and/or ratepayers.

- **Encourage private and public investment dollars to go towards products and services that advance the state’s climate and clean energy goals and provide state support for companies pursuing funding opportunities.**

In 2016, Maine invested just 0.8% of its GDP into R&D spending, which puts the state 45th in the country in this investment metric. Maine falls behind other states in private sector and university investment but has more investment from the nonprofit sector as a proportion of GDP compared to other states.⁷⁹



Source: Camoin Associates, National Science Foundation⁸⁰

However, despite its lower than average overall R&D investment, Maine has a well-established entrepreneurial support system that provides services to start-ups, allowing Maine to be a great place to start a business. As decisions arise around where to put public and private financing, investment should be encouraged to go towards products

and services that advance climate and clean energy solutions and discouraged regarding investment in fossil-fuel, high-carbon, and environmentally degrading businesses. When possible, the State of Maine, Maine companies, and support organizations should pursue federal dollars to grow cleantech startups and the entrepreneurial ecosystem.

An example of financing for innovative solutions is Maine Technology Institute's (MTI) Emerging Technology Challenge for Maine's Forest Resources. Given the identified potential of Maine's forest products industry, the purpose of the program was to support and attract the development of innovative technology companies in the forest resource sector.

As a result of the program, MTI awarded \$1.5 million in grants to two forest products emerging technology companies. While this program was focused specifically on forest products, it was initiated as a pilot project to inform similar innovation challenges in other sectors. The clean energy sector is primed for a similar opportunity for the benefit of Maine's economy.⁸¹

Several organizations in Maine provide guidance, resources, and financing to startups across the state. Since its creation in 1999, the Maine Technology Institute has provided nearly \$270 million to over 2,500 projects. Its \$45 million bond-funded program created in 2018, the Maine Technology Asset Fund (MTAF), will generate 5,350 jobs over three years with nearly \$1.4 billion in economic impact. Organizations such as Coastal Enterprises Inc. (CEI), E2Tech, Maine Center for Entrepreneurs, and Startup Maine, among others are also key players in driving the entrepreneurial ecosystem in Maine.⁸²

Maine companies have opportunities to participate in regional, and even global programs and startup opportunities, such as The Cleantech Open, the oldest and largest cleantech startup accelerator program. A number of successful Maine companies have participated in the Cleantech Open – some even winning the regional competition and receiving awards at the global competition – and have gone on to create beneficial and innovative cleantech solutions for Maine and beyond. These companies include: Pika Energy, Introspective Systems, Surge Hydro, Rapport, Cerahelix, BaselineES, Parent Technology Group, and Wood & Sons, among others. Continuing to support innovation and drive Maine companies to growth opportunities and resources remains vital to ensuring an expansive and supportive innovation ecosystem in the state.⁸³ .

- **Invest in broadband expansion in order to support business success and growth, as well as to provide the platform for innovative clean energy and grid management solutions.**
- **Achieve the state’s goal of 95% broadband deployment by 2025 and strive to serve 99% of the state by 2030, at the latest, with high-speed access.**

Broadband is a vital component of Maine’s business ecosystem and clean energy economy. The ability for businesses to adopt e-business processes enable improvements in business efficiencies and expanded marketing that are becoming essential to business success.⁸⁴ Particularly in rural and remote communities in Maine, connection through broadband internet is critical, and those communities simultaneously face higher costs in accessing high-speed broadband.

In recognition of the importance of broadband, especially during the disruption caused by the COVID-19 pandemic, and that much of Maine does not have adequate, high-speed access, achievement of Maine’s goal of 95% high-speed broadband deployment by 2025 as established by ConnectMaine is vital. Maine should also strive to serve 99% of the state by 2030, at the latest, with high-speed access.⁸⁵

One successful effort to provide funding for broadband expansion was a \$15 million bond that voters passed by a 3-to-1 margin in the July 2020 primary elections. This funding will leverage up to \$30 million in additional private and government grants.⁸⁶ While helpful, additional funding will be needed to meet the state’s goals.

Affordability of broadband, in addition to access, is crucial. As companies implement innovative grid management systems and other internet-intensive initiatives, they require reliable and affordable high-speed broadband access to support research and development, business practices, and the software and algorithms that manage the electricity grid. These includes load-shaping strategies such as time-varying pricing, virtual energy markets, energy efficiency practices like smart thermostats, and other appliance management programs, among others. Maine must expand broadband to support the innovative clean energy and grid management solutions of the future.

Broadband should be considered as a central component of grid modernization and transmission and distribution expansion. For example, the New England Clean Energy Connect transmission project includes a \$10 million investment to a broadband fund to supply grants for expanding availability of broadband in western Maine.⁸⁷ This connection between electricity grid expansion and broadband access exemplifies potential co-benefits from growth in Maine’s clean energy sector.

The Island Institute has examined the benefits of broadband access, particularly across rural Maine communities. It’s research cites improvement of business efficiency, workforce development, quality of life improvement, attraction and retention of young families, support of schools and education, the ability to provide second incomes, and the opportunity for telehealth and telemedicine, all of which contribute to the local economy and help sustain communities and attract new community members.⁸⁸ Many of these community benefits align with the needs of the clean energy economy.

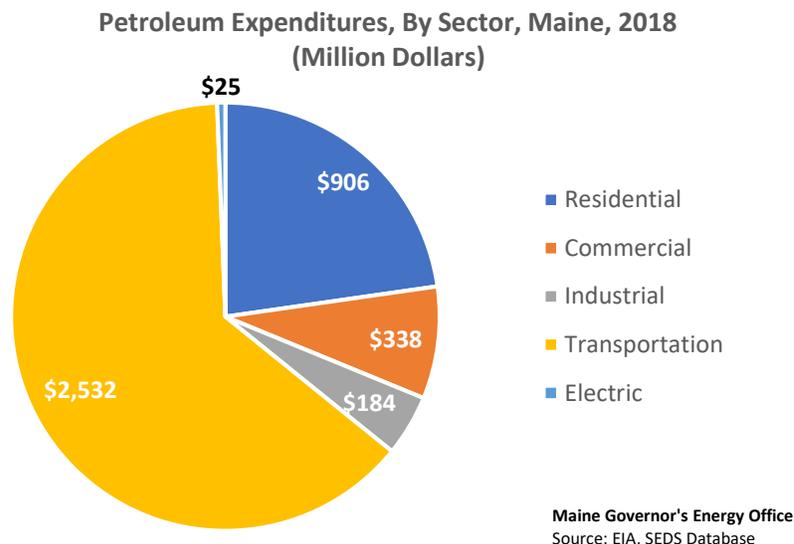
IV: Equity & Just Transition

- **Include equity and cost considerations in the support and development of energy programs, particularly those targeted at low to moderate income households, to aid in decreasing overall energy burdens and shift towards low-carbon heat and energy sources.**

Throughout Maine’s continued efforts to strengthen the clean energy sector, equity must be a key consideration. Maine should continue to prioritize this and share best practices with other states that are actively engaged in these efforts. Current policy planning processes in Maine are already explicitly including equity considerations. The Maine Climate Council worked with the University of Maine to assess the proposed climate action recommendations from an equity perspective to better understand how the associated actions could impact vulnerable populations and suggest refinements to improve equitable distribution of benefits.⁸⁹

The GEO is conducting a Renewable Energy Market Assessment⁹⁰ to provide important information about how Maine can meet its clean energy requirements, and it will also include analysis and insight into equity issues. Continued targeted efforts will be needed to ensure equity considerations and equitable implementation of policies and programs occur within clean energy efforts across the state. In-state and regional renewable energy generation has the potential to stabilize energy costs for Maine people. Fossil fuels often experience price volatility that is influenced by a global market and presents challenges in forecasting fossil fuel prices. In contrast, renewable energy generation can provide price stability through their ability to utilize existing non-purchase fuels such as solar, wind, water, and geothermal after development. The overall costs of building and generating electricity from renewable sources have shown to be stable or decreasing over time, compared to the fluctuating costs of fossil fuels.⁹¹

Not only can in-state generation resources provide more stable energy costs, but the economic benefits and payments for purchase of these sources of energy can stay within the state, rather than going to out-of-state fossil fuel providers.⁹² In 2018, Maine spent \$4.4 billion on out-of-state fossil fuels, with the majority of that spending on petroleum products.⁹³ In addition to keeping energy payments within the state, clean energy generation also supports overall energy price reductions and price stability. Currently, most of Maine’s petroleum expenditures are associated with transportation and home heating.



Source: EIA⁹⁴

Maine should continue to support energy efficiency programs, particularly those targeted at low- to moderate-income households, to aid in decreasing overall energy expenditures per household, and shift towards low-carbon heat and energy sources for buildings.

In 2018-2019 Efficiency Maine Trust (EMT) offered programs to almost 38,000 low-income participants that saved over 12 million kWh of electricity per year, with estimated lifetime savings of nearly 120 million kWh, at a benefit-to-cost ratio of 3.82. EMT partnered with the Department of Health and Human Services to reach additional low-income households, increasing their low-income household outreach list by over 400%. That expansion of outreach in addition to intentional actions doubled weekly installations from 6 to 12. While EMT provides programs and financial incentives for all Mainers to make energy efficiency and weatherization improvements, the results of EMT's low-income electrification program especially exemplify the opportunity to assist Maine's low-to-moderate income households.⁹⁵

MaineHousing also offers a number of energy-related programs targeted for low to moderate income households. These programs include assistance for heating and electricity costs, heat pump installation, weatherization, improvements to central heating systems, and education on reducing home energy needs. In 2019, nearly 390 homes were weatherized and over 970 households educated on reducing home energy needs through these programs.⁹⁶

Additionally, energy efficiency offers economic benefits to all energy consumers, not just those who pursue individual projects, through lower overall demand for electricity resulting in lower wholesale electricity rates, as high-cost power plants can run less and expensive transmission upgrades can be avoided or accomplished through nonwires alternatives.⁹⁷ These outcomes can benefit all Maine ratepayers through a more affordable and stable energy supply.

- **Support policy solutions that ensure fair distribution of benefits within the state and access to those associated benefits across all communities.**

Already, Maine has included equity and just transition considerations within recently established clean energy programs. Solar and distributed generation legislation included a requirement for shared and community solar projects to have ten percent of total nameplate capacity be subscribed by households with low or moderate income or by organizations serving such households. This type of policy provision aids in the effort to extend the benefits of renewable energy generation across income levels and communities in the state.

Maine's new, more ambitious RPS statute established a requirement within the renewable energy generation solicitation to place 30% weight on economic benefits, with the other 70% weight on price. This 30% weight on economic impact is a way for the state to ensure that through the pursuit of clean energy targets, benefits are provided to local communities that could include, but are not limited to, creation of local well-paying jobs, investment through taxes, community benefits packages, and other community economic investments. Similar approaches to policy development and program design can continue to provide economic benefits to Maine's communities. Additionally, as was seen with the first round of RPS resource procurement, renewable generation can be comparatively low-cost.⁹⁸

Transitioning away from fossil-fuels to clean energy sources and pursuing energy efficiency also results in improved public health. A study of the Regional Greenhouse Gas Initiative (RGGI)⁹⁹ and a study from the United States Environmental Protection Agency (EPA)¹⁰⁰ establish monetized benefits of improved public health from a reduction in fossil-fuel usage and increased energy efficiency. Developing a strong clean energy economy in Maine will provide these associated public health benefits to Maine people across communities.

When possible, specific focus should be given to creating jobs, particularly targeting those areas that face economic challenges. Economic development and job creation are encouraged in low-income urban and rural communities through Opportunity Zones. These designated areas were established by Congress in the Tax Cuts and Job Act of 2017 and provide tax incentives for development in economically distressed communities.¹⁰¹ Given this incentive for development, and the recognized need for economic support, opportunity zones in Maine are an example of areas that can be targeted for economic and workforce benefits associated with a stronger clean energy economy.



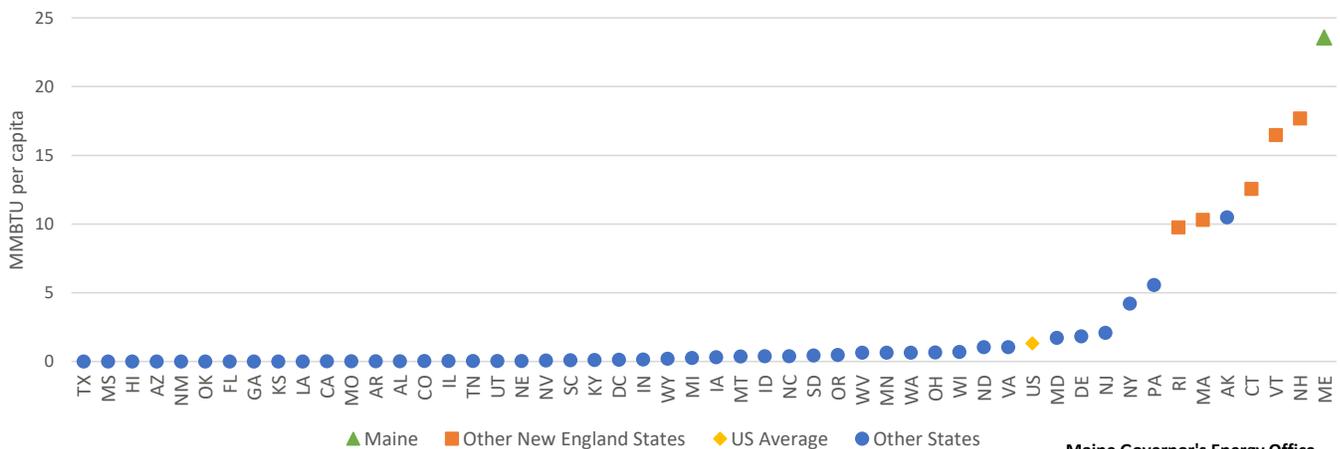
The Bingham Wind Project in Somerset and Piscataquis Counties began operation in 2016 with fifty-six 3.3MW turbines for a combined capacity of 185MW. The project created over 1,000 construction jobs among other positive supply chain impacts. In 2019, Bingham Wind paid \$1.3 million in property taxes and nearly \$700,000 in community benefit payments, in addition to the environmental and public health benefits of supplying zero-carbon, renewable electricity to the grid.¹⁰²

Bingham Wind Project in Somerset and Piscataquis Counties, Maine (Novatus Energy)

- **Identify opportunities to create programs that will assist energy companies in transitioning to the clean energy economy of the future.**

States across the country are facing challenges around fossil-fuel centered industry and communities as they transition away from carbon-intensive fuel sources. This is particularly tangible in areas where large amounts of fossil fuels are produced and whole communities are built around those industries. Currently, Maine is highly dependent on fossil fuels in the heating and transportation sectors. Maine is the most heating oil dependent state for residential heating in the country, sending billions of dollars out of state on fossil fuels each year. This reliance on fossil fuels also produces the majority of Maine’s in-state energy emissions in the residential and transportation sectors.

Total Residential Distillate Fuel Oil Usage Per Capita, 2017



Maine Governor's Energy Office
Source: EIA, SEDS Database

While Maine does not produce fossil fuels, over half of Maine’s fuel sector jobs involve oil and other petroleum fuels. In order to reduce our dependence on fossil fuels and its associated emissions, Maine will need to focus on transitioning the heating and transportation sectors to technologies that utilize clean electricity and low-carbon fuels. The impacts to this sector as Maine transitions away from high-carbon energy sources should be acknowledged and strategies should be incorporated to help these workers and businesses transition to the future economy.

The 10-year economic strategy highlights the transition of forest products industry as a model for this kind of transition:

“For example, in the last couple of years the forest product industry has seen quantum leaps forward in development where new products have begun to emerge such as nanocellulose. This product takes advantage of the great abundance of trees with cutting edge science and engineering. To keep pushing this evolution, support is needed in the existing value chain, i.e. loggers are still required to fell trees and transport is still required to mills, in addition to new elements such as coders, chemists and biologists. This thematic approach requires cross cutting labor force policies that generate the depth of skills and training needed from basic to advanced degrees.”¹⁰³

Maine’s pathway to a clean energy economy must ensure these companies and workers are provided with new opportunities. Workers will be needed, and many of the skills in these energy sectors can be utilized, in clean energy employment. Additionally, in order to pursue carbon reduction strategies such as strategic electrification, significant expansion and modernization of the electric grid will be required, providing growth opportunities within the transmission and distribution sector, including management, construction, and other relevant services. These job opportunities could provide transition opportunities for workers with similar skillsets that may be displaced. But supports and resources need to be diligently created and expanded as needed in a concerted effort to create a just transition to a clean energy economy.

CONCLUSION

Maine can grow our economy and combat climate change. The serious, collective economic implications of climate change and COVID-19 create an opportunity to both jumpstart economic recovery and build a better future through the clean energy economy.

Making clean energy a priority in climate action and economic recovery, we can create thousands of good paying jobs, improve the public health of Maine people, protect our natural resources, and produce affordable clean energy.

Actions to strengthen Maine's clean energy economy alone are insufficient to be the only method to mitigate and adapt to climate change and recover our economy, but they can play a significant role. The strategies outlined in this report can build a growing clean energy economy, sustainable industries, and good paying jobs in Maine for the long-term.

The time to act is now.



APPENDIX A

Maine Clean Energy Economy Workforce Survey

This is not a scientific survey and is not a statistically valid sample. Rather, this survey is a self-selected sample of entities that were willing to participate and is meant to be illustrative of the energy sector and provide insight into qualitative, overarching themes.

The survey was created by the Governor’s Energy Office (GEO) and the Governor’s Office of Policy Innovation and the Future (GOPIF). It was distributed via the GEO website, the Maine Climate Council website, and various relevant energy-related organizations in September 2020. The intent of this survey is to provide high-level, qualitative analysis to help inform the current status and future impact and needs of Maine’s clean energy workforce as the state transitions to a clean energy future.

The highest percentage of respondents represented companies and organizations categorized as renewable energy (36%), followed by energy efficiency (26%), professional services (18%), other (12%), and grid, storage, and fuels. The other category primarily represents nonprofits, educational institutions, and companies within the energy supply chain. The grid, storage and fuels category includes transmission, distribution and storage, alternative transportation and other fuels.

Responses by Sector		
Renewable Energy	42	36%
Energy Efficiency	31	26%
Professional Services	21	18%
Other	14	12%
Grid, Storage & Fuels	10	8%
Total	118	100%

Some responses were not utilized due to a lack of survey completion or because the company/organization did not fit into the energy sector as was defined for this survey. Additionally, some responses were re-categorized, particularly out of the ‘other’ category, and into the defined subsectors for accuracy of analysis.

Across sectors, about half of respondents’ work and half of their employees are dedicated to clean energy and/or energy efficiency. These responses are broken down by subsector in the chart below.

	% companies work dedicated to clean energy/energy efficiency	% companies’ employees dedicated to clean energy/energy efficiency
Energy Efficiency	69%	61%
Professional Services	43%	43%
Renewable Energy	51%	51%
Grid, Storage & Fuels	47%	34%
Other	32%	23%

The following summary is of responses to the question: “Do you expect that Maine’s efforts to transition to a clean energy economy will have significant positive or negative workforce and economic impacts within your company, or no impact?”

Responses by Sector	Positive	% Positive	Negative	% Negative	No Impact	% No Impact
Energy Efficiency	19	61%	2	6%	11	35%
Professional Services	18	86%	0	0%	3	14%
Renewable Energy	36	86%	4	10%	2	5%
Grid, Storage & Fuels	8	80%	1	10%	1	10%
Other	14	100%	0	0%	0	0%
Total	95	81%	7	6%	17	14%

Over 80% of respondents indicated that they expect to experience positive workforce and economic impacts within their company as a result of Maine’s efforts to transition to a clean energy economy; 14% indicated no expected impact, and 6% indicated a negative expected impact. These percentages do not add up to 100% due to rounding.

There were a variety of responses to the question, which was asked of everyone, of whether companies expected to experience an increase in projects and/or revenues as a result of supportive clean energy policies. Many noted a positive expected impact as a results of Maine’s prime position to grow and build its clean energy sector.

- “Maine is well suited to be an international leader in floating offshore wind technology with technical expertise, floating structures manufacturing skills, facilities, deep water high wind resources and a talented work force.”
- “Given the widespread support for renewable energy in the legislative and executive branches, we believe the signs point toward more opportunities for the clean energy industry in the near- to medium terms”

Some stated that increased projects and revenues would be partially dependent on the availability of adequate and trained workforce.

- “Yes. If, and only if we can attract enough skilled talent to actually do the work. Maine has a shortage of skilled people in this field.”
- “Lack of trained staff prohibits expansion.”
- “We are only restricted by qualified staffing and fleet expense.”

Less common, but still noted, others were expecting potentially negative impacts.

- “We believe these ambitions while well intentioned will lead to increased operating costs as well as restrictive new regulations that will increase cost and decrease opportunity.”

The respondents represented companies and organizations with around 5,300 total employees.

	Current Employees	Projected Additional Employees in 1-2 Years	Projected Additional Employees in 3-5 Years
Total	5,330	254	704
Average	61	4	14
% increase of 2020 Total		5%	13%

Some respondents indicated employment values that were of their total global or national employment, including outside of Maine, and those numbers were excluded from analysis to estimate Maine-based employment only. On average, companies anticipate 5% employment growth over the next 1-2 years, and 13% employment growth over the next 3-5 years. However, many companies noted that those values represent in-house employment growth only, and that their success in Maine’s energy sector will result in significant co-benefits through job growth of relevant supply chain businesses.

The following chart represents respondents’ answers to whether or not they anticipate being able to meet their future workforce needs.

Do you anticipate being able to meet your future workforce needs?		
	Total	Percentage
Yes	68	71%
No	12	13%
Unsure	16	17%
TOTAL	96	101%*

*percentages do not equal 100% due to rounding

While the majority (71%) of those who responded to this question did say they expected to meet their own hiring needs, many indicated that this would not be accomplished without challenges. Some indicated that they would need to hire from out of state, and others noted that they would need help from training programs and community colleges in order to ensure adequate qualified workers.

- “Yes, but it will not be easy, will require education and help from the voc/tech community”
- “Yes, but many new candidates typically come from outside of Maine”
- “I closed my solar installation business unit, due to lack of qualified recruits a few years ago.”
- “Yes - with struggles anticipated to fill some of the positions.”
- “Yes, with focused efforts on recruitment and training”

Additionally, many noted that while they would be able to meet their workforce needs, they anticipated hiring difficulties and setbacks in the industry overall in terms of lack of contractors and other such positions to carry out projects.

- “Internally yes. However, we anticipate a shortcoming for contractors that are able to install and assemble solar energy projects.”
- “We don’t believe there are enough qualified contractors with sufficient workforce to build all of the Maine solar projects that are being developed as a result of the renewable energy legislation.”

Many, particularly within the renewable energy sector, expressed concern about not having enough electricians in the state.

- “Most likely. The construction hire will hopefully be an in-house electrician but there are shortages of electricians in ME, having enough electricians and other labor in the state is likely going to be a challenge”
- “Yes, but the state of Maine needs to be generating *way* more electricians. There is an extreme shortage of them and it’s a great career for people to get into.”

The following chart shows the responses to the question, “If you anticipate workforce challenges, what do you expect to be your biggest obstacle to ensuring adequate workers in Maine to meet the need over the next 1-5 years? Choose up to three.”

	Lack of workforce with necessary skills within the state	Lack of workforce seeking relevant employment	Lack of training/ educational programs within the state	Lack of policies supporting growth in the clean energy sector	Lack of new workforce entering the state	Too many workers leaving the state	Other
Energy Efficiency	16	9	6	2	3	1	2
Professional Services	5	1	0	1	1	1	3
Renewable Energy	16	4	8	11	5	3	5
Grid, Storage & Fuels	1	0	0	1	1	0	0
Other	4	2	3	3	0	0	3
Total	42	16	17	18	10	5	13
Percentage	35%	13%	14%	15%	8%	4%	11%

The most prominent reason given as an expected challenge to meeting workforce needs was a lack of workforce with necessary skills within the state (35%) which was followed by lack of policies supporting growth in the clean energy sector (15%), lack of training/educational programs within the state (14%), and lack of workforce seeking relevant employment (13%).

Companies within the following subsectors indicated the workforce education or training resources they have utilized, in the chart below.

	Apprenticeship	On the Job Training	Internship/ Work Experience	Training Assistance	Consultation/ Seminars/ Workshops	Hiring Tax Credits	Candidate Recruitment	Maine Quality Centers	Maine's Community Colleges	Other
Energy Efficiency	5	14	4	3	8	0	1	0	7	5
Professional Services	0	8	7	3	4	0	7	0	1	2
Renewable Energy	7	20	22	8	11	1	10	0	7	3
Grid, Storage & Fuels	2	2	3	1	3	0	2	0	1	1
Other	3	3	6	0	3	0	3	1	1	3
TOTAL	17	47	42	15	29	1	23	1	17	14
AVERAGE	3.4	9.4	8.4	3.0	5.8	0.2	4.6	0.2	3.4	2.8
PERCENTAGE	8%	23%	20%	7%	14%	0%	11%	0%	8%	7%

About a quarter of respondents utilized ‘on the job training’, followed closely in popularity by internship/work experience (20%) and consultation/seminars/workshops (14%). A number of respondents also indicated that they have utilized apprenticeships, training assistance, candidate recruitment, Maine Community Colleges, and other programs. Only a handful of respondents indicated utilization of Maine Quality Centers or Hiring Tax Credits.

In response to the utilization and effectiveness of workforce education or training resources toward desired outcomes, many respondents indicated success. Many noted that internships were an effective pathway to fulltime employment and that in-house training was a reliable way to ensure adequately trained workforce for their needs. Additionally, many respondents expressed successful collaboration with Maine Community College System (MCCS) and a continued desire to build partnerships and programs with MCCS.

There were many responses to the question of what additional programs the State of Maine could offer to help meet expected workforce needs as the state grows a clean energy economy that offered insight into gaps and future needs. There were many concerns around the state’s lack of electricians and the need to continue to train, license and build that workforce in order for the successful growth of the clean energy sector. Many expressed the need for better outreach and promotion of current program offerings and continued coordination with Maine Community College System, including requests for various additional training program offerings. Overall, there was a theme of needing coordination among the state, training/educational institutions, and industry in order to best align training programs with future workforce needs and employment opportunities. On education, some respondents indicated that encouraging science, technology, engineering, and mathematics (STEAM) and trades education in K-12 would be helpful in building interest and setting the foundation for skilled workers in Maine. And finally, there were a few mentions of needing to attract more skilled workers to the state through various incentives.

ENDNOTES

- 1 Maine Public Law 2019, Chapter 476 (LD 1679 *An Act To Promote Clean Energy Jobs and To Establish the Maine Climate Council*)
- 2 Maine Department of Economic and Community Development (DECD). *Maine Economic Development Strategy 2020-2029: A Focus on Talent and Innovation*. November 2019. <https://www.maine.gov/decd/strategic-plan>
- 3 Maine DECD. *Maine Economic Development Strategy 2020-2029: A Focus on Talent and Innovation*.
- 4 ConnectMaine. *State of Maine Broadband Action Plan*. January 2020. <https://www.maine.gov/connectme/about/annual-reports>
- 5 Maine Public Law 2019, Chapter 477 (LD 1494 *An Act To Reform Maine's Renewable Portfolio Standard*)
- 6 This chart is showing just Class I (and Class IA in Maine) resource requirements; the 80% RPS by 2030 includes Class II resources which can make up the remaining 30% in Maine.
- 7 ISO New England. *The New England states' framework for reducing greenhouse gas emissions continue to evolve*. October 2019. <http://isonewswire.com/updates/2019/10/2/the-new-england-states-frameworks-for-reducing-greenhouse-ga.html>
- 8 Maine DECD. *Maine Economic Development Strategy 2020-2029: A Focus on Talent and Innovation*.
- 9 Karl-Erik Stromsta. Greentech Media. *Maine's \$100M Floating Offshore Wind Project Finds Major Backers: RWE and Mitsubishi*. August 2020. <https://www.greentechmedia.com/articles/read/maines-floating-offshore-wind-project-scores-major-backers-rwe-and-mitsubishi>
- 10 Of the harvested wood: 50% is pulpwood, 27.5% are sawlogs, 20% is biomass, 2.6% is firewood and pellets. (Forest Opportunity Roadmap/Maine)
- 11 Forest Opportunity Roadmap/Maine (FOR/ME). *Vision and Roadmap for Maine's Forest Products Sector*. September 2018. <https://formaine.org/>
- 12 Forest Opportunity Roadmap/Maine (FOR/ME).
- 13 American Jobs Project. *The Maine Jobs Project: A Guide to Creating Jobs in Offshore Wind*. June 2018. http://americanjobsproject.us/wp/wp-content/uploads/2018/06/Maine_Report_6_7_18_FINAL.pdf
- 14 E2, BW Research, ACORE, E4TheFuture. *Some Clean Energy Employees Are Returning to Work, but Sector's Full Recovery Unlikely If Congress Doesn't Act*. News release, July 10, 2020. https://e4thefuture.org/wp-content/uploads/2020/07/Clean-Energy-Jobs-Update-June-2020_COVID19-Impact-Release_JULY-2020.pdf
- 15 E2. *Clean Jobs America 2020: Repowering America's Economy in the Wake of COVID-19*.
- 16 E2. *Clean Jobs America 2020: Repowering America's Economy in the Wake of COVID-19*.
- 17 In 2019, job numbers indicated that there were 8,946 traditional energy workers employed throughout the state. Of these workers: 2,928 were in electric power generation, 3,230 are in fuels, and 2,789 are in transmission, distribution, and storage (2020 USEER)
- 18 National Association of State Energy Officials (NASEO) and Energy Futures Initiative. *2020 U.S. Energy & Employment Report (USEER)*. 2020. Accessed July 16, 2020. <https://www.usenergyjobs.org/>
- 19 NASEO and Energy Futures Initiative. *2020 U.S. Energy & Employment Report*.
- 20 NASEO and Energy Futures Initiative. *2020 U.S. Energy & Employment Report*.
- 21 NASEO and Energy Futures Initiative. *2020 U.S. Energy & Employment Report*.
- 22 NASEO and Energy Futures Initiative. *2020 U.S. Energy & Employment Report*.
- 23 NASEO and Energy Futures Initiative. *2020 U.S. Energy & Employment Report*.
- 24 NASEO and Energy Futures Initiative. *2020 U.S. Energy & Employment Report*.

- 25 E2, BW Research, ACORE, E4TheFuture. *Clean Energy Employment Initial Impacts from the COVID-19 Economic Crisis*. September 2020. <https://e2.org/wp-content/uploads/2020/10/Clean-Energy-Jobs-September-COVID-19-Memo-Final.pdf>
- 26 International Renewable Energy Agency (IRENA). *Renewable Power Generation Costs in 2019*. 2020. https://www.irena.org/media/Files/IRENA/Agency/Publication/2020/Jun/IRENA_Power_Generation_Costs_2019.pdf
- 27 E2, E4TheFuture, BW Research Partnership. *Build Back Better, Faster: How a federal stimulus focusing on clean energy can create millions of jobs and restart America's economy*.
- 28 Efficiency Maine. *Efficiency Maine Helps Brighten More than 50 Maine Public Schools with Incentives to Support Lighting Upgrades*. July 2020. <https://www.energymaine.com/efficiency-maine-helps-brighten-more-than-50-maine-public-schools-with-incentives-to-support-lighting-upgrades/>
- 29 Efficiency Maine. *Efficiency Maine Helps Brighten More than 50 Maine Public Schools with Incentives to Support Lighting Upgrades*.
- 30 E2. *Clean Jobs America 2020: Repowering America's Economy in the Wake of COVID-19*. April 2020. <https://e2.org/wp-content/uploads/2020/04/E2-Clean-Jobs-America-2020.pdf>
- 31 Brattle Technology Partnership Practice, prepared for Maine Technology Institute. *Re-Examining Maine's Economic Position, Innovation Ecosystem and Prospects for Growth In Its Technology-Intensive Industry Clusters*. April 2014. <https://www.mainetechnology.org/program/cluster-initiative-program/>
- 32 The Solar Foundation. *10th Annual National Solar Jobs Census 2019*. February 2020. <https://www.thesolar-foundation.org/national/>
- 33 Maine Public Utilities Commission. *Commission Selects Renewable Energy Projects to Help Achieve Maine's Renewable Portfolio Standard Goals*. September 2020. <https://www.maine.gov/tools/whatsnew/index.php?topic=puc-pressreleases&id=3329595&v=article08>
- 34 American Jobs Project. *The Maine Jobs Project: A Guide to Creating Jobs in Offshore Wind*. June 2018. http://americanjobsproject.us/wp/wp-content/uploads/2018/06/Maine_Report_6_7_18_FINAL.pdf
- 35 One example of this production is Maine Standard Biofuels which is a biorefinery that collects used cooking oil and recycles it into a variety of bio-based products. Their bioheat is a cleaner burning heating oil that can be used in any oil furnace or boiler, as well as a B99.9 biodiesel fuel for transportation. Source: Maine Standard Biofuels (<https://www.mainestandardbiofuels.com/>)
- 36 University of Maine, Forest Bioproducts Research Institute. (n.d.) <https://forestbioproducts.umaine.edu/>
- 37 Dr. Jurgen Weiss, J. Michael Hagerty, and Maria Castaner. The Brattle Group. *The Coming Electrification of the North American Economy*. March 2019. <https://wiresgroup.com/the-coming-electrification-of-the-north-american-economy/>
- 38 Examiner's Report, Maine Public Utilities Commission, Docket No. 2017-00232, March 29, 2019
- 39 Efficiency Maine Trust. Registered Vendor Webpage. <https://www.energymaine.com/at-home/vendor-locator/>
- 40 According to the 2019 Brookings Report, "mean hourly wages exceed national averages by 8 to 19 percent. Clean energy economy wages are also more equitable; workers at lower ends of the income spectrum can earn \$5 to \$10 more per hour than other jobs."
- 41 Mark Muro, Adie Tomer, Ranjitha Shivaram, Joseph Kane. Metropolitan Policy Program at Brookings. *Advancing Inclusion Through Clean Energy Jobs*. April 2019. <https://www.brookings.edu/research/advancing-inclusion-through-clean-energy-jobs>
- 42 NASEO and Energy Futures Initiative. *2020 U.S. Energy & Employment Report*.

- 43 Mark Muro, Adie Tomer, Ranjitha Shivaram, Joseph Kane. Metropolitan Policy Program at Brookings. *Advancing Inclusion Through Clean Energy Jobs*. April 2019. <https://www.brookings.edu/research/advancing-inclusion-through-clean-energy-jobs>
- 44 Solar Energy Industries Association. Webpage. *Solar Investment Tax Credit (ITC)*. Accessed October 2020. <https://www.seia.org/initiatives/solar-investment-tax-credit-itc>
- 45 Introspective Systems. *Introspective Systems Selected to Meet with Members of Congress to Discuss Future of Clean Energy Economy and Development*. March 2019. <https://www.introspectivesystems.com/introspective-systems-selected-to-meet-with-members-of-congress-to-discuss-future-of-clean-energy-economy-and-development/>
- 46 Maine Department of Education. *Career and Technical Education*. Webpage. Accessed August 2019. <https://www.maine.gov/doe/learning/cte>
- 47 Maine Department of Education. *Career and Technical Education*.
- 48 Maine State Chamber of Commerce and Educate Maine. *Career Technical Education (CTE): Increasing Student Success by 100% For Maine*. 2017. https://www.educatemaine.org/docs/17-029_EDME_CTE-Policy-Brief-FNL.pdf
- 49 Maine State Chamber of Commerce and Educate Maine. *Career Technical Education (CTE): Increasing Student Success by 100% For Maine*. 2017. https://www.educatemaine.org/docs/17-029_EDME_CTE-Policy-Brief-FNL.pdf
- 50 Maine Community College System. *Maine Quality Centers Program FY19 Annual Report*. October 2019. <https://www.mccs.me.edu/about-mccs/system-info/mccs-reports/>
- 51 Northern Maine Community College. Webpage. *Wind Power Technology*. <https://www.nmcc.edu/academics/programs/academic-programs/wind-power-technology/>
- 52 Kennebec Valley Community College. Webpage. *Programs of Study*. <https://www.kvcc.me.edu/academics/information/programs-of-study/sustainable-construction/>
- 53 Maine Energy Marketers Association (MEMA) Technical Education Center. Webpage. <https://mtecenter.com/>
- 54 Maine Department of Labor Bureau of Employment Services. *Maine Apprenticeship Program 2019 Annual Report*. https://www.maine.gov/labor/jobs_training/apprenticeship/
- 55 Maine Department of Labor Bureau of Employment Services. *Maine Apprenticeship Program 2019 Annual Report*. https://www.maine.gov/labor/jobs_training/apprenticeship/
- 56 767 apprentices in 2018 to 1,104 apprentices in 2019; 96 sponsors in 2018 and 114 sponsors in 2019 (2019 Maine Apprenticeship Program Annual Report)
- 57 Maine Department of Labor Bureau of Employment Services. *Maine Apprenticeship Program 2019 Annual Report*. https://www.maine.gov/labor/jobs_training/apprenticeship/
- 58 Maine Department of Administrative and Financial Services Maine Revenue Service. Webpage. *Educational Opportunity Tax Credit*. https://www.maine.gov/revenue/taxrelief/ed_opp_credit.htm
- 59 New Mainers Resource Center. Webpage and 2018 Annual Report. <https://nmrcmaine.org/>
- 60 Live and Work in Maine. Website. <https://www.liveandworkinmaine.com/>
- 61 Maine Department of Labor. CareerCenter Webpage. <https://www.mainecareercenter.gov/index.shtml>
- 62 Maine Department of Labor. CareerCenter Programs. Webpage. <https://joblink.maine.gov/ada/r/programs>
- 63 Maine DECD. Report. *Maine Economic Development Strategy 2020-2029: A Focus on Talent and Innovation*. November 2019. <https://www.maine.gov/decd/strategic-plan>
- 64 NASEO. *States and Cleantech Innovation: An Examination of State Energy Offices' Roles in Clean Energy Technology-Based Economic Development*. June 2020. <https://www.naseo.org/news-article?NewsID=3511>
- 65 NASEO. *States and Cleantech Innovation: An Examination of State Energy Offices' Roles in Clean Energy Technology-Based Economic Development*.
- 66 Greentown Labs. Webpage. <https://greentownlabs.com/>

- 67 Overnight costs exclude interest expenses during plant construction and development (U.S. Energy Information Administration).
- 68 Xiaojing Sun. Greentech Media. *Solar Technology Got Cheaper and Better in the 2010s. Now What?* December 2019. <https://www.greentechmedia.com/articles/read/solar-pv-has-become-cheaper-and-better-in-the-2010s-now-what>
- 69 International Renewable Energy Agency (IRENA). *Renewable Power Generation Costs in 2019*. 2020. https://www.irena.org/media/Files/IRENA/Agency/Publication/2020/Jun/IRENA_Power_Generation_Costs_2019.pdf
- 70 Todd Gabe. School of Economics, University of Maine. *Economic Impacts of the New England Aqua Ventus (Phases I and II) Offshore Wind Power Program in Maine*. August 2013. <https://composites.umaine.edu/wp-content/uploads/sites/20/2020/08/Gabe-Report-Dec-4.pdf>
- 71 University of Maine. Webpage. *Advanced Structures & Composites Center*. <https://composites.umaine.edu/>
- 72 Midcoast Regional Redevelopment Authority (MRRA). Webpage. *Anaerobic Digester Biogas Power Plant*. <http://mrra.us/about/infrastructure/anaerobic-digester-biogas-power-plant/>
- 73 Introspective Systems. *Portfolio Project: Isle au Haut Microgrid*. https://www.introspectivesystems.com/wp-content/uploads/2019/04/Project-Isle_au_Haut_Introspective_Systems.pdf
- 74 Ocean Renewable Power Company. News Webpage. *ORPC set to discuss \$10 million model project for Eastport*. June 2020. <https://www.orpc.co/media/news/orpc-set-to-discuss-10-million-dollar-model-project-for-eastport>
- 75 Pika Energy. Webpage. <https://www.pika-energy.com/>
- 76 TechPlace. Webpage. <http://techplacemaine.us/>
- 77 Portland Press Herald. Steve Levesque. *From MRRA: You Can Make It Here*. July 2019. https://www.pressherald.com/2019/07/03/from-mrra-you-can-make-it-here/#goog_rewarded
- 78 Ocean Renewable Power Company. *Governor Mills Leads Celebration of Commercial RivGen Product Launch*. April 2019. https://www.orpc.co/uploads/news/gov-mills-leads-celebration-of-commercial-rivgen-product-launch_636911682366877007.pdf
- 79 Maine Economic Growth Council Administered by Maine Development Foundation. *Measures of Growth: Performance Measures and Benchmarks to Achieve a Vibrant and Sustainable Economy for Maine*. 2019. <https://www.mdf.org/wp-content/uploads/2019/04/MOG-FullReport2019-FNL.pdf>
- 80 Maine Development Foundation. *Measures of Growth*.
- 81 Maine Technology Institute. *The Maine Technology Institute (MTI) Awards \$1.5 Million in its Emerging Technology Challenge for Maine's Forest Resources*. April 2019. <https://www.mainetechnology.org/news/the-maine-technology-institute-mti-awards-1-5-million-in-its-emerging-technology-challenge-for-maines-forest-resources/>
- 82 Maine Technology Institute. Webpage. *Who is MTI?* <https://www.mainetechnology.org/who-is-mti/>
- 83 Cleantech Open Northeast. Webpage. <https://www.cleantechopen.org/en/page/northeast-en>
- 84 International Telecommunication Union (ITU). *The Impact of Broadband on the Economy: Research to Date and Policy Issues*. April 2012. https://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf
- 85 ConnectMaine. *State of Maine Broadband Action Plan*. January 2020. <https://www.maine.gov/connectme/about/annual-reports>
- 86 Edward D. Murphy. Portland Press Herald. *Bond measure approval will fuel state's goal of expanding rural broadband*. July 2020. <https://www.pressherald.com/2020/07/20/bond-measure-approval-will-fuel-states-goal-of-expanding-rural-broadband/>
- 87 Examiner's Report, Maine Public Utilities Commission, Docket No. 2017-00232, March 29, 2019

- 88 Island Institute. *Accessing Broadband in Your Community through the Community-Driven Broadband Process*. (n.d.) <http://www.islandinstitute.org/broadband>
- 89 Dr. Linda Silka, Sara Kelemen and Dr. David Hart. The University of Maine Senator George J. Mitchell Center for Sustainability Solutions. *Maine's Climate Action Plan: Framework, Analysis and Recommendations*. September 2020. <https://climatecouncil.maine.gov/reports>
- 90 Public Law 2019, Chapter 477 (LD 1494 *An Act To Reform Maine's Renewable Portfolio Standard*)
- 91 Dan Lieberman and Siobhan Doherty. Commission for Environmental Cooperation. *Renewable Energy as a Hedge Against Fuel Price Fluctuation*. 2008. <http://www3.cec.org/islandora/fr/item/2360-renewable-energy-hedge-against-fuel-price-fluctuation-en.pdf>
- 92 Dan Lieberman and Siobhan Doherty. Commission for Environmental Cooperation. *Renewable Energy as a Hedge Against Fuel Price Fluctuation*. 2008. <http://www3.cec.org/islandora/fr/item/2360-renewable-energy-hedge-against-fuel-price-fluctuation-en.pdf>
- 93 United States Energy Information Administration (EIA). State Energy Data System (SEDS). <https://www.eia.gov/state/seds/>
- 94 EIA, SEDS.
- 95 Efficiency Maine Trust. *FY2019 Annual Report*. November 2019. https://www.energymaine.com/docs/FY19-Annual-Report_final.pdf
- 96 MaineHousing – Maine State Housing Authority. Website. *Energy Assistance*. <https://www.mainehousing.org/programs-services/energy>
- 97 Abt Associates. *Analysis of the Public Health Impacts of the Regional Greenhouse Gas Initiative, 2009-2014*. January 2017. <https://www.abtassociates.com/insights/publications/report/analysis-of-the-public-health-impacts-of-the-regional-greenhouse-gas>
- 98 Maine PUC. *Commission Selects Renewable Energy Projects to Help Achieve Maine's Renewable Portfolio Standard Goals*. September 2020.
- 99 Abt Associates. *Analysis of the Public Health Impacts of the Regional Greenhouse Gas Initiative, 2009-2014*. January 2017. <https://www.abtassociates.com/insights/publications/report/analysis-of-the-public-health-impacts-of-the-regional-greenhouse-gas>
- 100 United States Environmental Protection Agency, State and Local Energy and Environment Program. *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report*. July 2019. <https://www.epa.gov/sites/production/files/2019-07/documents/bpk-report-final-508.pdf>
- 101 Maine DECD. Webpage. *Maine Opportunity Zones*. <https://www.maine.gov/decd/business-development/opportunity-zones>
- 102 Novatus Energy. Webpage. *Bingham Wind Project*. <https://www.novatusenergy.com/wind-project/bingham-wind-project/>
- 103 Maine DECD. *Maine Economic Development Strategy 2020-2029: A Focus on Talent and Innovation*. November 2019. <https://www.maine.gov/decd/strategic-plan>