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Clean Economy Rising

Wind, biomass fuel Maine's energy development

Overview

Maine helped pioneer the development of clean energy by harvesting its natural abundance of bioenergy, wind, hydropower, tidal power, and other renewable energy resources. The Pine Tree State has the highest renewable portfolio standard in the nation, requiring 40 percent of electricity to come from renewable sources by 2017. It boasts the first U.S. offshore floating wind turbine and commercial tidal energy projects. It also ranks first in the nation in biomass electricity generation per capita, and it has positioned itself to lead the expansion of other advanced energy technologies. This brief examines the reasons for Maine's success and its resulting economic growth.

Clean energy policies

Maine has the highest renewable portfolio standard in the nation, requiring 40 percent of total retail electricity sales to come from renewable sources by 2017, whereas most other states specify about 10 percent. In addition to the standard, the state established in 2008 a wind capacity goal of 8 gigawatts by 2030, with at least 5 GW generated offshore.[1] However, the renewable portfolio standard includes 30 percent from biomass and hydropower resources, which were already in operation at the time the standard was first passed in 1997. A sweeping energy bill approved in 2013 set new goals for reducing energy costs, increasing funding for energy efficiency, and improving reliability of electric systems.

Key State Policies					
✓	Renewable portfolio standard	○	Tax incentives	○	Green power purchasing
✓	Net metering and interconnection standards	✓	Bonds/loans/rebates/ other financing	○	Nonutility sales of renewable electricity allowed

Source: North Carolina State University, Database of State Incentives for Renewables and Efficiency

Sources of power and economic growth

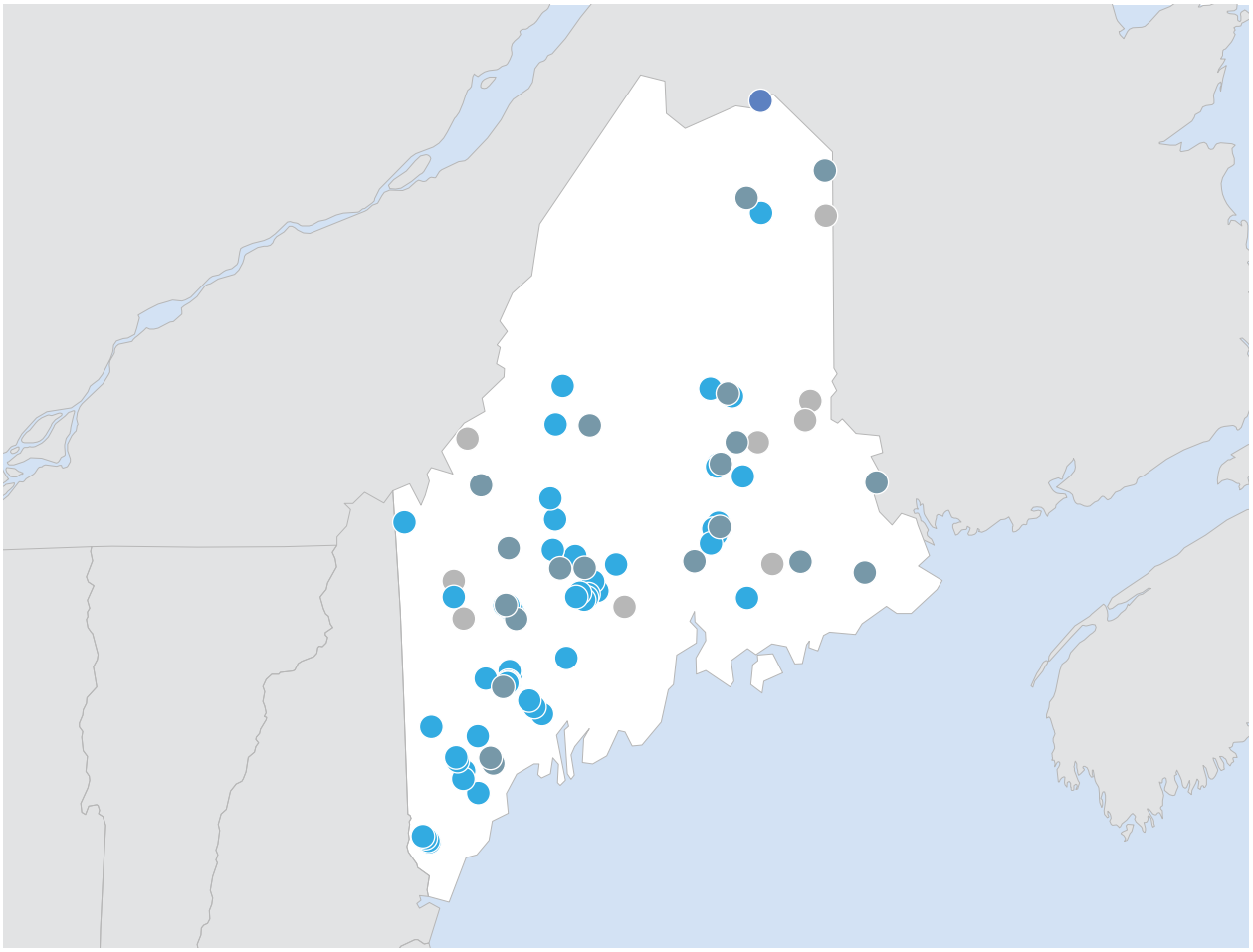
Maine's policies support growth in its clean energy economy. From 2009 to 2013, the wind sector saw the greatest rise with the installation of 389.2 megawatts. During these five years, private investment in clean energy was $901 million, according to Navigant Research, and it will grow by an additional $1.9 billion from 2014 to 2023. A study prepared by London Economics International for the Maine Public Utilities Commission found that the state's renewable portfolio standard will increase its gross state product by $1.1 billion and will create an estimated 11,700 jobs over the next five years.[2] Employment in clean energy grew by 4 percent annually from 2003 to 2010, with the addition of 2,914 positions. Biofuels and biomass comprised the fastest growing sector, with an annual average jobs gain of 77.3 percent.[3] The Center for Workforce Research and Information estimates that Maine's renewable energy and energy efficiency sector will grow at an annual rate of 7.1 percent a year, or by about 600 jobs, from 2006 to 2038.[4]

50% The proportion of New England's renewable power generated in Maine

Source: U.S. Agency for International Development, National Association of Regulatory Utility Commissioners

Some of Maine's economic potential comes from energy conservation and industrial efficiency systems such as combined heat and power, which provide reliable electricity, mechanical power, or thermal energy by capturing heat that is wasted during electricity generation to enable power systems to reach efficiencies of over 80 percent. The pulp and paper industry houses one-third of the state's combined heat and power facilities, which help reduce energy costs, increase efficiency, and improve reliability.[5] Maine also is taking the lead in emerging clean technologies, such as wood pellets, advanced transportation fuels, and cold climate heat pumps. Instead of generating heat from traditional fuel sources the latter extract heat from the outside air or ground and deliver it indoors.[6]

Renewable Electricity Power Plants, >1 Megawatt Capacity



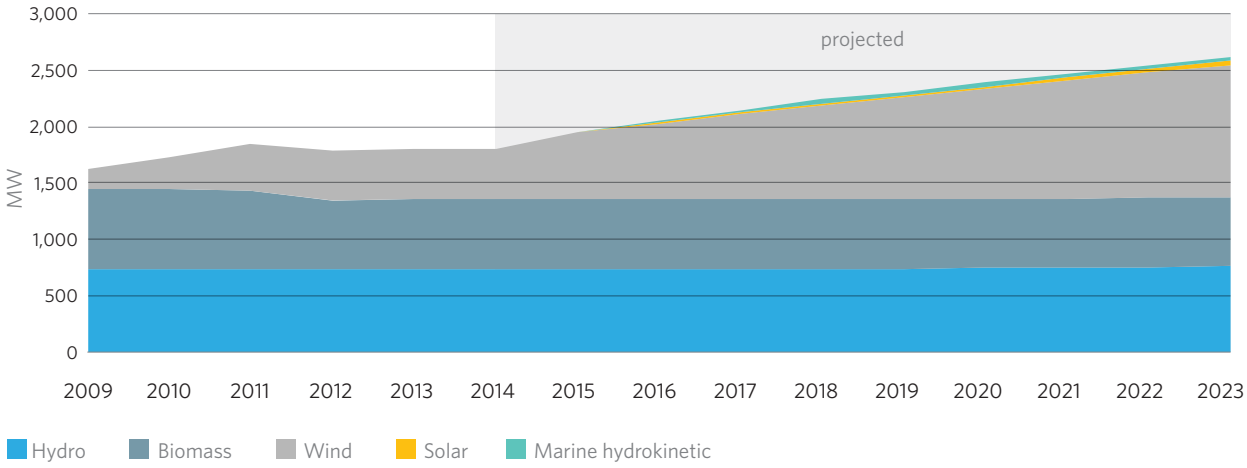
Hydro Wind Biomass Combined heat and power

Source: Energy Information Administration

Snapshot: Maine's clean energy economy

Clean Energy Capacity, by Sector and Year

Actual (2009–13) and projected (2014–23) growth in cumulative capacity

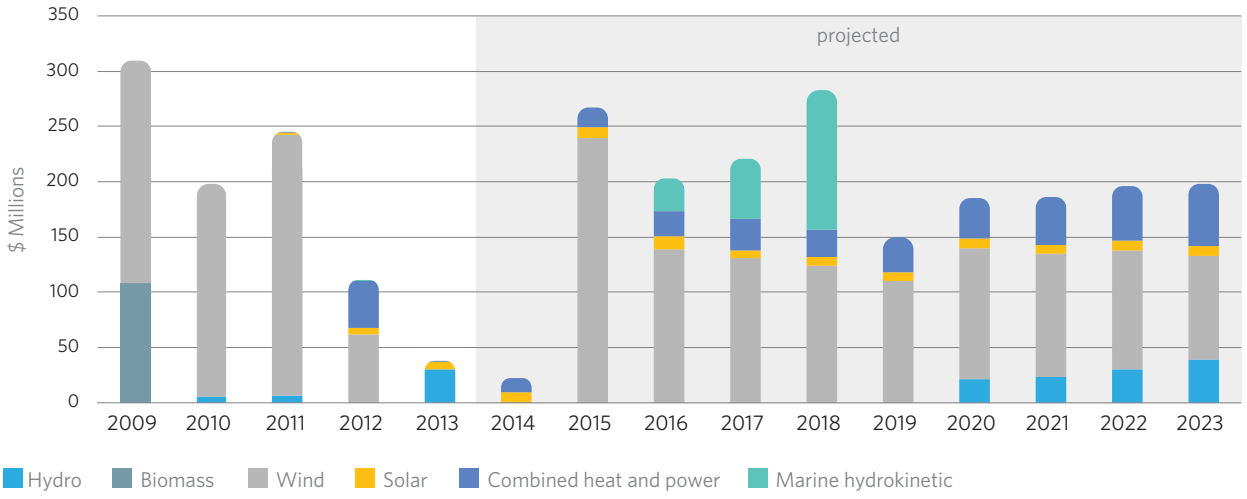


Note: Navigant Research provided data and projections of annual capacity additions from 2009 to 2023. These figures were added to baseline 2008 cumulative capacity data from the Energy Information Administration (except for wind and solar, for which cumulative data were available from Navigant Research). Navigant Research's methodology is described at the end of this brief, and that of the Energy Information Administration is in Table 3, available at http://www.eia.gov/renewable/state/maine/.

Sources: Navigant Research, Energy Information Administration

Clean Energy Investment, by Sector and Year

Actual (2009-13) and projected (2014-23) annual investment



Source: Navigant Research

Key Statistics	
9 MW	in new renewable capacity installations, 2013
$38 million	in private investment, 2013
12,680	energy- and environment-related jobs, 2011

Sources: Navigant Research, Bureau of Labor Statistics

> Maine's onshore and offshore wind resource is capable of powering nearly 47 times the state's current electricity needs."
>
> — American Wind Energy Association

Truck unloading wood pellets for a biomass combined heat and power plant at the Jackson Laboratory in Bar Harbor.

Wind industry highlights

Maine has significant wind resources along its 3,500 miles of Atlantic shoreline and on the crests of the Appalachian range in its northwestern region. Its onshore and offshore potential could power nearly 47 times the state's current electricity needs.[7]

In recent years, the percentage of total electricity supplied by wind has rapidly increased. More than a dozen such projects are online, representing over $910 million in total capital investment.[8] As a result, Maine now leads New England in wind generation. In 2011 and 2012, a total of 164.8 MW of wind capacity were added, including First Wind's Rollins project near Lincoln and Patriot Renewables' Spruce Mountain site in Woodstock in 2011, and the Record Hill wind farm in Oxford County in 2012. As of 2014, the state has 13 completed projects totaling 431 MW in capacity, and another 1,261 MW in various stages of development.[9]

In 2013, Maine became the first state to connect an offshore turbine to the power grid when the DeepCwind Consortium, led by the University of Maine, launched the VolturnUS prototype project.[10] A multimillion dollar private-public partnership, the demonstration is the culmination of a five-year collaboration to develop and install a floating turbine off the coast of Castine, Maine (see project spotlight). The University is completing final design and engineering work on a full-scale floating platform and project that would be deployed farther off the coast.

Maine companies also are developing world-class engineering, design, and manufacturing capabilities to meet the unique requirements for commercial offshore floating wind turbines, building on existing expertise in composite materials technologies.[11] Development of an offshore wind industry in the state has the potential to bring almost $20 million in investment by 2030, creating a new sector of the clean energy economy and employing thousands of people.[12]

Maine Wind
National rankings and statistics, 2013

Key statistics, 2013	
431 MW	in total capacity
1.3 GW	of capacity in queue
13	wind projects online
$690.9 million	in private investment (2009-13)
160,000	homes powered by wind

Sources: American Wind Energy Association, Navigant Research

Company Spotlight

First Wind

First Wind, a leader in utility-scale renewable power, has invested $125 million in Maine businesses and organizations since 2006.[*] The company has built or is planning six wind energy projects and operates two transmission lines connecting three of its projects to the grid. First Wind's largest project is Oakfield Wind, a 148-MW installation expected to come online in 2015. Construction will generate 300 direct, on-site full-time jobs, $14.7 million in tax revenue over 20 years, and $12 million in other benefits to communities. [†]

Bull Hill Wind project.

[*] First Wind, "Accelerating Energy Innovation" (2012), http://www.firstwind.com/wp-content/themes/firstwind/library/pdf/First%20Wind%20Corporate%20Brochure.pdf.

[†] First Wind, "Oakfield Wind," last modified 2014, http://www.firstwind.com/projects/.

Project Spotlight

Nation's First Prototype of an Offshore Floating Wind Turbine

In 2013, the DeepCwind Consortium, led by the University of Maine, built the world's first prototype of a grid-connected offshore floating wind turbine called VolturnUS.[*] Unlike conventional offshore wind projects, which are supported by pilings on the seafloor, floating turbines are mounted to a structure at the surface that is attached to the seabed with cables and anchors, allowing projects in areas where bottom-mounted turbines are unfeasible. The consortium, which received over $3 million from the U.S. Department of Energy and nearly $1 million from the University of Maine, is working to cut the cost of offshore wind to compete with other forms of power generation.[†] The university and other private partners also plan to install two full-size turbines off Maine's Monhegan Island, producing 12 MW of power, and to develop a full-scale offshore wind farm capable of producing 5 GW by 2030.[‡]

VolturnUS, the nation's first offshore floating wind turbine, off the coast of Castine, Maine.

[*] U.S. Department of Energy, "Maine Project Launches First Grid-Connected Offshore Wind Turbine in the U.S.," May 31, 2013, http://energy.gov/articles/maine-project-launches-first-grid-connected-offshore-wind-turbine-us.

[†] Zach Connerty-Marin, "$3 Million DOE Grant Keeps VolturnUS Afloat," The Maine Campus, Sept. 14, 2014, http://mainecampus.com/2014/09/14/3-million-doe-grant-keeps-volturnus-afloat/.

[‡] Associated Press, "UMaine Marks Offshore Wind Turbine's First Year," *The Washington Times*, Sept. 5, 2014, http://www.washingtontimes.com/news/2014/sep/5/umaine-marks-offshore-wind-turbines-first-year/; and Meg Cichon, "DeepCwind Tirelessly Developing Floating Offshore Wind," RenewableEnergyWorld.com, June 21, 2011, http://www.renewableenergyworld.com/rea/news/article/2011/06/deepcwind-project-tirelessly-developing-floating-offshore-wind.

Biomass industry highlights

Maine, the most heavily forested U.S. state, generates 2.1 million kilowatt hours of electrical power annually from biomass, which is energy made from wood and wood waste-derived products such as wood pellets. The state ranks third in the nation in installed biomass capacity and leads the country in biomass electricity generation per capita.[13] Biomass accounts for more than one-fifth of Maine's energy generation.

No.1 Maine's rank in biomass electricity generation per capita.

Source: Energy Information Administration

Maine is leveraging its natural resources, industrial knowledge, and research facilities to boost its biomass sector. The state's well-established forest products industry has provided much of the infrastructure, expertise, and trained labor force needed for this expansion. Building on this foundation, the state university system supports cutting-edge research on biomass, which is used to create electricity, and biofuels, which are primarily used for transportation. The University of Maine's Forest Byproducts Research Institute and Technology Research Center, through partnerships with local bioproduct companies, foster a strong community of innovation and entrepreneurship.

Not only is Maine's growing biomass sector supporting key research and development, but it also is focused on sustainability. Of the state's 20 biomass facilities, four are among the first in the world to achieve certification under the Sustainable Forestry Initiative Standard. This international certification recognizes responsible forestry practices and promotes sustainable use of biomass resources.[14]

Scrap lumber, forest debris, and other waste residue used to generate biomass electricity.

Company and Institution Spotlights

A Growing Network of Biofuels and Biomass

From biomass research to commercial energy generation, Maine supports a range of companies and institutions driving regional innovation.

The Jackson Laboratory

In Bar Harbor, the Jackson Laboratory, an independent, nonprofit organization focusing on genetics research, has established a cutting-edge biomass energy center to provide its power. Fueled by wood pellets from resources sustainably grown and harvested in Maine, the energy center has reduced the laboratory's annual fuel oil consumption by 75 percent, saving more than $2 million a year. The facility received a $1 million grant through Efficiency Maine to support the project.*

The Jackson Laboratory in Bar Harbor.

The University of Maine's Forest Bioproducts Research Institute

The Forest Bioproducts Research Institute at the University of Maine studies ways to bolster commercialization of fuels, chemicals, and advanced materials from forest bioproducts. The institute also fosters collaboration among researchers, wood suppliers, and end users. In 2006, it obtained a $6.9 million award from the National Science Foundation and a matching state grant to develop facilities in Maine to support the biomass industry.†

Continued on next page

ReEnergy Holdings LLC

ReEnergy, which has four energy facilities in Maine, aims to produce renewable energy that benefits the local economy and its natural resources. The company's facilities use forest-derived biomass, including scrap lumber and forest debris, as well as other waste residue, to produce renewable energy. Across the four sites, biomass such as recovered wood from urban uses, construction scrap, and demolition debris produces enough electricity to power nearly 150,000 homes.[‡]

ReEnergy biomass facility in Ashland.

[*] The Jackson Laboratory, "Jackson Laboratory Breaks Ground on Highly Efficient Biomass Energy Plant," Nov. 22, 2010, http://www.jax.org/news/archives/2010/biomass_plant.html.

[†] The University of Maine, "Forest Bioproducts Research Institute," http://forestbioproducts.umaine.edu/about-fbri/.

[‡] ReEnergy Holdings LLC, last modified 2011, http://www.reenergyholdings.com/.

Emerging opportunities

Marine and hydrokinetic energy technologies convert the energy of waves, tides, and river and ocean currents into electricity. These systems represent an emerging industry with hundreds of potentially viable technologies.[15] They also offer operators unique advantages, including close proximity to major coastal areas of high energy demand, capacity predictability, and the ability to leverage solutions and lessons learned from more mature renewable industries such as wind and solar.

> "Ocean energy provides an exciting opportunity for the United States to help advance the goal of developing clean, renewable energy, lessening our reliance on foreign oil; and creating new industries and thousands of rewarding jobs."
>
> —U.S. Senator Susan Collins

The U.S. Department of Energy's Water Power Program supports commercial development of marine and hydrokinetic energy devices to achieve the program's 2030 goal: Produce 15 percent of national electricity needs using water power.[16] Though still an emerging industry, the Energy Department's Water Power Program funds activities to accelerate deployment of wave, tidal, and current projects, and to speed development of the market.[17]

Institution Spotlight

Maine Takes the Lead in Tidal Energy

The nation's first commercial, grid-connected tidal energy project, located on the bottom of Cobscook Bay—near the mouth of the Bay of Fundy, known for the world's biggest, regular tides—grew from innovative research and development by corporate, academic, and government partners.* After a successful demonstration project, Ocean Renewable Power Co. LLC, a commercial developer, installed in September 2012 the tidal turbine, which can power about 30 homes. The University of Maine's Marine Tidal Power Initiative led the research partners in investigating tidal power, economic development, and marine ecosystem protection.† Sandia National Laboratories, the National Renewable Energy Laboratory, and other institutions provided research and development assistance for the project. The U.S. Department of Energy, the Maine Technology Institute, and private investors supplied the funding.‡

Ocean Renewable Power Co.'s TidGen® Power System prior to installation at the company's Cobscook Bay Tidal Energy Project site in Maine.

* Office of Energy Efficiency and Renewable Energy, "First Ocean Energy Delivered to the U.S. Grid," U.S. Department of Energy, Sept. 19, 2012, http://www1.eere.energy.gov/water/news_detail.html?news_id=18638.

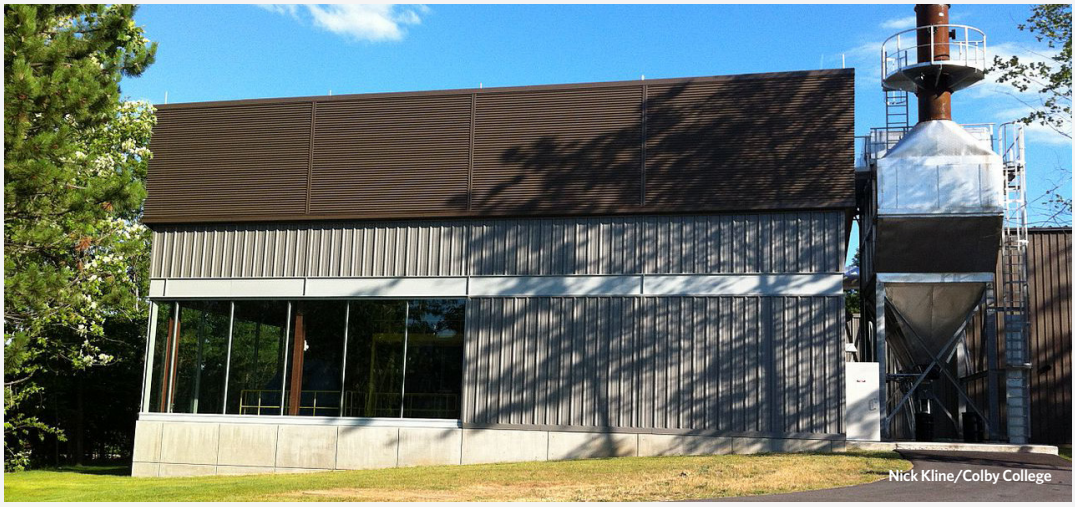
† University of Maine's Senator George J. Mitchell Center for Sustainability Solutions, "Renewable Energy From the Tides," http://umaine.edu/mitchellcenter/renewable-energy-from-the-tides/.

‡ Senator Susan Collins, "A Clean Energy Economy and Jobs," *CQ Roll Call*, March 27, 2014, http://www.rollcall.com/news/a_clean_energy_economy_and_jobs-231714-1.html.

Institution Spotlight

Colby College's Biomass Facility

Colby College committed to achieve carbon neutrality by 2015 as part of its 2010 Climate Action Plan, which seeks to foster environmental stewardship through education, conservation, and conscientious policies and procedures.* Because heating previously accounted for 70 percent of the campus's total carbon emissions, the college hired Portland-based PC Construction to install a biomass heating facility. In addition to college funds and loans, the project received a $750,000 grant from Efficiency Maine, the state's independent administrator for energy efficiency programs.† The unit is fueled by low-grade forest waste and debris, including wood chips, bark, and treetops sourced from sustainable forestry operations within 50 miles of the campus.‡ The plant fulfills 90 percent of the campus's steam demand and replaces 1 million gallons of heating fuel with 22,000 tons of forestry byproducts annually.§ Colby officials expect energy cost savings of $1 million a year. During construction, the enterprise created more than 75 jobs and is expected to support four to five permanent positions in Maine's forest products industry.**



Colby College's biomass facility.

* Colby College, "Biomass Plant Under Construction at Colby," Dec. 28, 2010, http://www.colby.edu/news/2010/12/28/biomass-plant-under-construction-at-colby-4/.

† Colby College, "Sustainability Report 2010-2011," http://www.colby.edu/administration_cs/green/upload/2010-11-Sustainability-Report-final.pdf.

‡ Environmental Policy Group, Colby College Environmental Studies Program, "The State of Wood Biomass Energy in Maine," in The State of Maine's Environment 2010 (2010), https://wiki.colby.edu/display/stateofmaine2011/The+State+of+Biomass+Energy.

§ Ibid.

** Associated Press, "Vermont Biomass Builder Does Project at Colby," *Portland Press Herald*, Feb. 23, 2013, http://www.pressherald.com/2013/02/23/vermont-biomass-builder-does-project-at-colby/.

Conclusion

Maine's clean energy strategy and renewable portfolio standard help the state and its economy by encouraging investment and collaboration in cutting-edge technologies for advanced power generation. Renewable resources and skilled technical workers in traditional and emerging industries offer Maine great potential for continued growth in its clean energy economy.

Acknowledgments

This policy brief is one of a collection examining state clean energy economies. The states selected have demonstrated leadership in clean energy policies, installations, and economies, or are at a crossroads in their energy futures. The brief was prepared by The Pew Charitable Trusts' clean energy initiative, with Kerry Schlichting as lead author. This research was funded in part by The 11th Hour Project.

Unless otherwise specified, data on capacity additions and investment were provided by Navigant Research, an energy market research firm, and include solar photovoltaics, industrial sector combined heat and power, geothermal power (excluding heat pumps), biomass power (excluding landfill gas, anaerobic digesters, and biogas recovery), hydropower projects, permanently installed (not pilot) marine and hydrokinetic projects, and wind projects greater than 1 megawatt.

The Clean Energy Business Network

Pew's Clean Energy Business Network seeks to inform and engage clean energy business leaders in policy issues affecting the industry. For more information or to sign up for this free resource, visit pewtrusts.org/businessnetwork.

Endnotes

1 American Wind Energy Association, "Maine Wind Energy," last updated April 10, 2014, https://www.awea.org/Resources/state.aspx?ItemNumber=5220.

2 London Economics International, "Maine RPS Summary: Review of RPS Requirements and Compliance in New England States," Maine Renewable Energy Association (2011), 2, http://www.renewablemaine.org/pubs/LEI_Study_Summary_by_MREA.pdf.

3 Metropolitan Policy Program at Brookings, "Sizing the Clean Economy: The Clean Economy in the State of Maine," The Brookings Institution (2011), http://www.brookings.edu/~/media/Series/Clean%20Economy/23.PDF.

4 Center for Workforce Research and Information, "Maine's Green Economy: An Overview of Renewable Energy and Energy Efficiency Sectors," Maine Department of Labor (February 2010), 9, http://www.maine.gov/labor/cwri/publications/pdf/GreenEconomyReport.pdf.

5 ICF International, "Combined Heat and Power Installation Database," U.S. Department of Energy (2013), http://www.eea-inc.com/chpdata/States/ME.html.

6 Efficiency Vermont, "Who Says There Is No Such Thing as Efficient Electric Heat?" Sept. 9, 2013, https://www.efficiencyvermont.com/Blog/blog/2013/09/09/Who_Says_There_is_No_Such_Thing_as_Efficient_Electric_Heat.

7 American Wind Energy Association, "Maine Wind Energy."

8 Ibid.

9 Ibid.

10 U.S. Department of Energy, "Maine Project Launches First Grid-Connected Offshore Wind Turbine in the U.S.," May 31, 2013, http://energy.gov/articles/maine-project-launches-first-grid-connected-offshore-wind-turbine-us

11 Maine Governor's Energy Office, "Economic Development and Financing: Energy & Jobs," last modified 2012, http://maine.gov/energy/initiatives/economic-development.html.

12 Advanced Structures & Composites Center, "Our Research - Offshore Wind," University of Maine, http://composites.umaine.edu/our-research/offshore-wind/.

13 U.S. Energy Information Administration, "Maine State Profile and Energy Estimates," http://www.eia.gov/state/?sid=ME.

14 "Maine Biomass Facilities Receive Sustainable Certification," *Bangor Daily News*, June 13, 2013, http://bangordailynews.com/2013/06/13/business/maine-biomass-facilities-receive-sustainable-certification/.

15 Office of Energy Efficiency and Renewable Energy, "Marine and Hydrokinetic Energy Research & Development," U.S Department of Energy, http://energy.gov/eere/water/marine-and-hydrokinetic-energy-research-development.

16 Office of Energy Efficiency and Renewable Energy, "Marine and Hydrokinetic Market Acceleration and Deployment," U.S. Department of Energy, http://energy.gov/eere/water/marine-and-hydrokinetic-market-acceleration-and-deployment.

17 Office of Energy Efficiency and Renewable Energy, "Marine and Hydrokinetic Energy Research & Development."

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