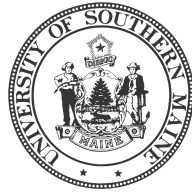


Economic Impacts of Wind Energy Construction and Operations in Maine

2006-2018



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Executive Summary

From 2006 to 2014, fourteen utility scale wind energy projects have been constructed or are currently under construction in Maine. The facilities are being built in nine counties with a total rated generating capacity of 614 megawatts. Projects planned for construction from 2015 to 2018 will add an additional 690 megawatts of capacity, bringing Maine's total current and planned wind generation capacity to 1.3 gigawatts.

Investment in Maine

Based on information provided by the companies that are leading the construction of the vast majority of this new wind energy generation, over \$532.5 million has been spent in Maine on projects from 2006 to 2014. An additional \$745.1 million anticipated over the next four years will bring the total spending in Maine on wind power to \$1.28 billion by 2018. These figures do not include the costs of turbines, blades, and electrical gear bought from outside Maine.

Job Creation

These investments created or supported an average of 1,560 jobs per year from 2006-2018, with the largest employment anticipated in 2015 at over 4,200 jobs. While wind energy projects affect employment in all Maine counties (except York), the vast majority of these jobs are in rural areas of western, eastern, and northern Maine.

Employee Earnings

The jobs, including employment both directly and indirectly related to wind projects, will result in an increase in \$1.14 billion in employee earnings over 2006-2018. The peak year for earnings will be \$256 million in 2015. Earnings include both salaries and benefits. These figures mean that the majority of in-Maine expenditures on wind energy development goes to employee compensation.

Ongoing Employment

Once complete, wind energy projects can employ between 1 and 15 people on site for operations and maintenance. These employees, with the indirect effects, will account for an estimated 160 jobs from 2018 on. Periodic replacement and repair of turbines and towers will require employment levels comparable to the construction phase, which could result in 185-550 employees per year depending on the level of overhaul activity.

New Markets

The large amount of wind energy development in Maine has led a number of companies to begin development markets for their services to wind power projects outside of Maine. A survey of firms supporting wind energy development in and outside Maine found that 23 firms had \$89.6 million in sales over 2011-2013, resulting in an average of 390 employees in Maine over this period and \$61.3 million in earnings.

1. Introduction

The development of wind energy generation has become a significant industry in Maine over the past decade. Since the first utility scale¹ wind project at Mars Hill in Aroostook County went into operation in 2006, Maine has steadily been adding wind generation capacity. Fourteen projects are either operating or scheduled for completion in early 2015, and another four projects are set to begin construction from 2015 to 2018. When completed, these projects will have an installed capacity of 1304 megawatts (1.34 gigawatts), larger than any other single electric generating facility in Maine.

Region	County	Project	Rated Capacity (MW)	Construction Start Year	Operations Start Year
Aroostook	Aroostook	Mars Hill	42.0	2006	2007
Mid Coast	Waldo	Beaver Ridge	4.5	2007	2008
Eastern	Washington	Stetson	83.0	2008	2010
Mid Coast	Knox	Vinalhaven	4.5	2008	2009
Western	Franklin	Kibby	132.0	2008	2009
Eastern	Penobscot	Rollins	60.0	2010	2011
Eastern	Hancock	Bull Hill	34.0	2011	2012
Western	Oxford	Record Hill	50.0	2011	2012
Western	Oxford	Spruce Mountain	20.0	2011	2011
Western	Franklin	Saddleback	34.0	2014	2015
Aroostook	Aroostook	Oakfield	150.0	2014	2015
Eastern	Hancock	Hancock	51.0	2015	2016
Eastern	Penobscot	Passadumkeag	42.0	2015	2016
Kennebec	Somerset	Bingham	186.0	2015	2016
Western	Oxford	Canton	23.0	2015	2016
Aroostook	Aroostook	Number Nine	250.0	2015	2017
Eastern	Washington & Penobscot	Bowers	48.0	2016	2017
Eastern	Washington	Downeast	90.0	2016	2018
Total Capacity Completed or Begun 2006-2014			614.0		
Total Capacity Completed or Begun 2015-2018			690.0		
Total 2006-2018			1304.0		

Table 1 - Wind Energy Projects Included in the Analysis

Together, the construction of these projects will total \$1.277 billion in spending in Maine over 12 years. This amount includes the development and permitting costs plus the costs of construction and turbine installation, which is carried out by Maine-based companies. Because the construction of wind generation projects is often in remote areas, it also includes the costs of food and lodging for the specialized workers required at each site. The figure does not include the costs of turbines, switching and transformer equipment that is needed to complete the projects; these are manufactured outside Maine and brought to each site. The report also examines the impacts of the operating period employment in each of the regions and the impacts of growing sales by Maine companies to contribute to wind energy development outside Maine.

¹ Utility level projects are designed to sell electricity into the wholesale market for electricity in New England or to sell directly into retail markets. They are distinguished from individual projects which provide electricity to designated users.

In addition to analyzing the construction of wind projects in Maine, the report also examines the economic impacts in Maine of the activities of Maine companies who assist in the development of projects outside Maine, both in the U.S. and internationally. The large amount of wind power development in Maine has provided companies the opportunity to develop substantial experience and expertise in the field, which is now being tapped by developers outside Maine.

This report examines the employment and earnings impacts of the development and operation of current and planned projects. The analysis is based on actual expenditure data provided by the two principal firms constructing wind power projects in Maine, Reed & Reed and Cianbro. This data was examined using models of regional economies in Maine developed by Regional Economic Models Inc. (REMI) of Amherst, MA, and maintained at the Maine Center for Business & Economic Research at the University of Southern Maine. The regions analyzed are single or multi-county regions:

- **Aroostook**
- **Cumberland**
- **Western:** Androscoggin-Franklin-Oxford
- **Eastern:** Penobscot-Piscataquis-Hancock-Washington
- **Kennebec Valley:** Kennebec-Somerset
- **Midcoast:** Sagadahoc-Lincoln-Knox-Waldo

2. Wind Power Projects in Maine

A. Expenditures in Maine

Table 2 summarizes expenditures on wind energy construction from 2006 to 2018. Projects through 2014 represent either completed or underway construction. Projects from 2015 to 2018 include the completion of some projects begun in 2014 and projects that will begin in 2015 to 2017. Future projects are in various stage of development including planning, permitting, and the securing of power purchase agreements with utilities.

2006	2007	2008	2009	2010	2011	2012
\$5.94	\$0.51	\$76.65	\$69.01	\$62.74	\$51.69	\$24.59
2013	2014	2015	2016	2017	2018	Total
\$22.78	\$218.57	\$271.79	\$143.35	\$254.97	\$75.04	\$1,277.62

Table 2 - Total expenditures on wind power developments in Maine by year in Millions of Dollars

Over this entire period, wind power investments will total \$1.28 billion. From 2006 to 2014 the total expenditure for projects completed or begun before the end of 2014 was \$532.5 million, which accounts for 614 MW. Projects planned to begin in 2015 or later will result in an estimated \$745.1 million in investment for an additional 690 MW. The largest project in Maine designated Number Nine (at 250 MW capacity), is planned for 2016-2017 in Aroostook County.

Figure 1 shows the distribution of expenditures by region. Over the entire period, the Eastern region receives the most investment, followed by Aroostook County (on the assumption that the Number Nine project is built as planned). The Kennebec Valley and Western regions receive about the same amount of investment.

B. Employment Impacts

Table 3 shows the number of jobs estimated to have been created or supported in each region as a result of the expenditures in Table 2. Over the entire period, the wind projects increased employment in Maine by an average of 1,566 jobs per year. Projects through 2014 increased employment by an average of 1,037 jobs per year, which will increase to an average of 2,756 jobs from 2015-2018. The peak year for employment is expected to be 2015, when over 4,200 jobs will be created connected to wind energy development in Maine. The Bingham project in Somerset County will make the Kennebec Valley region the peak employment of all regions at years with over 2,200 jobs.

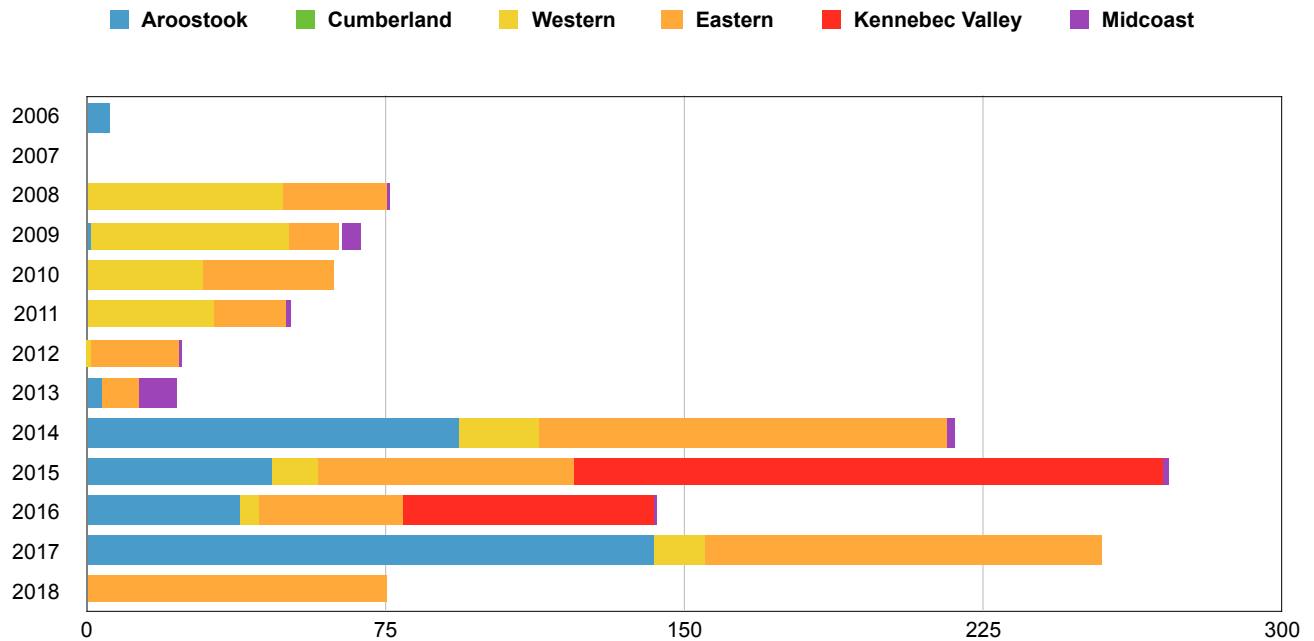


Figure 1 - Wind Development Expenditures by Region and Year

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Aroostook	139	10	3	17	8	-	-	55	1,441	693	552	1,988	-
Cumberland	-	-	46	52	37	37	16	16	16	65	49	36	58
Western	-	-	946	942	521	538	-	-	262	153	31	133	-
Eastern	2	1	536	264	539	321	358	85	1,640	1,022	523	1,413	973
Kennebec Valley	-	-	24	26	20	18	8	8	26	2,222	934	19	-
Midcoast	-	-	32	113	13	22	20	117	39	79	48	24	10
TOTAL	141	11	1587	1414	1138	936	402	281	3,424	4,234	2,137	3,613	1,041

Table 3 - Employment Impacts By Region

Not surprisingly, the construction industry is the largest industry affected by the projects, with about 54% of the jobs estimated. If the construction industry is used to approximate those jobs directly tied to the wind energy development, then the multiplier of the jobs is 1.85. On average across all years the construction industry employed 840 jobs per year, with indirect jobs of 740 per year. From 2014 on the construction industry will average over 1400 jobs per year, which will be about 6% of all construction jobs in Maine.

With large-scale construction projects, the jobs created are in one sense temporary, lasting the duration of each project. But the large and growing amount of wind energy investments means that many of the jobs have become effectively permanent, with a significant workforce at companies like Reed & Reed and Cianbro moving from project to project. Jobs in other industries, such as restaurants, hotels, and engineering are best described as “supported by” the wind projects. These are not necessarily new jobs, but a portion of each job’s income earned in a given year derives from the wind development expenditures.

	Avg 06-14	Avg 15-18	Avg 06-18	Share of State 06-14	Share of State 15-18	Share of State 06-18
Aroostook	186	808	377	17.9%	29.3%	24.1%
Cumberland	24	52	33	2.4%	1.9%	2.1%
Western	357	79	271	34.4%	2.9%	17.3%
Eastern	416	983	591	40.1%	35.7%	37.7%
Kennebec Valley	14	794	254	1.4%	28.8%	16.2%
Midcoast	40	40	40	3.8%	1.5%	2.5%
Maine	1,037	2,756	1,566			

Table 4 - Employment Impacts by Region

Table 4 and Figure 2 track the employment impacts by region. Beginning in Aroostook County with Mars Hill in 2006, development employment shifted primarily to the western region from 2008-2011, and then shifted to the eastern region from 2012 on. Through the period analyzed, the eastern region accounts for the bulk of employment with 38%. Large projects under way and planned for the Kennebec Valley and Aroostook regions will bolster employment there in the next several years, but the eastern region will continue to dominate in employment.

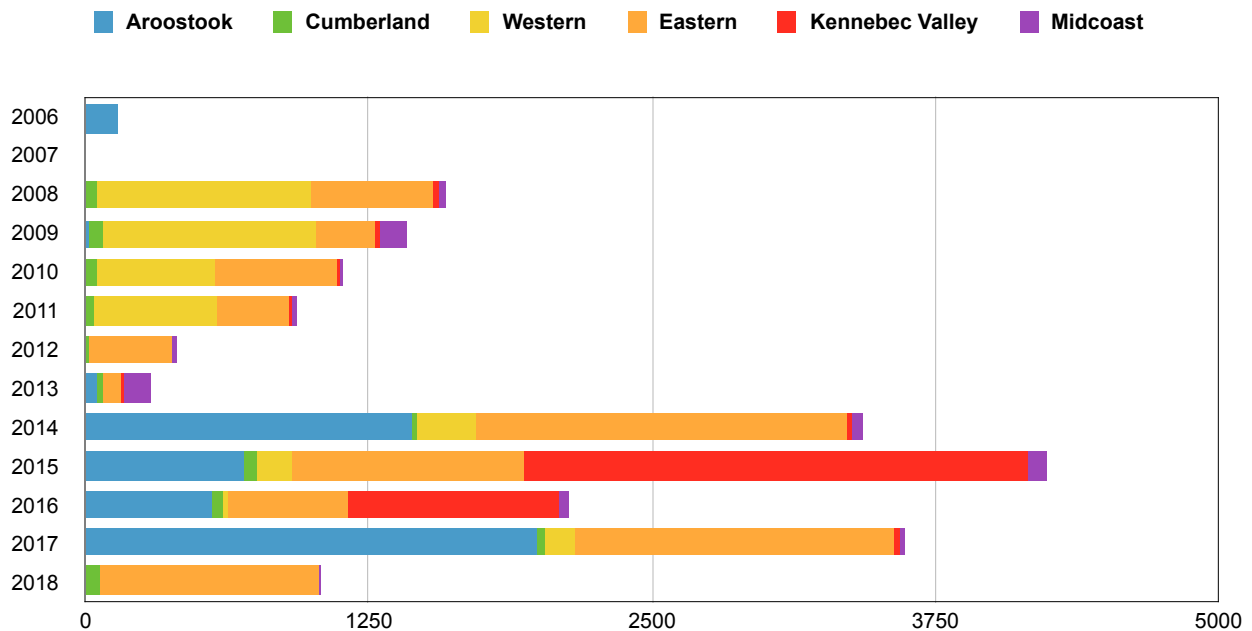


Figure 2 - Estimated Employment Impacts

While the dominant employment impacts are in the regions where the wind energy projects are located, there are employment effects in most of Maine, including Cumberland County, which sees employment gains from the various services that are provided to the wind energy there. York County is the only county in Maine without significant economic impact from wind energy development.

These employment estimates should be considered conservative. That is, they are probably somewhat lower than actual employment effects. This is because the evolution of the wind energy and supporting industries in Maine is continuing throughout the period, with more of the supporting inputs coming from Maine sources. This evolution is not fully captured in the data sets used for analysis because of lags in data reporting.

C. Earnings Impacts

Over 2006-2018, employee earnings increase in Maine by a total \$1.137 billion. Projects through 2014 added \$453.0 million, and it is anticipated that earnings will increase by a total of \$687 million from 2015-2018. 2015 is expected to be the peak year for earnings gains with \$256 million added to the economy.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Aroostook	\$5	\$1	\$0	\$1	\$0	\$0	\$0	\$2	\$63	\$36	\$31	\$102	\$8
Cumberland	\$0	\$0	\$3	\$3	\$2	\$3	\$1	\$1	\$1	\$4	\$3	\$2	\$4
Western	\$0	\$0	\$39	\$41	\$26	\$27	\$3	\$0	\$14	\$10	\$3	\$8	-\$2
Eastern	\$0	\$0	\$22	\$13	\$27	\$17	\$19	\$7	\$86	\$60	\$36	\$87	\$66
Kennebec Valley	\$0	\$0	\$1	\$1	\$1	\$1	\$1	\$1	\$2	\$140	\$67	\$8	\$3
Midcoast	\$0	\$0	\$1	\$5	\$1	\$1	\$1	\$7	\$2	\$5	\$3	\$2	\$1
Total	\$5	\$1	\$66	\$64	\$57	\$49	\$25	\$18	\$168	\$255	\$143	\$209	\$80

Table 5 - Increases in employee compensation from wind energy development (in Millions)

In this analysis, “earnings” includes wages and salaries paid, employee benefits such as health insurance, and the employer share of social security taxes. It does not include proprietors income, which is the income earned by businesses other than corporations.

The dollar amounts in this table are in constant 2005 dollars because the analysis does not include inflation, so the precise value of, for example, the \$168.00 million in earnings in 2014 expressed in 2005 dollars in Table 5 is not estimated. As a rough guide, however, the Consumer Price Index can be used to “inflate” the 2005 dollars to 2014 levels. In this case the earnings estimated for 2014 would be \$204.24 million in today’s dollars.

D. Operating Period Employment

Once generating power, employment at wind power projects can be divided into two parts. First, each site requires at least one person to perform daily checks of equipment and perform routine maintenance on the site and the equipment. The number of people employed for these purposes varies by site and the number of turbines operating. In estimating operations employment, a rough guideline of 1 employee per 20 megawatts of installed capacity, with the condition that this will not fall below 1 employee. These assumptions yield the figures in Table 6. The analysis of the total employment estimates results in Table 7 and Figure 3 (following page).

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Aroostook	3	3	3	3	3	3	3	3	3	13	13	13	29
Western	0	0	0	0	9	10	13	13	13	16	17	17	17
Eastern	0	0	0	0	6	10	12	12	15	18	27	27	27
Kennebec	0	0	1	1	2	2	2	2	2	2	14	14	14
Mid Coast	0	0	0	0	1	1	1	1	1	1	1	1	1
TOTAL	3	3	4	4	20	25	31	31	34	50	72	72	89

Table 6 - Estimated Operating Period Employment by Region

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Aroostook	4	4	4	4	4	4	4	4	4	18	18	18	38
Western	0	0	0	0	18	21	28	28	28	33	35	34	34
Eastern	0	0	0	0	12	21	25	25	32	37	55	55	54
Kennebec	0	0	2	3	5	5	4	4	4	4	34	35	35
Midcoast	0	0	0	0	2	2	2	2	2	1	2	2	2
MAINE	4	4	6	7	41	53	63	63	70	93	144	144	163

Table 7 - Estimated Total Employment Effects of Operating Period Employment by Region

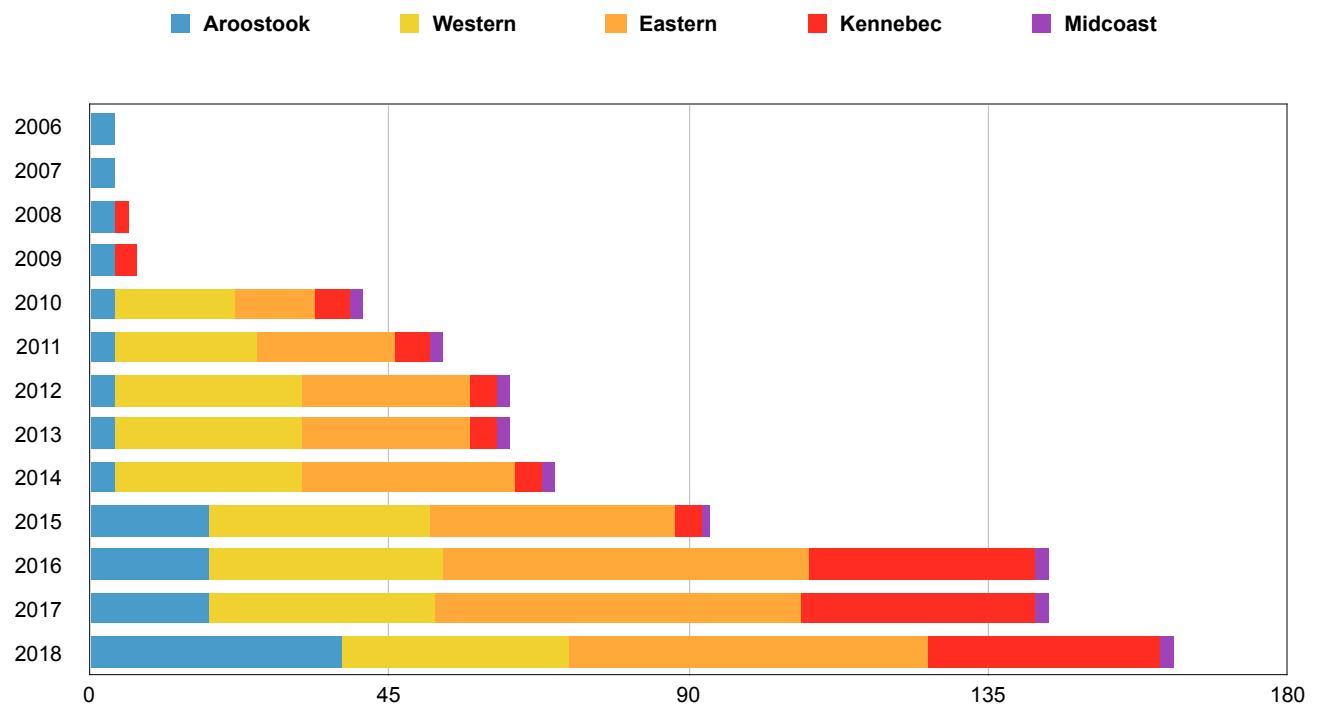


Figure 3 - Estimated Total Employment Effects of Operating Period Employment by Region

The multiplier effect for operating period employment is 1.8 statewide, but varies by region. The smaller economy of Aroostook County means that the multiplier is smallest there at 1.3. The multiplier in the other regions ranges from 2 to 2.4. This indicates that although operating period employment is relatively small, it does have a somewhat larger total employment effect.

The other part of employment during the operating phase occurs when major overhauls of the generation equipment are required, generally every 5-7 years. These maintenance periods require shutting down a turbine, taking it off the tower, conducting the overhaul and repairs, and then reinstalling the turbines. These projects require employment that is similar in scale to phases in the original construction periods.

The exact employment impacts from these operations cannot be estimated as precisely as the construction periods because the timing of these overhauls will vary by company and project. But with over 1300 MW of installed capacity in place after 2018, it is likely that each year will see between 100 and 300 employees engaged on overhaul and major repair operations. With the average construction multiplier of 1.85, this would imply total employment effects of between 185 to 550 employees per year in addition to the operations employment discussed above.

3. Maine Firms Supporting Wind Projects Outside of Maine

A survey of firms conducted by the Maine Ocean & Wind Industry Initiative in 2014 identified sales of \$89.6 million by Maine firms outside of Maine over 2011-2013.

The survey had 68 responses about activities working on wind projects in Maine and elsewhere over 2011-2013. Six to eight firms (depending on the year) reported providing services to international projects, while 17-23 firms reported supporting projects in the U.S. but outside of Maine.

	2011	2012	2013
Cumberland	156	101	83
Western	11	13	6
Eastern	32	11	6
Kennebec Valley	52	96	39
Midcoast	184	351	26
TOTAL	434	571	159

Table 8 - Employment impacts of Maine firms supporting wind projects outside Maine

Firms reported that, on average for these three years, 6% of their wind-related revenues were from international projects and 24% was from projects elsewhere in the U.S. The remaining 70% of these firm's wind-related revenues that came from projects in Maine are assumed to be accounted for in data provided by prime contractors.

	2011	2012	2013
Cumberland	\$11	\$8	\$7
Western	\$1	\$1	\$0
Eastern	\$2	\$1	\$0
Kennebec Valley	\$3	\$6	\$3
Midcoast	\$8	\$9	\$2
Total	\$25	\$25	\$12

Table 9 - Wages and salaries from supporting wind projects outside Maine (in Millions)

Table 8 shows the estimated employment in Maine associated with \$89.6 million in sales outside of Maine. This activity will normally vary by year, and this is demonstrated in these three years with a low of 159 employees in 2013 following a high of 571 employees in 2012. The average additional employment in Maine during these three years was 388 and total earnings increase of \$61.3 million.

As with the estimates of employment from development in state, these estimates from outside Maine activities are very likely conservative. They are derived from a survey with a limited number of respondents and there are likely other companies that had small or one-time involvement outside of Maine and thus would be difficult to include in the sample frame from which the data is derived.