VERMONT
CLEAN ENERGY DEVELOPMENT FUND
DEPARTMENT OF PUBLIC SERVICE

Vermont Clean Energy Industry Report

2018

[bw] RESEARCH PARTNERSHIP

Acknowledgements

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Executive Summary

For the first time since the Vermont Clean Energy Industry Report's inception in 2013, the state's clean energy economy exhibited a decline in employment, driven largely by losses in the solar industry. Job declines in the solar industry were also a first-time national phenomenon since The Solar Foundation began tracking employment in 2010. In Vermont, the shedding of solar jobs came alongside a decline in solar installations over the same period of about 9%. More importantly, however, these shifts follow significant policy reforms to the state's net metering program, which made the siting of new renewable energy projects—especially larger installations—more difficult, leading to an almost 20 percent decline in applications.

This year's data notes other shifts in Vermont's clean energy economy. The industry shed jobs across all major technology segments, and business activities that lost the most jobs over 2017 include utilities and trade, and to a lesser extent, installation and manufacturing. The solar industry's in-state customer base has declined, and some businesses tapped into markets in bordering states. At the same time, there are notable changes in the allocation of clean energy labor hours within the industry. In general, there are more majority-time workers in the renewable energy space—those that spend 50 to 99 percent of their time supporting renewable energy business activities—but fewer total full-time clean energy workers. There was also a significant decline in small clean energy businesses, as activity has shifted to medium and medium-large firms. Additionally, important to note for this year's findings, clean energy jobs in Vermont support workers with higher median hourly earnings—about $26.71—compared to both the overall median and living wage for the state.

A bi-annual analysis that looks more specifically at the state's wood energy sector highlights additional changes within this subsector of the clean energy economy. Namely, there was an overall shift in wood energy offerings, where fewer firms reported logging as their primary activity as the market shifted to wood fuel processing and preparation. The transition occurred alongside overall declines in wood energy revenues, but most specifically in the logging sub-sector. The market shift from logging to wood fuel processing and preparation was likely the result of an attraction to increased market share and revenue for wood fuels. But this industry shift was not sufficient to prevent job loss in the woody and non-woody biomass workforce. In general, wood energy firms cited low fossil fuel prices, market competition, fluctuating product prices, the general economic downturn, and an insufficient demand for their products as the most common reasons for market and revenue declines. Primary concerns regarding future business prospects are largely related to regulations and product pricing, followed by lack of demand due to low fossil fuel costs.

Given the previous 12 months' changing dynamics compared to historical trends, the 2018 Clean Energy Industry Report highlights the following key themes in the current landscape of Vermont's clean energy economy:

Policy change and uncertainty at both the state and national levels have created turbulence in the clean energy sector. The data underscores clear evidence that policies have a direct impact on the size and breadth of a region's clean energy workforce, and the feedback is fairly quick—within 12 months as the 2017 to 2018 data collection indicates. While declines may be attributed to uncertainty in the national policy climate, statewide policy reforms have a clear impact on the clean energy workforce. Vermont's policy framework overall remains committed to fostering clean energy growth, as evidenced by larger, overarching policy prescriptions such as the Renewable Energy Standard. Yet even small changes indicate that the clean energy economy is sensitive to policy volatility, as recent revisions to the net metering program have moved throughout the clean energy industry resulting in fewer projects and workforce cuts. However, it is important to note that the rapid rise of the solar industry across several major clean energy centers in the country may have resulted in unsustainable bubbles of solar employment growth. Unable to sustain this growth, solar industry leaders like Massachusetts and California ended up seeing respective employment declines of 21 and 14 percent, respectively.[1] For Vermont, restructuring the net metering policy may have resulted in some job loss, but has also set the state up with the opportunity for more sustainable job growth into the future.

Changing market dynamics within the industry indicate market consolidation and declining labor intensity. Between 2017 and 2018, there was an 11-point decline in the proportion of small clean energy establishments compared to the total. In just 12 months, these small businesses that perhaps sought work due to previously wide-ranging market opportunities have recently exited and activity is now more consolidated across larger establishments. With regards to the workforce, there was a similar sort of consolidation, but on both ends of the labor intensity spectrum. There are fewer minority-time workers—those that spend less than 50 percent of their labor hours on clean energy work—as well as fewer total full-time workers—those that dedicate all their labor hours to clean energy work. Solar and biomass jobs tend to have higher labor intensities, so the job losses experienced in these sectors resulted essentially in less clean energy work per person. Clean energy businesses are likely reallocating their minority-time clean energy workers to non-clean energy activities, maybe even exiting the clean energy space in general. The result is a core clean energy workforce with more majority-time workers—those that spend the majority, but not all, of their labor hours on clean energy work—even though the overall number of full-time clean energy workers went down.

The combined effects of turbulence and consolidation have resulted in new arrangements in the renewable energy space, particularly for the solar industry. Despite both job loss and a decline in annual installed capacity for the solar industry, there were relatively small declines across the state's clean energy installation workforce. At the same time, there was also a higher proportion of renewable energy workers that spend most or all of their time on clean energy work activities. Instead of shedding installation jobs, data indicates that solar firms sought customers outside of Vermont. The proportion of in-state solar customers declined by 30 percent in 12 months, but Vermont's solar businesses responded by tapping into out-of-state markets.

[1] The Solar Foundation. *National Solar Jobs Census 2017.* February 2018. It should be noted that The Solar Foundation only reports solar jobs at the 50 percent or higher threshold—those workers that spend the majority of their time on solar-related work activities—which differs from this report.

Industry Overview

Clean Energy Job Growth and Policy Reforms

A note about clean energy workers and survey methodology:

Employment data for this report captures, as the clean energy workforce, all employees from qualifying clean energy firms that spend ***any portion of their time*** supporting the research, development, production, manufacture, distribution, or installation of clean energy products and services. This includes support services such as consulting, finance, tax, and legal services related to clean energy technologies.

As such, employment totals in this report should not be equated to Full-Time Equivalents (FTEs), but instead taken as a total quantification of the state's clean energy economy. To better understand labor intensity, survey data provides both a 50 percent and 100 percent employment threshold for workers that spend at least half of their time and those that spend all of their time supporting the clean energy portion of business. For more information please refer to Table 1 and Figure 5 of this report.

It is important to note that solar employment in this report will not match numbers reported in The Solar Foundation's (TSF) Solar Census. Where TSF uses the 50 percent threshold for their employment totals, VCEIR reports have always reported total solar employment; as a result, VCEIR solar employment totals will be higher compared to TSF reports.

It is also important to note that employment data excludes any retail employment—i.e., workers at gasoline stations, fuel dealers, motor vehicle dealerships, appliance and hardware stores, and other retail establishments are not included in the survey.

In this fifth annual assessment of the size and characteristics of Vermont's clean energy workforce, the 2017 through 2018 data collection effort finds that the state is home to approximately 18,800 clean energy workers. Clean energy jobs in Vermont provide higher median hourly earnings—about $26.71—compared to the state's overall median wage of $21.33.[2] In fact, this is well above Vermont's living wage for two adults, one working with one child of $23.10.[3]

For the first time since data was reported in 2014, the Vermont Clean Energy Industry Report shows that clean energy jobs in the state declined by about 1.7 percent. The decline over these 12 months amounts to a loss of close to 320 jobs. Despite this, the clean energy workforce still accounts for six

[2] Emsi 2017. Clean energy industries are defined as those NAICS codes that typically have clean energy-related jobs, such as solar photovoltaic installers, electricians, carpenters, civil or electric engineers, construction laborers, etc.

[3] Massachusetts Institute of Technology, Living Wage Calculator. The living wage for two adults, one working, with one child, is $23.10 per hour.

percent of total statewide jobs (Figure 1).[4] All three major sectors shed employment between 2017 and 2018—energy efficiency by 0.4 percent, while renewable energy and clean transportation firms shed jobs at a rate of roughly 4.1 and 1.3 percent, respectively (Figure 2).

Figure 1. Clean Energy Employment Growth, 2013-2018

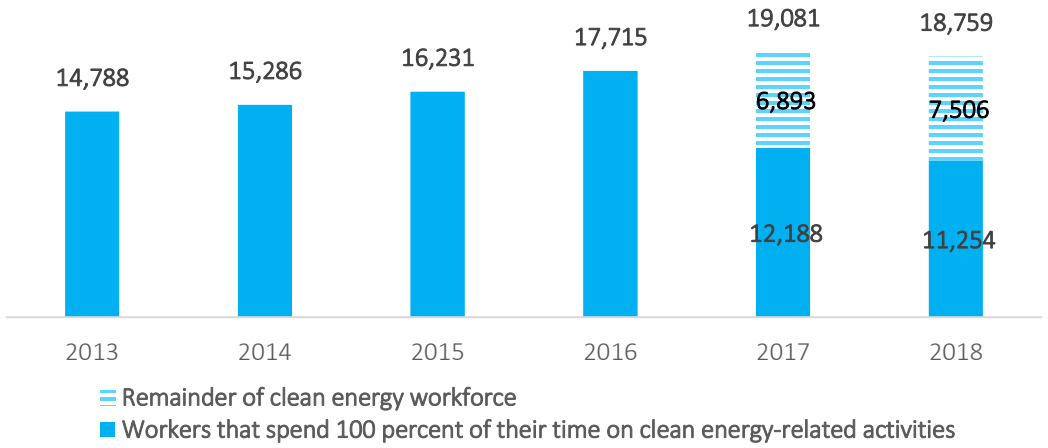
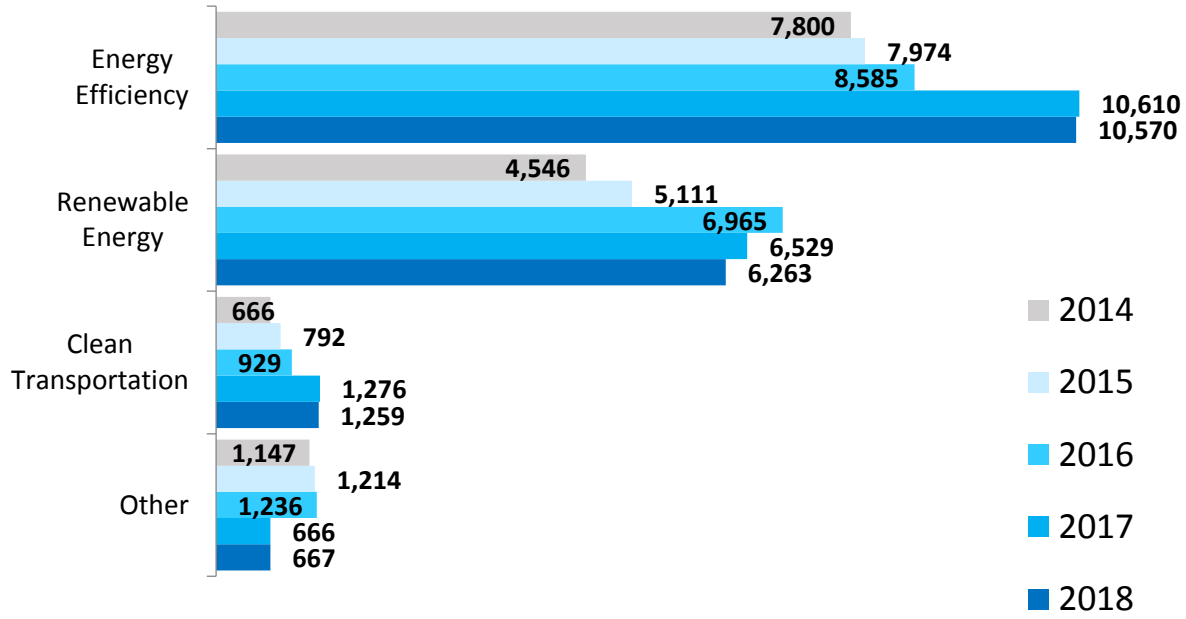


Figure 2. Clean Energy Employment Growth by Technology, 2014-2018[5]

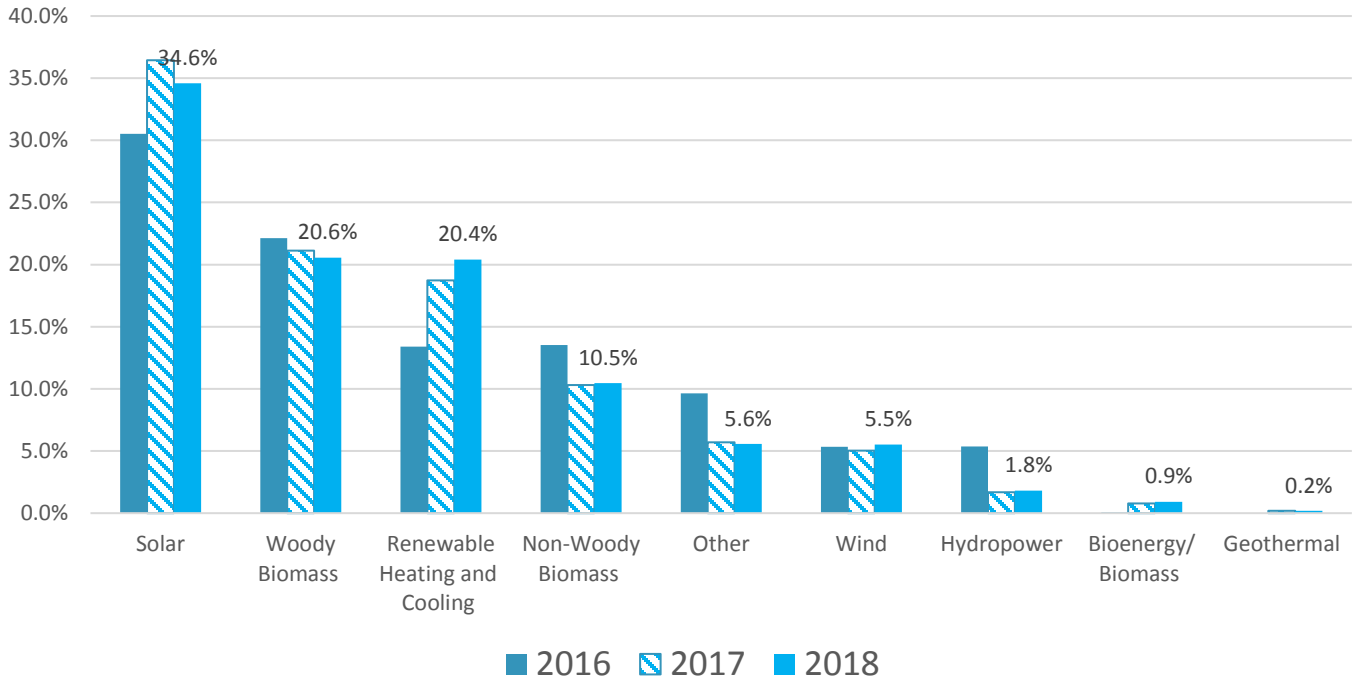


[4] Bureau of Labor Statistics, Quarterly Census of Employment and Wages. Total Covered Employment, June 2017. Extracted on 10 April 2018.

[5] Clean transportation workers are defined as clean energy employees that spend any portion of their time supporting hybrid electric, plug-in hybrid, electric, natural gas, hydrogen, or fuel cell vehicle technologies.

Employment declines are most notable in the solar and biomass sub-technologies, with small losses in the clean transportation sector. The solar industry overall also sagged at the national level, where jobs ebbed by almost four percent in just 12 months; this is the first year of decline since the initial National Solar Jobs census in 2010.[6] Between 2017 and 2018, the solar industry in Vermont shed roughly 215 jobs, or nine percent of the state's solar workforce. At the same time, solar installations across the state declined by about 9 percent.[7] Nevertheless, solar jobs do remain the largest segment of Vermont's renewable energy workforce, accounting for just over a third of total renewable energy workers (Figure 3).

Figure 3. Renewable Energy Generation Employment by Sub-Technology, 2016-2018[8]



[6] The Solar Foundation. *National Solar Jobs Census 2017.* February 2018. It should be noted that The Solar Foundation only reports solar jobs at the 50 percent or greater threshold, or solar workers that spend the majority of their time on solar-related work activities, which differs from the methodology for this report.
[7] *Case No. 18-0086-INV Biennial Update of the Net-Metering Program*. Vermont Public Utilities Commission May 1, 2018.
[8] **Bioenergy and biomass:** Generation of electricity from materials derived from biological sources or any organic material which has stored sunlight in the form of chemical energy; this includes utility and non-utility employment involved in facility construction, turbine and other generation equipment manufacturing, and wholesale parts distribution of all bioenergy electric generation technologies. **Woody and non-woody biomass:** Workers engaged in the harvest, production, trade, transport, and professional service support of fuel developed from the by-product of management, restoration, and hazardous fuel reduction treatments, the product of natural disasters including trees and woody plants, and fuels made from other materials, including biodiesel, such as straw, manure, vegetable oil, or animal fats. **Renewable heating and cooling:** Heating, ventilation, and air conditioning (HVAC) from renewable energy resources or work that increases the energy efficiency of HVAC systems (i.e. solar thermal).

Following the solar industry, woody biomass and renewable heating and cooling represent the second and third largest sub-technologies of the renewable energy generation sector (Figure 4). Woody and non-woody biomass firms shed a collective 110 jobs, for a respective decline of 6.7 and 2.7 percent. The state also lost about 35 electric vehicle workers. On the contrary, wind energy firms grew their workforce by 5.3 percent, creating 17 new wind energy jobs across the state. Renewable heating and cooling firms grew by 4.5 percent, or by 56 jobs.

The declines in the clean energy workforce come alongside several policy reforms enacted in 2016 and implemented through 2017. The most notable of these changes includes a revision to rates for new net metering customers. The initial success of the net metering program led to a boom of renewable energy project installations, particularly in solar. However, the program's rate of roughly 20 cents per kilowatt hour—which was greater than most Vermont retail rates—was determined to be unsustainable.

The next iteration of the policy, Net Metering 2.0, decreased the adjuster rates by one to two cents per kilowatt hour for small systems and three to five cents per kilowatt hour for larger systems. Net Metering 2.0 also redefined monthly charges which cannot be paid with credits and prevented permitting of projects larger than 150 kW unless they were on a roof or preferred sites. Combined, these changes essentially make new renewable energy projects, particularly larger projects, less attractive; this has subsequently led to a significant decline in new projects compared to 2016 levels.[9]

In addition to these changes, however, the state did remove the aggregate cap on net metering in January 2017. The cumulative capacity of net-metered systems was previously limited to 15 percent of a utility's peak demand during 1996 or the peak demand during the most recent full calendar year, whichever was greater.[10]

In addition to Net Metering 2.0, the Public Utilities Commission adopted a new rule on sound from wind generation facilities in November 2017. The new rule sets the sound limit at 39 decibels at night and 42 decibels during the day.[11] At the time of data collection, these reforms had not shown an effect on the wind energy workforce in Vermont

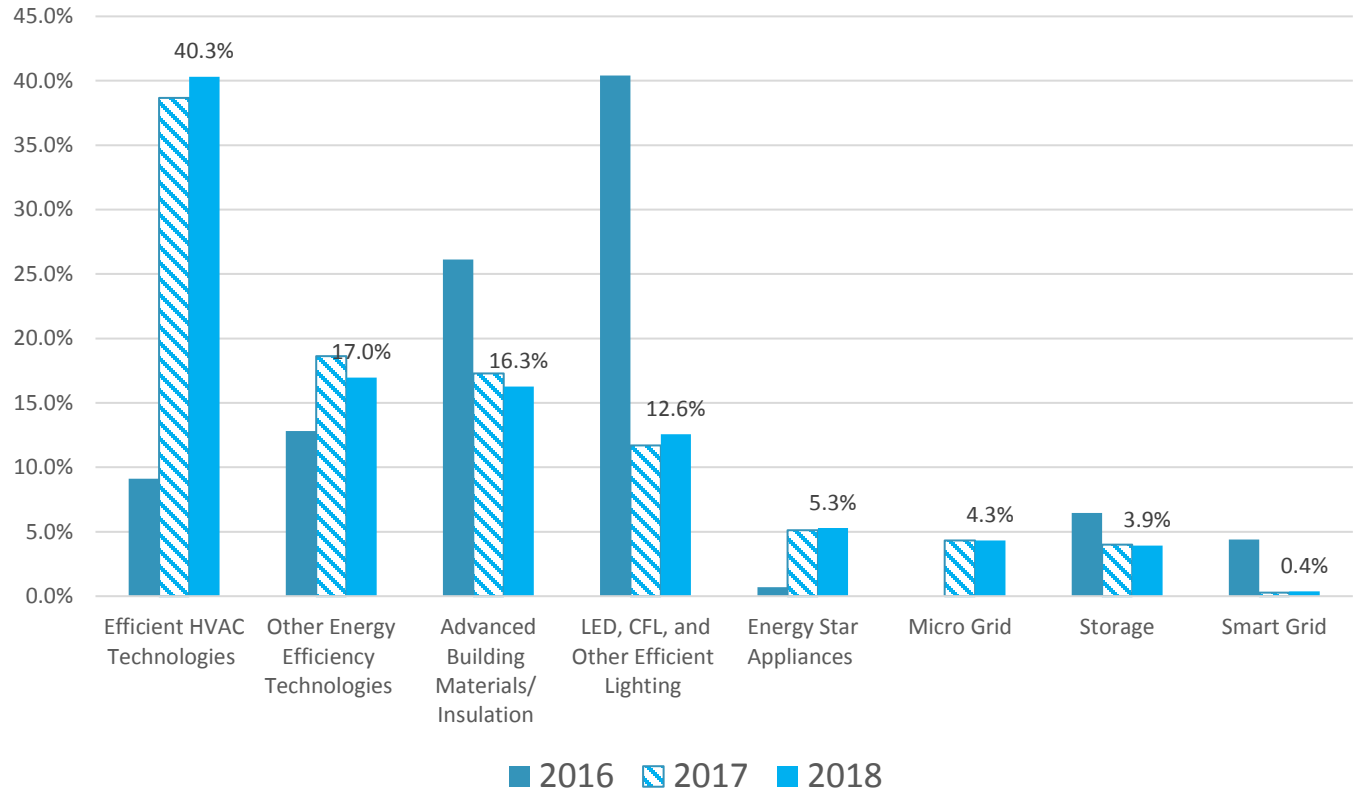
Despite the restructuring of the net metering program, other recent policy reforms signal continued growth potential in the energy efficiency and biomass space. The state's energy efficiency sector is quite diverse, with workers engaged in a number of sub-technologies including efficient HVAC technologies, advanced building materials and insulation, efficient lighting, energy star appliances, and grid modernization and storage technologies (Figure 4).

In general, the state remains aggressive with its Renewable Energy Standard. Retail electricity providers cannot sell electricity within Vermont without ownership of sufficient energy produced by renewable energy plants or tradable renewable energy credits. At the start of 2017, 55 percent of

[9] Threlkeld, Kathryn and Steven Pappas. *Net metering takes its toll on Vermont.* The Barre Montpelier Times Argus Online. 2 March 2018.
[10] Act 99 of 2014 §219a(h)(1)(A)
[11] *Vermont Public Utility Commission Adopts Rule on Sound from Wind Generation Facilities*. Vermont Public Utilities Commission. Press Release, November 7, 2017.

each retail electricity provider's annual sales must be from renewable energy. This amount increases four percentage points every third January 1st thereafter, until reaching 75 percent on January 1st, 2032.[12]

Figure 4. Energy Efficiency Employment by Sub-Technology, 2017



Clean Energy Establishments and Labor Intensity

The total number of establishments conducting clean energy work also declined by almost four percent, from 3,751 establishments in 2017 to 3,612 in 2018. In general, there are still 43 percent more clean energy establishments in Vermont compared to the 2,519 locations recorded in 2015. Most clean energy establishments are still concentrated in the energy efficiency sector, with 2,232 locations, followed by renewable energy and clean fuels with 1,229 locations, and clean transportation at 152.

The shifts in this year's labor intensity thresholds indicate that more workers are spending the majority of their time on clean energy work, while at the same time, there are fewer overall full-time clean energy workers. Overall labor intensity—the proportion of individuals who spend a majority of their time on clean energy-related business activities—increased by 1.7 points, from 68.3 percent to 69.8 percent; the overall proportion of workers that spend all of their time on clean energy work remained unchanged. In particular, there are more renewable energy employees that spend the

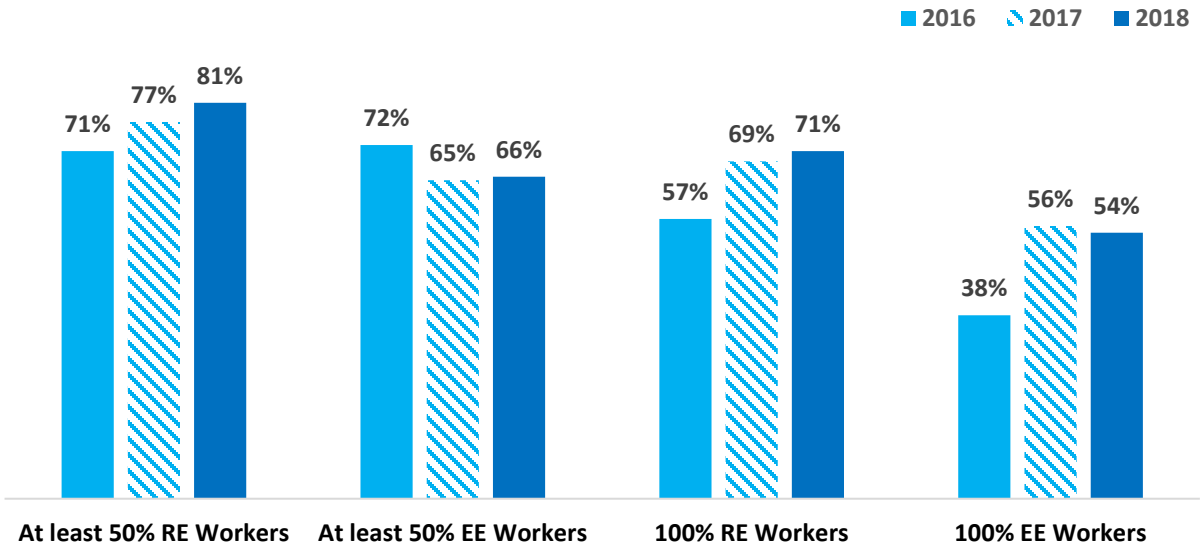
[12] 30 V.S.A. §8005

majority or all of their time working with clean energy technologies—a respective increase of four and two points (Table 1 and Figure 5).

Table 1. Clean Energy Employment Thresholds, 2014-2018[13]

	Workers that spend at least 50 percent of their time						Workers that spend 100 percent of their time					
	2014	2015	2016	2017	2018		2014	2015	2016	2017	2018	
Renewable Energy	75%	70%	71%	77%	68%	81%	55%	55%	57%	69%	70%	71%
Energy Efficiency			72%	65%		66%			38%	56%		54%

Figure 5. Clean Energy Employment Thresholds, 2016-2018



[13] Labor intensity for 2014 and 2015 is only available for the overall clean energy workforce; additional granularity by sector was not introduced until the 2016 survey.

Clean Energy Value Chain

Overall clean energy employment losses were seen across several value chain segments, including utilities, manufacturing, trade, and to a lesser extent, installation, maintenance, and repair. Installation still accounts for the largest component of activity in Vermont's clean energy economy. This value chain segment comprises more than a third, or 36 percent, of all clean energy establishments and 44 percent of all clean energy jobs. Professional services, like consulting, finance, and legal support, account for 28 percent of establishments, followed by trade at 17 percent, and manufacturing at six percent (Figure 6).

Utilities shed jobs at the highest rate of 13 percent, which equates to about 150 workers. Manufacturing and trade shed jobs at a rate of five percent each, totaling almost 190 lost jobs. The installation workforce also shrank by 70 workers, a decline of 0.8 percent (Figure 6 and Figure 7).

Figure 6. Clean Energy Establishments by Value Chain, 2018

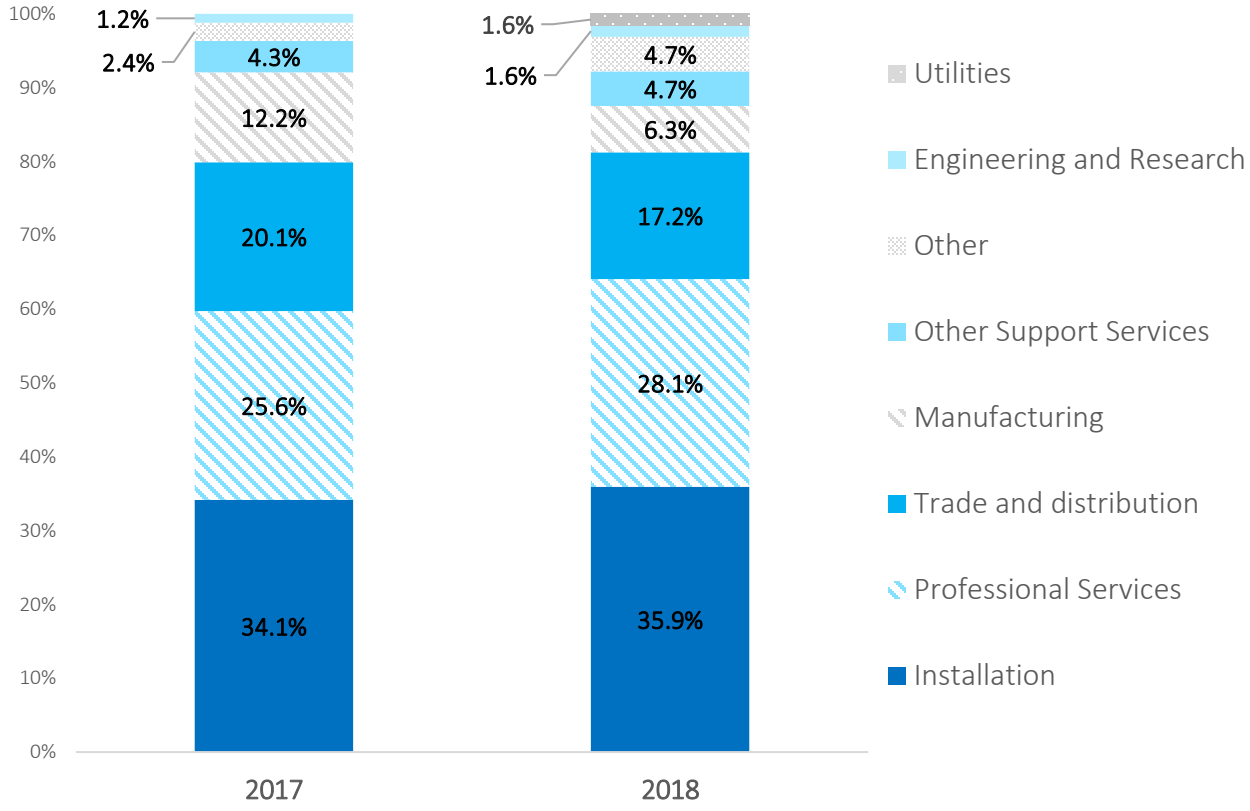
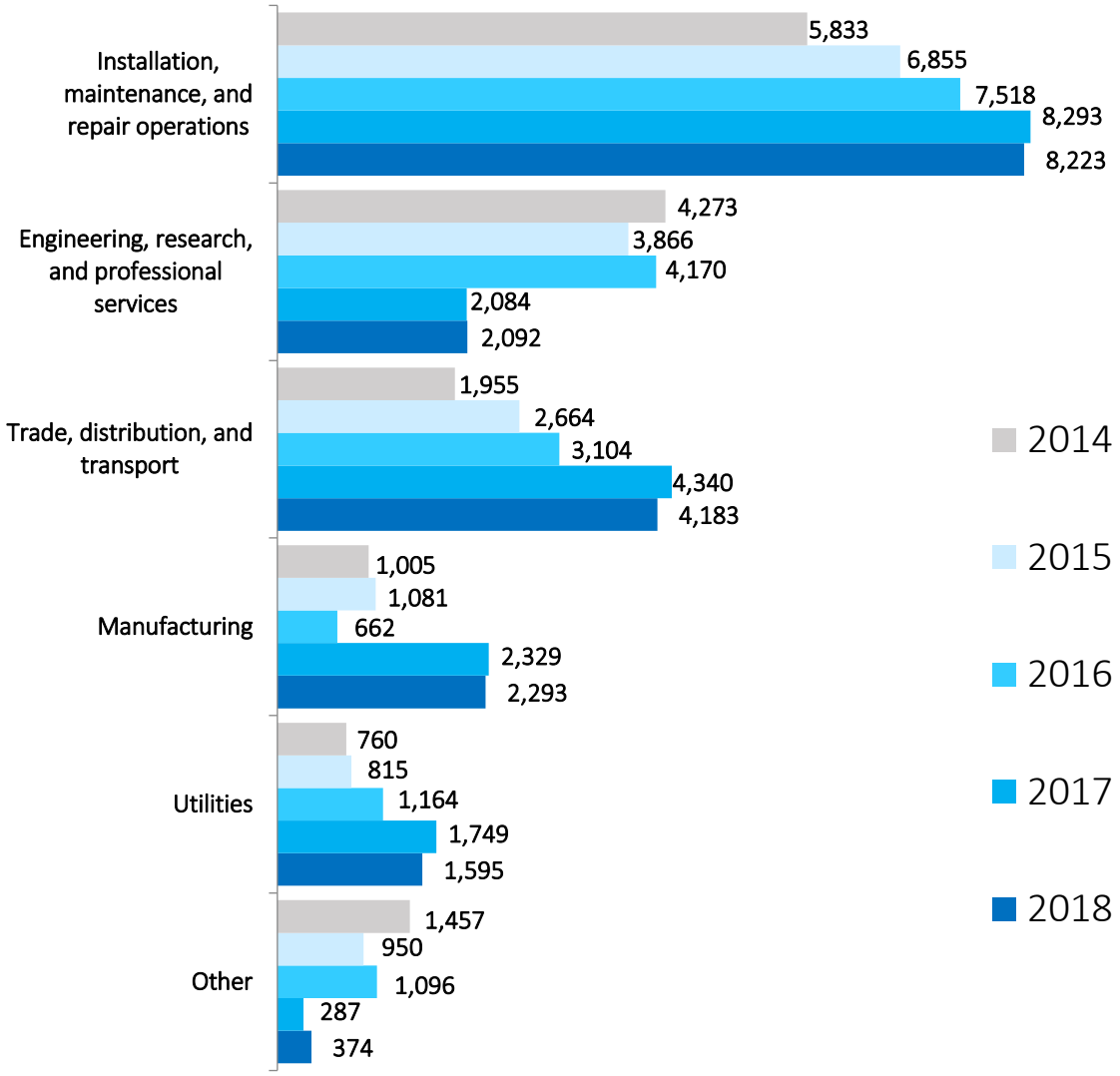


Figure 7. Value Chain Employment Growth, 2014-2018[14]

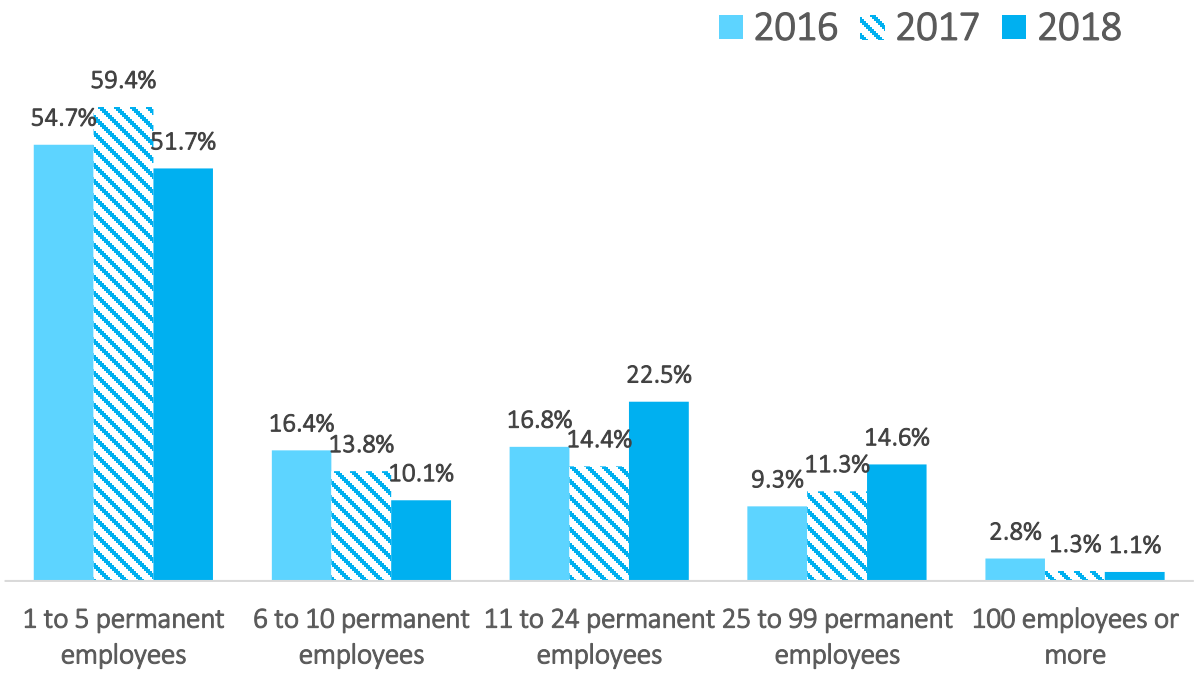


[14] The "utilities" category here includes all workers at establishments that are engaged in the provision of utility generation services. Such utility generation employees only include clean energy-related utility generation, such as energy efficiency, solar, hydroelectric, biomass, or wind electric generation.

Clean Energy Market and Labor Supply

Most clean energy establishments in Vermont are small, with one to five employees. The proportion of small establishments, however, decreased over 2017 and shifted to more medium-sized firms with 11 to 24 employees as well as medium-large establishments with 25 to 99 employees (Figure 8).

Figure 8. Clean Energy Establishment Size, 2016-2018



The intensity of hiring difficulty increased significantly between 2017 through 2018. Almost eight in ten, or 79 percent, of surveyed clean energy employers reported that they had trouble finding qualified workers to fill open clean energy positions; this represents an overall increase of about three percentage points in hiring difficulty. The proportion of employers that reported hiring was very difficult over 2017 increased by 18 points, from 24 percent in 2017 to 41 percent in 2018 (Figure 9).

Lack of experience, training, or technical skills remains the number one reason for hiring difficulty, with 52 percent of employers indicating that they are having trouble finding experienced candidates to fill open positions; this represents an increase of six percentage points over 2017. Non-technical

skills, location, and inability to provide competitive wages all moved up, as more employers selected these as reasons for hiring difficulty in 2018 compared to 2017. New in 2018, four percent of employers attributed their hiring difficulties to the overall condition of the economy ("Economic Structure/Conditions"; Figure 10).

Figure 9. Hiring Difficulty, 2018[15]

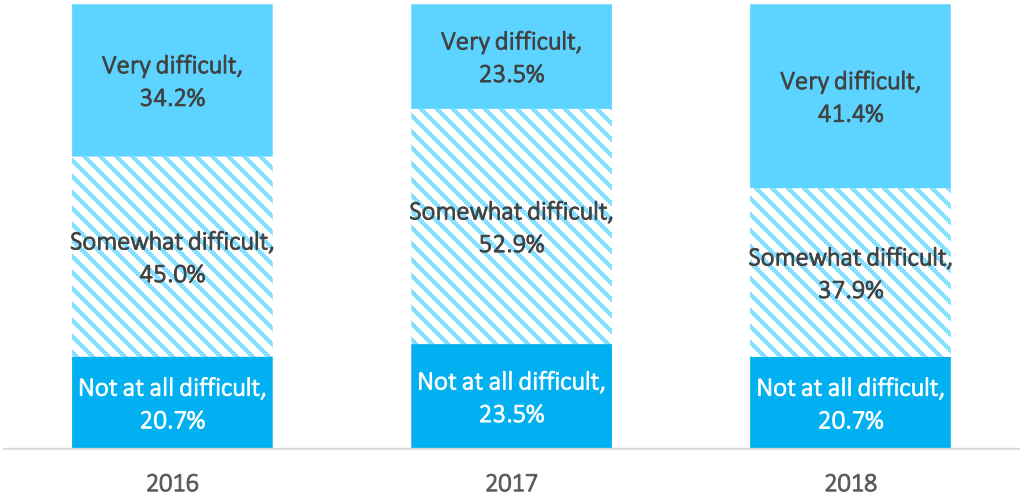
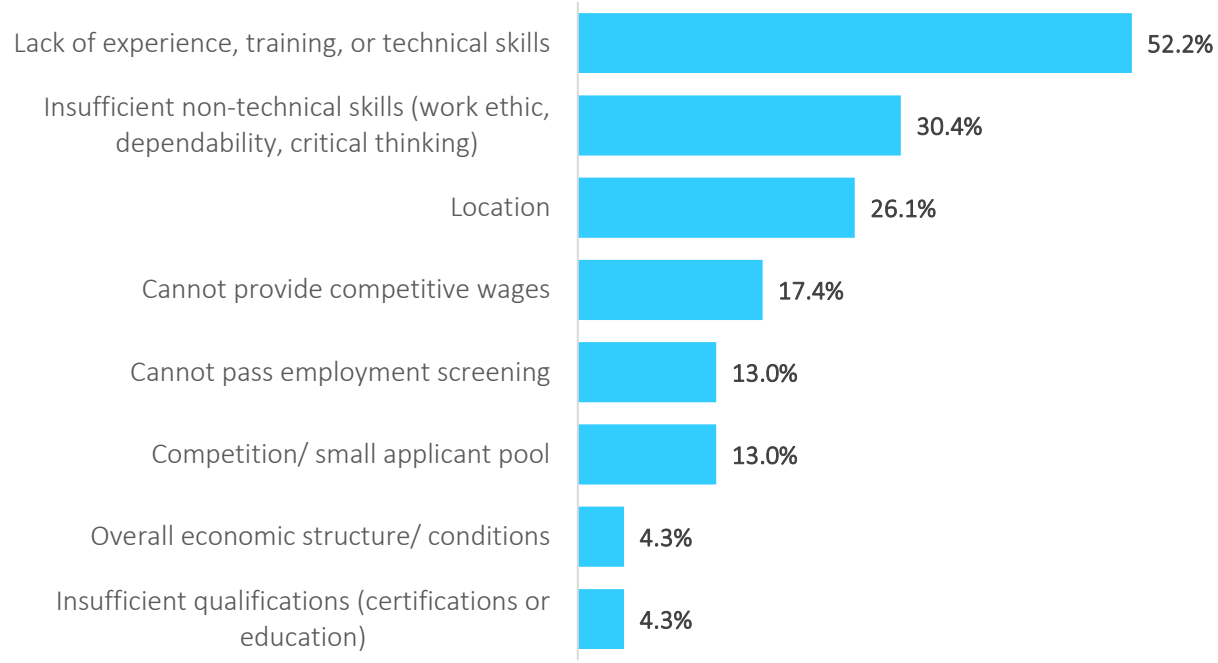


Figure 10. Reasons for Hiring Difficulty, 2018[16]

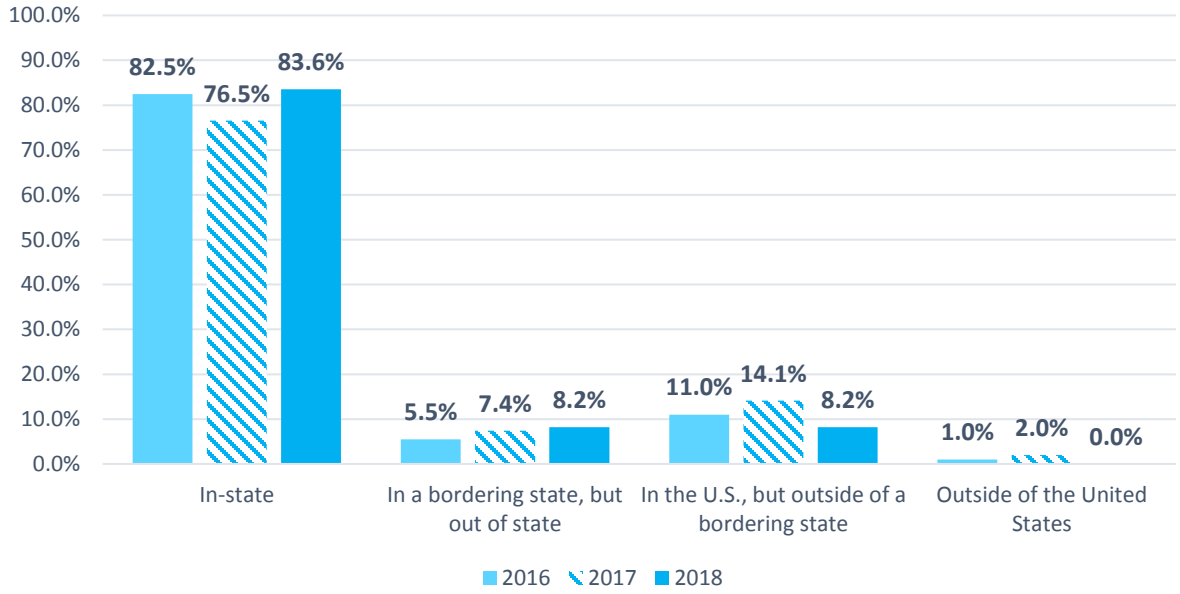


[15] This analysis was conducted with DK/NA responses factored out.

[16] This was a multiple choice question; percentages do not sum to 100 because respondents could select more than one response.

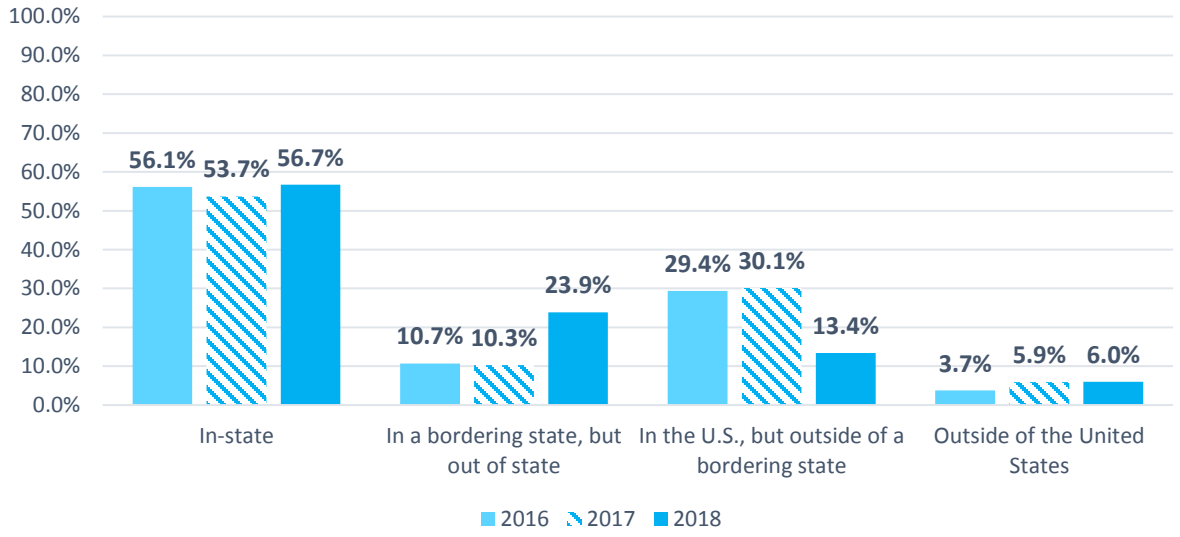
Vermont's clean energy customer base remains largely within the state. Following a slight decrease in in-state customers between 2016 and 2017, the proportion has returned to roughly 84 percent in 2018 (Figure 11). At the same time, there are also slightly more in-state vendors as well as vendors from a bordering state as opposed to across the United States (Figure 12).

Figure 11. Customer Location, 2016-2018



Of interest to note this year, is the change in customer distribution specifically for solar firms. Between 2017 and 2018, in-state solar customers declined by 30 points while customers in a bordering state or across the United States increased by 23 and eight points respectively.

Figure 12. Vendor Location, 2016-2018



Wood Energy Sector: 2018 Special Analysis

The following section profiles Vermont's wood energy sector using a supplemental survey specific to wood energy employers. The survey questions for this 2018 Clean Energy Industry Report refer to the 12 months between the first quarters of 2017 and 2018. Historical comparisons are made to the 2016 Clean Energy Industry Report, which was the first time the supplemental wood energy survey was administered; the term for the 2016 results covers the 12 months between 2015 and 2016. In total, there are roughly 560 wood energy establishments, including sole proprietors, across the state of Vermont.

For the purposes of this report, firms are qualified as wood energy employers if they support any of the following activities related to wood energy only: forestry, fuel supply chain such as logging, chipping, wood pellet, firewood, and other wood fuel production, as well as the design, development, production, sales, installation, and service of pellet, chip, or other wood burning stoves, inserts, furnaces, boilers, or other equipment that produces heat or electricity.

Wood Energy Sector Overview

Most wood energy establishments in Vermont are engaged in logging activities or the processing and preparation of wood fuels; together these two sub-sectors comprise just over three-quarters of the wood energy industry sector. The remainder of the sector works with combustion systems and other wood energy products or services. The VCEIR first looked into this subset beginning in 2016. Between 2016 and 2018 the proportion of firms that are primarily engaged in logging or combustion systems decreased and shifted towards wood fuel processing and preparation and other wood energy activities (Figure 13).

Wood energy firms that supply wood fuels or combustion systems largely serve residential and commercial customers, with fewer than 15 percent indicating that they serve primarily industrial or institutional customers (Figure 14).

Figure 13. Wood Energy Firms, Primary Sector, 2016 and 2018

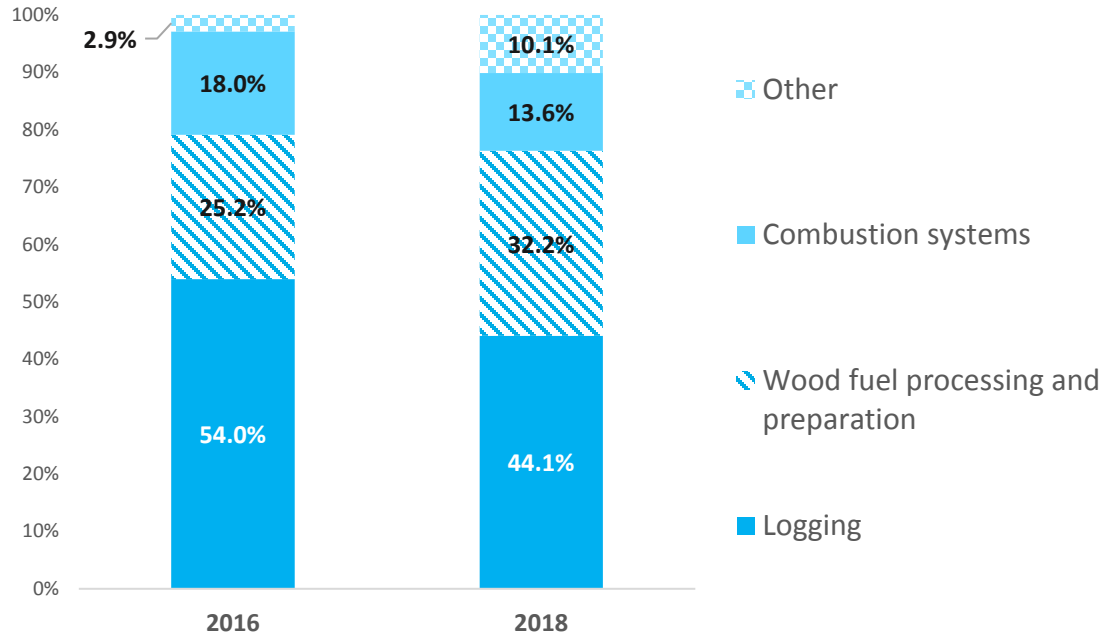
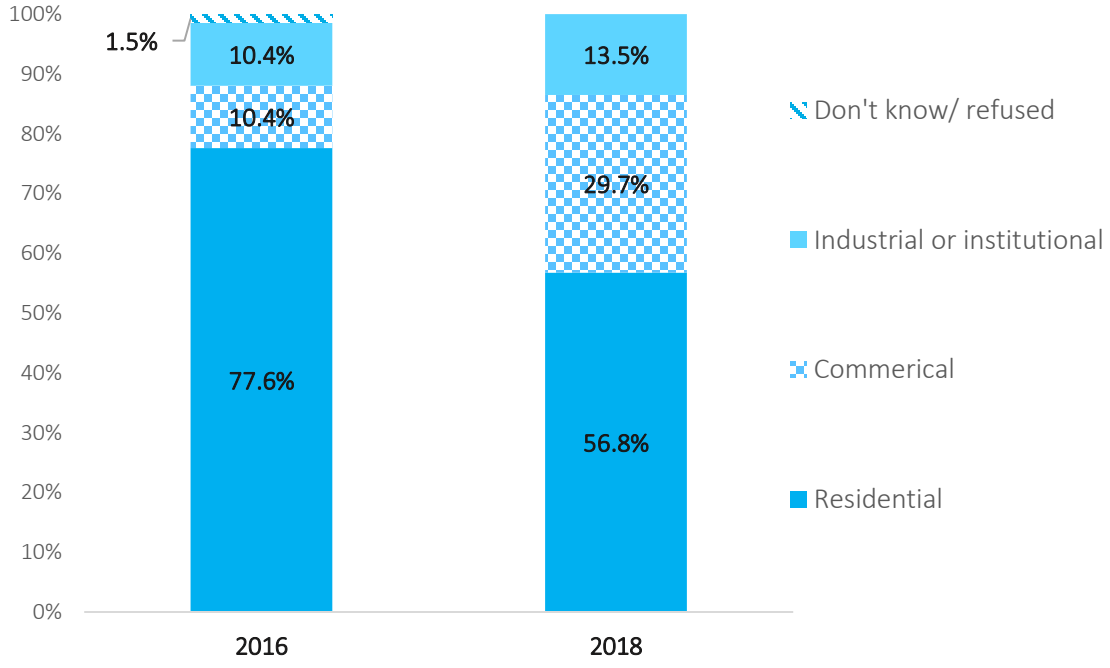


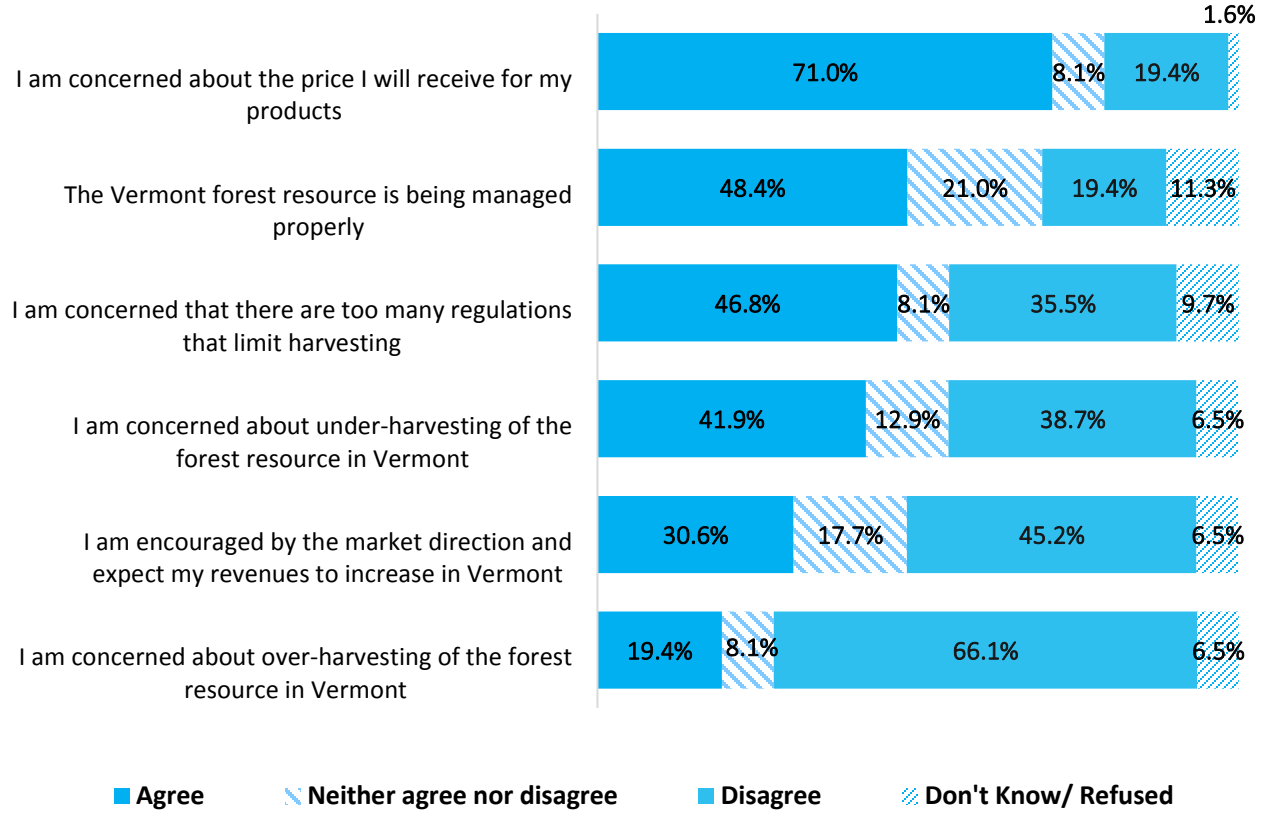
Figure 14. Wood Fuel and Combustion Systems, Customers, 2016 and 2018[17]



[17] This question was only asked of wood energy firms that work with wood fuels or combustion systems; it was not sked of logging firms.

For the most part, wood energy employers are satisfied with the management of Vermont's forest resources. Almost half (48 percent) indicated that they agree the forest is being managed properly, and only 19 percent felt that the forests are being over-harvested. In fact, more employers are concerned about under-harvesting and too many regulations that limit harvesting (Figure 15).

Figure 15. Health of Vermont's Forest Resources, 2018

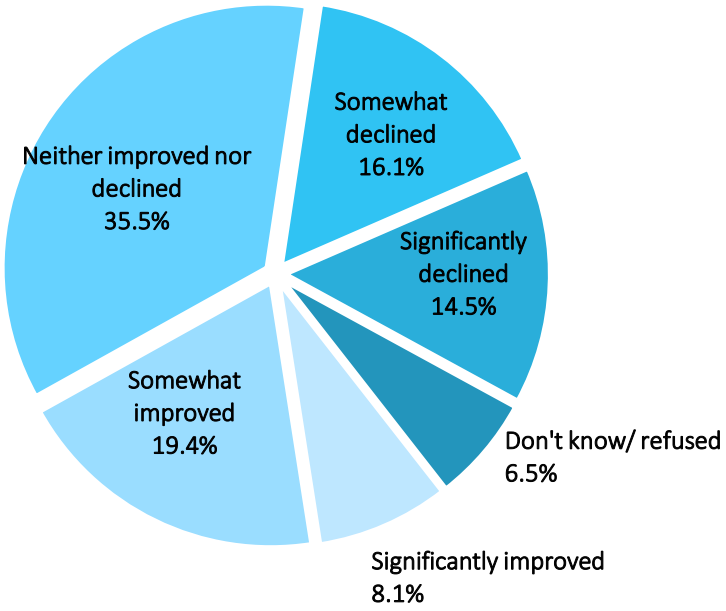


Wood Energy Market and Revenues

Over the 12 months between the last quarters of 2017 and 2018, there was a fairly even split between employers who felt that the market demand for wood energy products and services either improved (28 percent), declined (31 percent), or stayed the same (36 percent) (Figure 16). Employers who felt the market had declined most commonly cited the following reasons for decline: low fossil fuel prices, market competition, fluctuating product prices, general economic downturn, and an insufficient demand for their products. In general, the primary concerns for wood energy employers with regards to their firm's future business prospects in Vermont are related to regulations and product prices, followed by lack of demand due to low fossil fuel costs.

There was a higher proportion of logging firms that reported that the market for wood energy-related products has declined over the last 12 months.

Figure 16. Annual Change in Market for Wood Energy Products, 2018



Between 2017 and 2018, many wood energy employers reported that their revenues remained the same, while 27 percent noted that revenues declined. Only about 19 percent of wood energy employers reported revenue increase over those 12 months. This distribution is roughly unchanged compared to the 2015 through 2016 figures (Figure 17). A greater proportion of wood fuel processing and preparation employers reported an increase in revenue compared to logging firms.

In general, only a third of wood energy firms derive all of their revenue from selling wood energy products and services, followed by another quarter of firms that receive half to most of their revenue from wood energy. The proportion of firms that derive all of their revenue from wood energy products and services decreased significantly, from 46 percent in 2016 to 32 percent in 2018 (Figure 18).

Figure 17. Annual Wood Energy Revenue Growth, 2016 and 2018

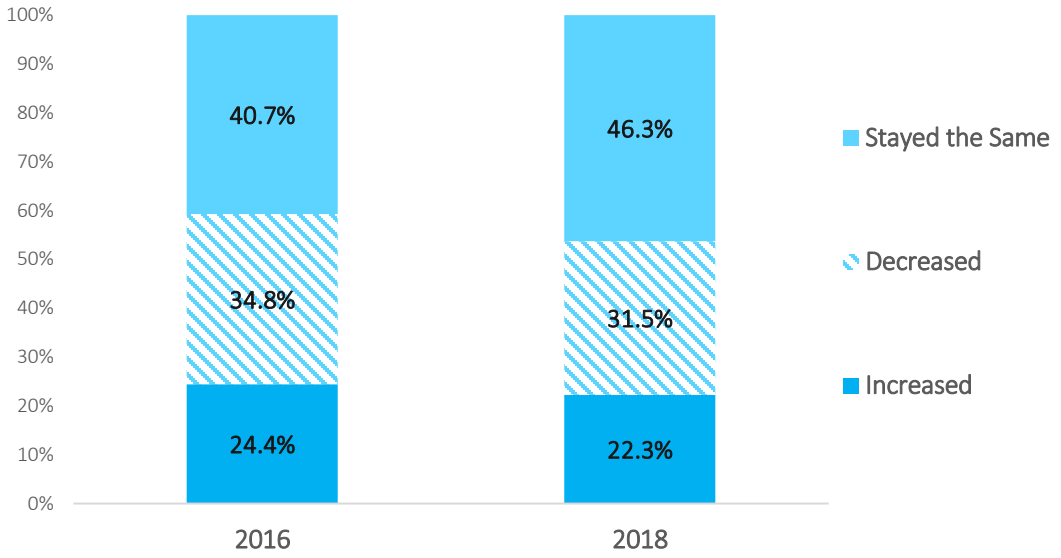
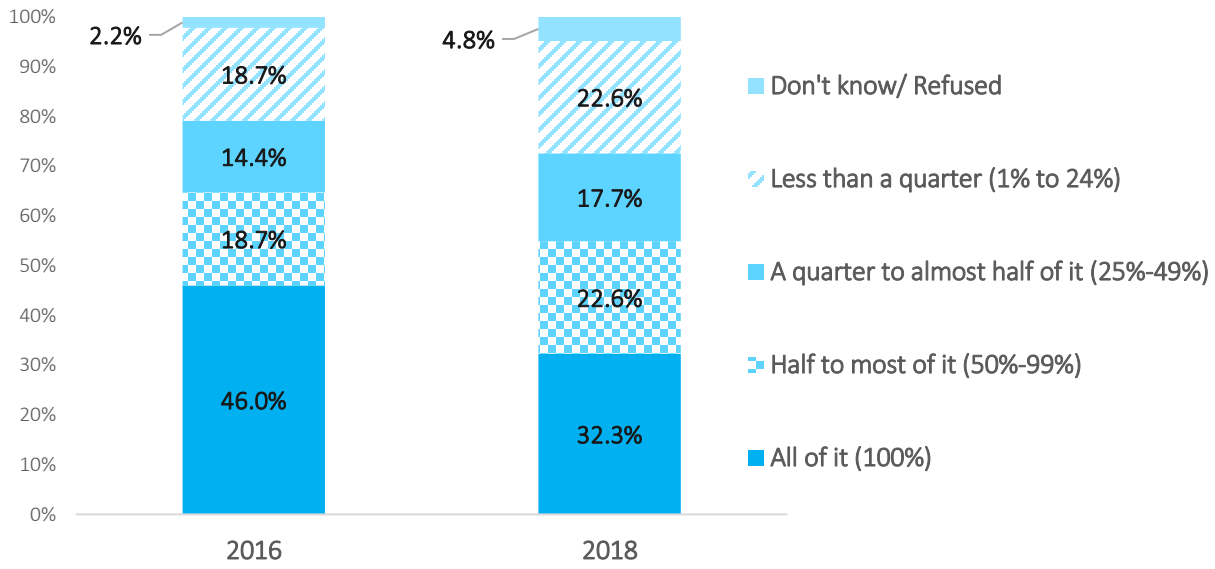


Figure 18. Wood Energy Revenue Share, 2016 and 2018



Wood Energy Policies and Economic Development

Few wood energy employers reported that their customers used any incentives, rebates, tax, credits, or other programs over the 12 months between 2017 and 2018.

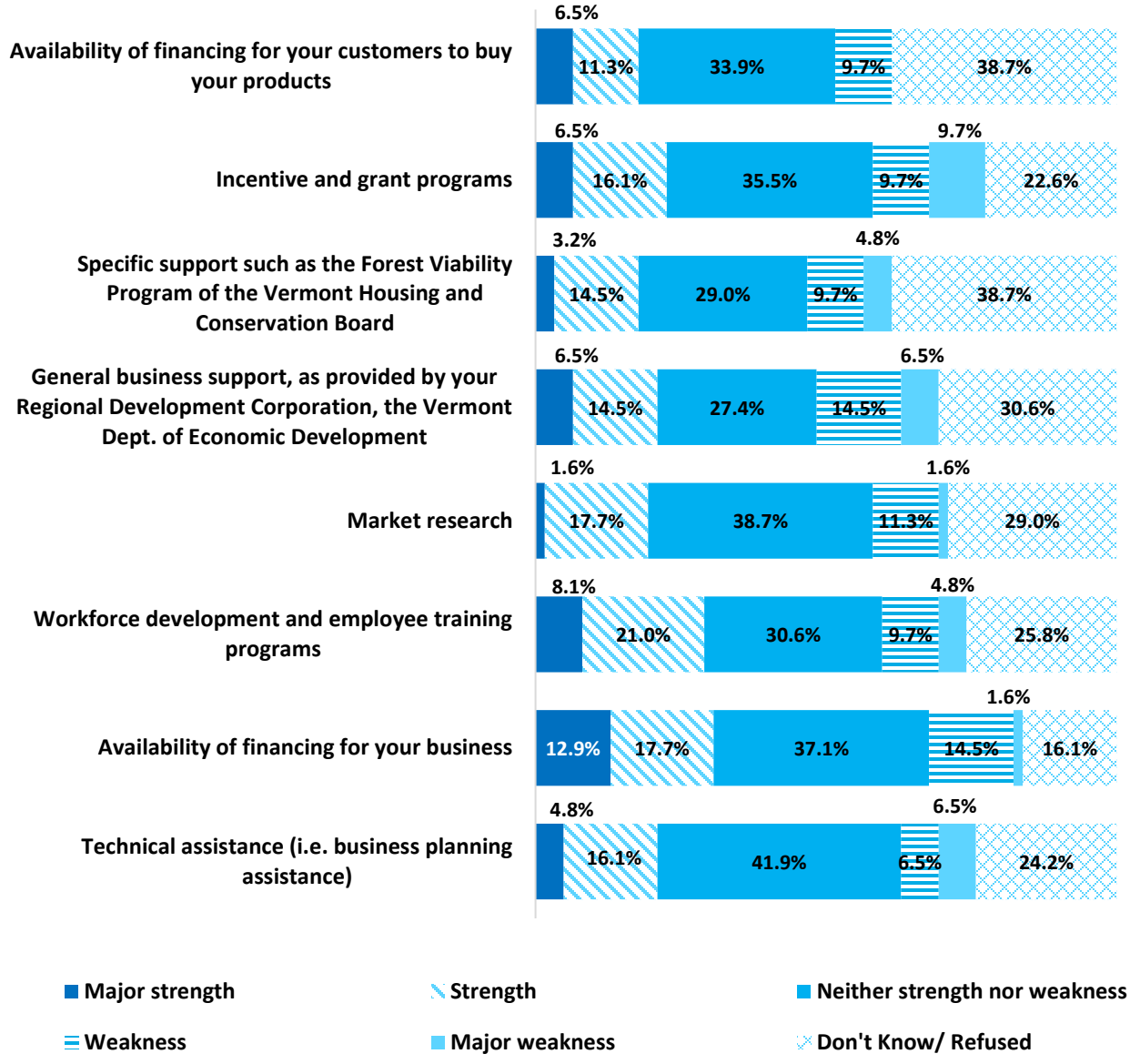
In terms of economic development activities within the state, wood energy employers are most satisfied with the availability of business financing, workforce development and employee training programs, as well as incentive and grant programs. Few employers (18 percent) indicated that the availability of financing for customers to buy their products was a strength; 34 percent reported it

was neither a strength nor a weakness, and 39 percent reported they either did not know or refused to answer (Figure 19).

With regards to product branding, few employers report that they currently brand their products as a Vermont product (27 percent), and of those that do about three in ten (29 percent) indicate that there is a benefit to this branding. Almost half of wood energy employers (47 percent) do brand their products as sustainably harvested, and 39 percent of these firms indicate that there is a benefit to the sustainably harvested brand.

The majority of wood energy firms—more than three-quarters, or 78 percent—brand their products as renewable or clean energy, and 57 percent report that there is a benefit to this brand.

Figure 19. Economic Development Activity Rating, 2018



Methodology

As with the 2016 and 2017 report, data for this year's report is derived from the United States Energy and Employment Report (USEER). The 2018 USEER methodology used the most recently available data from the Bureau of Labor Statistics Quarterly Census or Employment and Wages (BLS QCEW 2017 Q2). The survey was designed and conducted by BW Research Partnership on behalf of the Energy Futures Intiative (EFI) and the National Association of State Energy Officials. The methodology employed for the survey has been used for local, state, and federal energy-related data collection and analysis for nearly a decade.

The survey uses a stratified sampling plan that is representative by industry code (NAICS), establishment size, and geography to determine the proportion of establishments that work with specific energy-related technologies, as well as the proportion of workers in such establishments that work with the same. Survey results are analyzed and applied to the existing public QCEW data series, constraining the potential universe of energy establishments and employment.

The survey was administered by telephone with approximately 5,800 outbound calls in Vermont as well as by web, with over 660 emails sent to participants across the state. The phone survey was conducted by IHR Research. The web instrument was programmed internally and each respondent was required to use a unique ID in order to prevent duplication.

The sample was split into two categories, referred to as the known and unknown universes. The known universe includes establishments that have previously identified as energy-related, either in prior research or some other manner, such as membership in an industry association or participation in government programs. These establishments were surveyed census-style, and their associated establishment and employment totals were removed from the unknown universe for both sampling and for resulting employment calculations and estimates. Over the summer of 2017, BW Research cleaned, deduplicated, added to, and refined its database to reflect churn (companies out of business, moved, no longer in energy), unverified (no answer, answering machine, fast-busy, disconnect, etc.), verified, and other available demographic tags (industry, technology, sub-technology, size, etc.).

In addition to cleaning the original known energy database, BW Research also supplemented with industry association contact lists by technology (biofuels, coal, oil, and gas, energy storage, energy efficiency, solar, and wind), new companies from the unknown database that took the 2017 survey, and contact lists from subcontractors. BW Research also appended contact information, including six-digit NAICS codes, contact, employment, and location information.

The unknown universe includes hundreds of thousands of businesses in potentially energy-related NAICS codes, across agriculture, mining, utilities, construction, manufacturing, wholesale trade,

professional services, and repair and maintenance. Each of these segments and their total reported establishments (within the Bureau of Labor Statistics QCEW) were carefully analyzed by size (employment – provided by the Census Bureau's County Business Patterns) and state to develop representative clusters for sampling.

In total, approximately 341 business establishments in Vermont participated in the survey effort, with approximately 158 providing full responses to the survey. These responses were used to develop incidence rates among industries as well as to apportion employment across various industry categories in ways currently not provided by state and federal labor market information agencies. The margin of error is +/- 5.05 percent for Vermont at a 95 percent confidence interval.

Additionally, a wood energy sector survey was administered in Vermont to nearly 900 contacts. Of those, 158 responded, with more than 60 full completes. The margin of error is +/-7.35 percent for wood energy establishments. Using this margin of error, there are between 519 to 601 total wood energy establishments across Vermont.

With clean data files in place, BW Research developed a general methodology for state employment estimation that has a few variations depending on sub-technology. Steps in the process are listed below (100% NAICS B does not apply to clean energy segments).

100% NAICS A
These are NAICS codes where 100% of the reported employment is energy related AND 100% are allocated to a specific sub-technology. Examples include solar electric power generation, hydroelectric power generation, and motor vehicle manufacturing.

100% NAICS B
These are NAICS codes where 100% of the reported employment is energy related but the employment spans multiple technologies. Examples include oil and gas extraction and fossil electric generation.

Actual Survey Responses
These include the reported sub-technology employment totals by company location. Responses from establishments in 100% NAICS codes are excluded.

Known Database
Employment is allocated by location for verified establishments in the known when the following conditions are met: 1) Have InfoUSA appended data; 2) did not take survey (or actual survey response would be used), and 3) are not in a 100% NAICS.

Remainder
This represents remaining employment based on statistical extrapolation.

Industry Mix
Industry mix is the national proportion of industries that contribute to sub-technology employment. The mix of these industries (by 6-digit NAICS) is used to create proportions by state and remainder (see previous bullet) employment is allocated by these proportions.

This "industry mix" was developed by analyzing completed survey incidence nationally for all clean energy sub-technologies. For example, the six-digit NAICS industries below cover all firms that reported wind generation-related employment in 2017:

Example: Wind Generation Industry Mix (excluding 100% NAICS A):

237130	Power and Communication Line and Related Structures Construction
238210	Electrical Contractors and Other Wiring Installation Contractors
238220	Plumbing, Heating, and Air-Conditioning Contractors
332312	Fabricated Structural Metal Manufacturing
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing
333611	Turbine and Turbine Generator Set Units Manufacturing
334413	Semiconductor and Related Device Manufacturing
423610	Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers
424720	Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals)
541110	Offices of Lawyers
541320	Landscape Architectural Services
541330	Engineering Services
541611	Administrative Management and General Management Consulting Services
541614	Process, Physical Distribution, and Logistics Consulting Services
541711	Research and Development in Biotechnology

BW Research provided additional analysis of the publicly released Department of Energy data that included data from the Bureau of Labor Statistics, the Energy Information Administration, the U.S. Census Bureau, Emsi, the BW Research Partnership Energy Employment Index, historical data from prior Vermont Clean Energy Industry Reports, and supplemental primary research conducted in Q1 2018.

Of important to note, the USEER excludes any employment in retail trade NAICS codes—motor vehicle dealershipsz, appliance and hardware stores, and other retail establishments.