

# WOOD HEATING IN VERMONT

A Baseline Assessment for 2016

## PREPARED FOR

Vermont Department of Public Service Clean Energy Development Fund

## BY

Biomass Energy Resource Center at VEIC



## **ABOUT BERC**

The lead author of this report was Juliette Juillerat with review and guidance provided by Adam Sherman. The Biomass Energy Resource Center (BERC) is a program of the Vermont Energy Investment Corporation (VEIC), a mission driven non-profit organization focused on developing and implementing market solutions to expand the use of energy efficiency and renewable energy. Since 2001, BERC has specialized in the design and implementation of programs that stimulate and support wood energy conversion projects. BERC has a long-standing reputation as a source of independent and impartial information and services for modern wood heating. More information at – www.biomasscenter.org

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### Disclaimer

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## **Executive Summary**

The purpose of this baseline assessment is to determine and document the state of the wood heat market and sector in Vermont in 2016, so that further market development progress can be measured against a specific point in time. This 2016 baseline will also help evaluate the effectiveness of the various wood heat support programs in the future.

Vermont has a long history of heating buildings with wood. While heating homes with woodstoves has been common for generations, heating entire buildings with automated woodchip and wood pellet boilers in Vermont started in the 1980s. Since that time, there has been slow and steady growth of the use of automated woodchip and pellet fueled boilers in the commercial, institutional, and residential markets. Today, Vermont is home to the greatest concentration of installed advanced wood heating<sup>1</sup> (AWH) systems in North America.<sup>2</sup>

Vermont has set a long-term goal of meeting 90% of the State's total energy needs from renewables by 2050. The 2016 Comprehensive Energy Plan (CEP) calls for an increase in the portion of renewable energy used to heat Vermont's buildings to 30% by 2025, through both efficiency and increased use of renewable fuels (including wood). The Clean Energy Development Fund's (CEDF) primary goal is to support the development of renewable energy in Vermont. In addition to renewable energy goals, the State of Vermont has economic development, greenhouse gas reduction, and Working Landscape goals that can be met, in part, through the expanded use of wood heat.

Given all the activities happening in the AWH market, and that AWH is in the early stage of market development, the CEDF found it important to monitor the wood heat market to evaluate progress toward State energy goals and market development. Therefore, the CEDF hired the Biomass Energy Resource Center (BERC) to conduct a baseline assessment of the AWH market in Vermont and create this report.

This baseline assessment was compiled primarily from existing sources of data. Existing data was supplemented by information collected through interviews with key market players. The report is comprised of two primary sections: (1) Advanced Wood Heat (AWH), and (2) total wood heat. The section on AWH presents findings related to wood heating businesses, cumulative and annual installations, wood fuel consumption, trends in installations and consumption, and the overall economic impacts of AWH. The section on total wood heat presents findings related to the portion of thermal energy met with all types of wood fuel and appliances (including AWH), as well as the overall economic impact of all wood heating.

### Advanced Wood Heat Sector

In 2016 there were two operational wood pellet fuel production mills located in Vermont (and another two mills under development), dozens of woodchip fuel producers, three primary bulk

<sup>&</sup>lt;sup>1</sup> As further defined below: central, automated woodchip and bulk pellet heating systems installed indoors

<sup>&</sup>lt;sup>2</sup> Based on BERC's on-going monitoring and tracking of AWH systems across North America <u>http://www.biomasscenter.org/database</u>



pellet fuel delivery businesses, and 41 businesses offering the sale, installation, and service of AWH systems. Overall, the AWH industry contributed over \$8.6 million in sales revenue for installers, and producers and distributors of pellets and woodchips in Vermont – with an additional \$3 million to businesses located in the "Region" (defined in this assessment as within 200 miles from the center of Vermont)<sup>3</sup>. The AWH industry directly creates 54 full-time equivalent jobs in Vermont, with an additional 10 jobs outside of Vermont.

Using data from a variety of sources, BERC estimates that there are approximately 480 advanced wood heat installations in Vermont. The majority are residential, but approximately 100 are commercial or institutional bulk wood pellet fueled systems and another 62 are commercial or institutional woodchip systems. Based on information gathered from installer interviews, BERC estimates that an additional 64 residential pellet systems are installed in Vermont annually, as well as an additional 9 commercial and institutional pellet systems. On average, one to two woodchip systems have been installed each year in Vermont in recent years.

BERC estimates approximately 8,000 tons of bulk wood pellets<sup>4</sup> and 79,000 tons of woodchips were consumed in 2016 in Vermont's advanced wood heat systems. By comparison, Vermont and regional pellet mills reported selling a total of 4,800 tons of bulk pellets to Vermont customers. This leaves the origin of a large amount of bulk pellets in question. This report provides likely explanations for the difference. Evidence suggests that three quarter of bulk pellets burned in VT are imported from outside Vermont.

In the commercial and institutional sector, the rate of woodchip systems installations slowed down after 2009, due to a funding moratorium for the School Construction Aid program, administered by the Department of Education, which had provided funding toward the capital costs of woodchip system installations in schools. In 2010-2011, the rate of installation of commercial and institutional bulk pellet systems increased rapidly, exceeding the pace of woodchip system installations. This was primarily due to the commercial introduction of lower capital cost bulk pellet fueled heating systems and improved bulk pellet fuel delivery options. While woodchips are well suited for larger buildings, many smaller buildings have been able to take advantage of developments in the bulk pellet market. The result was an increase in bulk wood pellet installations in the school and multifamily housing sectors, as well as other commercial and institutional installations.

#### Total Wood Heating Sector

Using the most recent year (2014) of US Energy Information Administration (EIA) data available, wood fuels (both traditional and AWH) met an estimated 21% of heating needs in Vermont in 2014.<sup>5</sup> Heating with cordwood or pellet stoves provides home owners a lot of flexibility to burn more wood and less oil and propane when the price of oil or propane spike, and this, along with

<sup>&</sup>lt;sup>3</sup> The share of revenue from pellet and woodchip distribution for businesses located outside of Vermont was not estimated.

<sup>&</sup>lt;sup>4</sup> For the analysis, BERC separated the production and use of bulk wood pellets from the production and use of bagged pellets. Bagged pellets represent the greatest share of pellet sales in Vermont and much of the bagged pellets are used in wood pellet stove and fireplace inserts. While these are not included in the analysis of Advanced Wood Heating systems, their use is important in understanding the market for wood pellets.

<sup>&</sup>lt;sup>5</sup> Value calculated using EIA data and data from the Vermont Residential Fuel Assessment (RFA), 2015.



the Great Recession, are reasons for the current share of wood heat being twice as high in 2014 than it was a decade earlier, when oil prices were much lower.

The share of the total wood heat market occupied by advanced wood heat ranges from 0.5% for the residential sector to approximately 88% for the commercial and institutional sector. In the residential sector, approximately 65,000 household<sup>6</sup> heat with wood as their primary source of heat (20% of households heat with cordwood as primary fuel, 12% with pellets as primary and supplemental fuel), and only 377 are estimated to have an advanced wood heat system, which is equal to 0.6% of the number of households heating with wood.

The annual revenue associated with cordwood fuel production and sale is approximately \$85 million.<sup>7</sup> The annual revenue associated with the installation of wood stoves was not estimated as part of this baseline assessment. The fuel cost savings associated with heating with wood rather than with oil or propane were estimated at \$31.5 million annually.<sup>8</sup>

Heating with local wood reduces the economic drain on Vermont's economy. Factoring that only 22 cents of every dollar spent on heating oil or propane are likely retained in the local economy, and 80 cents of every dollar spent on wood are likely retained in the local economy,<sup>9</sup> an estimated net \$70 million was retained in the Vermont economy in 2016 by Vermonters choosing to heat with wood rather than fossil fuels (Figure 26). Wood heat lowers and stabilizes energy costs and keeps dollars circulating in the local economy. Wood heat also creates and supports jobs in the forestry, wood processing, and transportation sectors.

Looking into the future, AWH is expected to continue to grow and become a more mainstream heating option. However, some periods of stagnation are expected as the sector faces difficulties related to the fluctuating price of competing fossil fuels and continuing changes in technologies (such as air source heat pumps). Traditional wood heat (mostly home heating with cordwood stoves) is expected to continue making-up a significant, but highly variable share of total heating needs in Vermont, with Vermonters burning more or less wood depending on the price of competing fuels, among other factors.

<sup>&</sup>lt;sup>6</sup> Vermont Residential Fuel Assessment, 2015

<sup>&</sup>lt;sup>7</sup> Assuming \$19/MMBtu and 4.5 Trillion Btu of cordwood are consumed annually in Vermont

<sup>&</sup>lt;sup>8</sup> Assuming that wood heat systems replaced the same proportion of oil and propane systems as the proportion of oil and propane systems present in the State overall.

<sup>9 &</sup>lt;u>http://www.nebioheat.org/pdf/heatne\_vision\_full.pdf</u>



## Section 1 - Introduction

## 1.1 Background

Vermont has a long history of heating buildings with wood. While heating homes with woodstoves has been common for generations, heating entire buildings with automated woodchip and wood pellet systems has only been used in Vermont for a little over three decades. During that time, there has been slow and steady growth in the use of automated woodchip and pellet fueled boilers in the commercial, institutional and residential markets. Based on BERC's assessment of this market across the US and Canada, Vermont is home to the greatest density of installed advanced wood heating systems in North America.

The State of Vermont has set a goal of meeting 90% of Vermont's total energy needs from renewables by 2050. The 2016 Comprehensive Energy Plan (CEP) calls for increasing the portion of renewable energy used to heat Vermont's buildings to 30% by 2025, through a combination of efficiency and increased use of renewable fuels (including wood). Recent studies have concluded that Vermont's forests are growing over twice as much new wood than is harvested each year and that traditional markets for low-grade wood like pulpmills are disappearing. Local heating with wood fuels like wood pellets, woodchips, and cordwood presents an opportunity to strengthen the markets for low-grade wood that are vital to practicing good forest management. The most recent estimates indicate that Vermont forests have capacity to sustainably support an additional 894,900 green tons of harvested wood fuel annually.<sup>10</sup> Factoring the available wood fuel capacity and the goal to dramatically curb Vermont's consumption of imported heating oil and propane, the 2016 CEP proposes to achieve this goal by increasing the use of solid and liquid biofuels by 20% by 2025, on the way to doubling wood's share of building heat by 2035.<sup>11</sup>

The State of Vermont has clearly expressed its desire to limit greenhouse gas emissions that are responsible for global climate change through the establishment of laws and adoption of resolutions supporting clear carbon reduction goals for the State:<sup>12</sup>

- 1. In 2005, greenhouse gas reduction goals (10. V.S.A. §578) that call for a 50% reduction in emissions from the 1990 level by 2028 and a 75% reduction by 2050.
- 2. In May 2015, Vermont was one of the initial 12 signatories of the "Under2 MOU", committing to limit emissions to less than 80-95% below 1990 levels by 2050.
- 3. In August 2015 Vermont joined the conference of New England Governors and Eastern Canadian Premiers in adopting a resolution that sets a target of decreasing carbon pollution in the region by between 35 and 45 per cent below 1990 levels by 2030
- 4. In June 2017 Governor Scott announced that Vermont will join the U.S. Climate Alliance, a coalition of states continuing the work towards the goals of the Paris Agreement. Further, House resolution 15 and Senate resolution 10 strongly opposed the announced U.S. withdrawal from the Paris Climate Agreement and recognized Governor Philip Scott's enrolling Vermont in the U.S. Climate Alliance.

<sup>&</sup>lt;sup>10</sup> Vermont Wood Fuel Supply Study, 2010 Update,

http://www.biomasscenter.org/images/stories/VTWFSSUpdate2010\_.pdf 11 2016 CEP, page 8

<sup>&</sup>lt;sup>12</sup> <u>http://climatechange.vermont.gov/climate-pollution-goals</u>



Sustaining managed forests and direct displacement of fossil fuels with local, renewable wood fuels have been widely recognized as effective long-term strategies for GHG emission mitigation.<sup>13</sup>

The State of Vermont Comprehensive Economic Development Strategy 2014 – 2020 has set goals to preserve the environmental and economic benefits of the working landscape by ensuring that it can provide economic value. The plan identifies action area that would "raise capital, strengthen the workforce, establish appropriate infrastructure and ensure a healthy business environment to allow the businesses involved in the working landscape the best opportunity for future health."<sup>14</sup>

The State's support of the forestry industry is further demonstrated by the Vermont Working Lands Initiative, which was established by the Vermont Legislature in 2012, and calls for the creation and management of an enterprise fund and board, with a goal to support agriculture and forestry-based businesses.<sup>15</sup>

Advanced Wood Heat is aligned with and supports the goals of the CEP, Vermont's greenhouse gas reduction goals, the Working Lands Initiative, and the State's economic development targets. Tracking the development of wood heat allows the State of Vermont to measure progress toward these goals.

The Clean Energy Development Fund (CEDF) primary goal is to support the development of renewable energy in Vermont through three primary objectives:

- 1. Advance development of the clean energy sector of the Vermont economy
- 2. Increase cost effectiveness of clean energy
- 3. Decrease environmental impacts of Vermont's energy use

The CEDF offers programs that focus on supporting the development of the Advanced Wood Heat (AWH) market.<sup>16</sup> The CEDF currently offers an incentive program targeted at the most efficient residential and commercial/institutional woodchip and wood pellet systems that emit the least amount of particulate matter.

Several State-funded programs support the development of the AWH industry, in line with the goals stated in the CEP as well as other greenhouse gas and economic development plans. These programs include non-exclusive incentives and grants:

- CEDF's Small Scale Renewable Energy Incentive Program (SSREIP), as described above
- The Windham Wood Heat Initiative (with CEDF funding)
- Efficiency Vermont incentive program, also targeted at the most efficient AWH bulk pellet systems
- Statewide wood stove change-out program

Additional training programs support workforce development for the AWH industry:

<sup>&</sup>lt;sup>13</sup> <u>https://www.fs.usda.gov/ccrc/topics/forest-mgmt-carbon-benefits/wood</u>

<sup>&</sup>lt;sup>14</sup> http://accd.vermont.gov/sites/accdnew/files/documents/DED/CEDS/CEDSExecutiveSummary.pdf

<sup>&</sup>lt;sup>15</sup> http://fpr.vermont.gov/forest/forest\_business/working\_lands

<sup>&</sup>lt;sup>16</sup> As further defined below: central, automated woodchip and bulk pellet heating systems installed indoors



- The CEDF participates in the organization of trainings targeted at AWH installers and system designers
- The Energy Efficiency Network (administered by Efficiency Vermont) also offers AWH installer trainings
- The Vermont Agency of Commerce and Community Development offers grants that are available to installers to participate in AWH vendor trainings<sup>17</sup>

The State Agency 2016 Energy Plan establishes lead-by-example goals to increase the use of advanced wood heating: "State agencies should consider replacing older oil-fired heating systems with new, modern, clean wood product-burning heating systems." It is recommended in the plan that the Vermont Department of Buildings and General Services (BGS) target the largest oil-consuming locations and consider the age and useful life of the existing heating systems when determining which projects to undertake first.<sup>18</sup>

Agencies such as the Public Service Department, Department of Forests, Parks, and Recreation, and several private organizations including the Vermont Energy Investment Corporation, Housing Vermont, Renewable Energy Vermont, and the School Energy Management Program of the Vermont Superintendents' Association regularly collaborate under a variety of funding sources. These partners coordinate AWH programs, activities, training programs, and public outreach and education to increase the awareness of the benefits and availability of AWH.

Financing programs are available for residential, commercial and institutional customers looking to finance a wood heat project, including loan programs offered by:

- Vermont Economic Development Authority (VEDA) www.veda.org
- USDA Rural Development <u>http://www.rd.usda.gov/vt</u>
- Vermont Public Service Department's Heat Saver Loan for residential customers -<u>http://heatsaverloan.vermont.gov/</u>

## 1.2 Assessment Purpose

The goal of this baseline assessment is to determine and document the state of the wood heat market and sector in Vermont at the end of 2016, so that further market development progress can be measured against a specific point in time. This 2016 baseline will also help evaluate the impacts of the various support programs in the future. The aim of the CEDF programs is to advance the use of wood heating and measuring the impacts of the program over time is important to allow for adjustments in response to changes in the market. Changes in the market are better understood using baseline information.

The time is right for a baseline assessment. The AWH sector in Vermont is in its infancy and there are numerous parallel programs and activities focused on growing the AWH market.

<sup>&</sup>lt;sup>17</sup> <u>http://accd.vermont.gov/economic-development/funding-incentives/vtp</u>

<sup>&</sup>lt;sup>18</sup> <u>http://bgs.vermont.gov/sites/bgs/files/files/energy-environment/2016-State-Agency-Energy-Plan.pdf</u>



## 1.3 Scope of Assessment

The Biomass Energy Resource Center (BERC) was tasked with conducting a baseline assessment of the AWH<sup>19</sup> sector and wood heating, as a whole, in Vermont. This baseline assessment report covers the broader wood heat sector in the second half of the report, but offers a deeper dive into AWH, which is the primary wood heat market that has been targeted for development in the Vermont 2016 CEP.<sup>20</sup>

Advanced Wood Heat is defined here as central, automated woodchip and bulk pellet heating systems installed indoors. This definition differs slightly from the one that Clean Energy Development Fund (CEDF) uses in the Small Scale Renewable Energy Incentive Program (SSREIP) in that the incentive program is limited to systems that meet set peak efficiency, emission requirements, and fuel storage requirements, whereas this assessment is not limited to that segment of the top-performing AWH systems, but includes all AWH systems, whether they meet the requirements of the incentive program or not.

Advanced Wood Heat is defined here simply as bulk pellet and woodchip fueled boilers and furnaces. While other types of systems have advantages of their own, the definition used in this assessment does not include: boilers/furnaces fed manually with bagged pellets, pellet stoves, wood stoves, cordwood boilers, nor outdoor cordwood or pellet boilers. While not included in the AWH section of the report, these types of systems are included in the section of the report covering total wood heat in general.

This assessment focusses on wood heat and does not include any data on utility-scale power production (e.g. from either McNeil or Ryegate Stations), aside from including the wood consumed at facilities with AWH capable of co-generation in the AWH section, because that component is very small relative to the market as a whole and it is difficult to exclude.

The focus of this baseline assessment is on Vermont, but it is important to note that many businesses located outside of Vermont, mainly in New England, New York, and Quebec also serve Vermont customers with products and services. BERC strove to incorporate data from businesses serving Vermont, whether located in- or out-of-state, when describing the wood heat market in Vermont, and data is reported separately for both in- or out-of-state whenever possible. Similarly, businesses in Vermont serve customers outside of Vermont and this share of business is not included in this assessment.

## 1.4 Methodology

State-level data for space heating and domestic hot water are sparse, inconsistent, and often inaccurate. State-level data on wood fuel consumption has the same drawbacks. However, there are numerous distinct sources of existing information that were used to provide the estimates. In an effort to be efficient and make the most of various sources of existing data, BERC complied, reviewed, cross-referenced, and analyzed those different sources and wove them together to paint a comprehensive and coherent picture of the state of wood heat in Vermont. Businesses in the "Region" (defined in this assessment as within 200 miles from the center of Vermont) were included in the assessment if they provided services and installations in Vermont.

<sup>&</sup>lt;sup>19</sup> As further defined below: central, automated woodchip and bulk pellet heating systems installed indoors

<sup>&</sup>lt;sup>20</sup> 2016 VT Comprehensive Energy Plan, Page 4, 5, 24, and 325



The following sources of data provided the bulk of the data used in the analysis:

- CEDF SSREIP and Efficiency Vermont incentive program data (starting in 2012)
- The Vermont Residential Fuel Assessment (every 2 years between 1986-1998, 2008, and 2015) administered by the Department of Forests, Parks & Recreation, in partnership with the Department of Public Service
- Analysis performed as part of the Vermont State Wood Energy Team (VSWET) grant to characterize the school and multifamily market
- The annual Fuel For School Survey administered by the Department of Forests, Parks & Recreation
- BERC's online database of all known commercial and institutional-size facilities<sup>21</sup>
- Energy Information Administration's (EIA) State Energy Data System (SEDS) provide annual consumption estimates at the State level by sector and energy source
- Census American Community Survey (ACS) provided data on penetration level of wood heat appliances such as wood stoves. Census data also provided data on number of households in the State.
- The Vermont Clean Energy 2016 Industry Report, prepared for the CEDF by BW Research Partnership

Existing data listed above were supplemented by information gathered through interviews with key Regional market players such as:

- AWH system installers and importers/distributors
- Wood pellet fuel manufacturers and suppliers
- Wood pellet fuel distributors

To establish a baseline for the sector, the most detailed sources of data available were used and, where needed, assumptions and estimates were made to fill in any gaps. Whenever possible, values calculated using the different data sources were compared to verify the magnitude of the estimates and ensure estimates and results are consistent among data sources.

A more detailed description of the methodology is provided in Appendix D. Important notes regarding the data and precision of the results are also provided in the text accompanying figures and tables.

<sup>&</sup>lt;sup>21</sup> <u>http://www.biomasscenter.org/database/</u>



## Section 2 – Advanced Wood Heating in Vermont

This section of the report details the state of the AWH sector. Below the report covers the businesses dealing with the production and delivery of bulk wood pellets and woodchips used for heating, as well as the importation, assembly, sale, installation, and service of AWH systems.

## 2.1 Advanced Wood Heating Businesses

## 2.1.1 Wood Fuel Producers

### Pellet Mills

In 2016, there were two operational pellet mills in Vermont and two additional wood pellet mills under development with aspirations of becoming operational by the end of 2017 (Figure 1). It is anticipated that in 2018, there could be four operational pellet mills in Vermont.



**Figure 1**: Location of existing pellet mills within a ~200-mile radius from the center of Vermont that serve the Vermont market (yellow) and pending pellet mills (red).



In 2016 the two operational mills in Vermont reported approximately \$4.7 million in sales and 35 FTE employees. Of this revenue, only \$300,000 (7%) can be directly attributed to bulk pellet fuel sales in Vermont. Similarly, only 3.25 full-time equivalent (FTE) (9%) jobs can be attributed to the bulk pellet portion of total production in Vermont.

## Woodchip Producers

Throughout Vermont there are numerous woodchip fuel producers that actively serve the commercial and institutional heating market. While many suppliers are sawmills and logging contractors whose primary markets are not woodchip heating facilities, there are a growing number of businesses in Vermont who have made considerable investments in the infrastructure (chip screening equipment, live-bottom trailers, covered areas to store woodchips, etc.) necessary to serve the growing woodchip heating market.

It is difficult to separate woodchip suppliers' activities from other markets they serve (i.e. biomass power plants, pulpmills, etc.), but based on interviews with several of the premier woodchip suppliers to the heating market and the total annual woodchip heating fuel consumption of Vermont facilities, BERC estimates the woodchip fuel suppliers who serve the heating market employ 26 FTE and generate \$4.3 million in annual sales from woodchip heating fuel.

## 2.1.2 Wood Fuel Delivery Businesses

In 2016 there were three Vermont based companies offering bulk pellet fuel delivery services. Two businesses operated a total of three specialty pneumatic delivery trucks ranging in payload capacity from 10 - 30 tons and the third business offered bulk pellet delivery using existing grain delivery trucks. The three businesses reported a combined annual capacity to deliver 7,500 tons. This represents the capacity of the trucks during the winter months, when customers want pellet shipments. It does not factor the annual capacity these trucks have while they sit idle the remainder of the year.

In addition to the three Vermont based companies discussed above, there were another four businesses providing bulk wood pellet fuel delivery service to the Vermont market from their locations in Massachusetts, New Hampshire, Maine, New York, and Quebec.

Overall, Vermont-based bulk pellet delivery businesses reported annual sales revenue of \$450,000. Some of this revenue was already accounted for in the section on fuel producers; when considering only the *markup portion* of this revenue, these businesses generated an estimated \$51,600 from bulk deliveries in Vermont.

Vermont-based bulk wood pellet fuel delivery businesses employed 3.2 FTE employees for all their operations, and 88% of their deliveries were done in Vermont (equivalent to 2.8 FTE for the Vermont portion of the business).



Besides the bulk storage infrastructure located at each of the two operational pellets mills (both have a bulk pellet silo used for storing and loading pellets into bulk delivery trucks), there is only one other bulk pellet silo in use in Vermont. This 50-ton silo, owned by Bourne's Energy, is located in North Hyde Park, Vermont and it allows improved transportation efficiency of larger live-bottom trailer deliveries to bring 28-ton loads of pellets from regional pellet mills and allows the 12-ton Bourne truck to make more local deliveries by refilling closer to home.

In addition to the use of stationary bulk pellet storage silos, several regional pellet fuel distributors commonly use 28-30 ton tractor trailers as mobile bulk storage – allowing a smaller truck to refill from the 28-30 ton trailer without needing to drive back to a pellet mill.

Both strategies are effective means of reducing the number of miles traveled empty by smaller delivery trucks.

## 2.1.3 Heating Appliance Manufacturing

Vermont has been home to three companies that have manufactured advanced wood heating systems in Vermont. From the mid-eighties until 2010, Chip-tec woodchip systems were manufactured in Vermont. Chip-tec is no longer in business. For a brief period of time between

2011 and 2013 a small company called WeBiomass was assembling pellet boilers from Ireland at their location in Rutland. WeBiomass is also no longer in business.

Pellergy is a locally-owned small business and has been manufacturing high-efficiency wood pellet combustors for retro-fitting oil, propane, and cordwood boilers in their location in Barre since 2008. In 2015, with the rollout of new EPA regulations and testing requirements for residential boilers, Pellergy stopped manufacturing its combustor units and began importing and distributing wood pellet boilers manufactured in Upper Austria under the Pellergy brand.

Currently, there are no advanced wood heating systems manufactured in Vermont.<sup>22</sup>

### 2.1.4 Heating Appliance Sales, Installation and Service

There are numerous businesses that sell, install, and service AWH

systems. These businesses range in size from small HVAC and plumbing contractors installing a single residential pellet boiler every year or two, to larger companies with several employees wholly focused on both residential and commercial pellet and woodchip systems. It is important to note that the HVAC contractors that install only a few systems per year may be small firms or really large firms that do a high volume of installations with fossil fuels and heat pumps, but a low volume of AHW installations.

In effort to effectively summarize this diverse segment of the industry, we have grouped these businesses into two categories. Tier 1 consist of businesses that actively sell, install, or service

<sup>&</sup>lt;sup>22</sup> Note: there is one company manufacturing residential wood and pellet stoves in Vermont (Hearthstone), but reporting on their activities was outside the scope of this assessment.



pellet or woodchip systems on a consistent basis as a core part of their businesses. Tier 2 are those who sell, install, or service AWH systems only occasionally.

A total of 51 businesses were identified that sell, install, and service AWH systems for Vermont residents and businesses (list provided in the Appendix). Of these businesses, 41 were located in Vermont.



**Figure 2:** Location of Tier 1 (in red) and Tier 2 (in blue) AWH businesses providing sale, installation, and maintenance services for advanced wood heat (bulk pellet and woodchips).

Based on revenue figures provided these businesses during by interviews. BERC estimates that AWH businesses generate gross revenue of up to \$6.5 million from installations, sales, and maintenance.<sup>23</sup> Of that total, \$3.9 million is estimated to be generated Vermont-based businesses by (Figure 3). This value was calculated using revenue figures reported in interviews. assuming that the businesses that were not interviewed generated a similar revenue, and using the average from the last few vears for businesses that only install systems intermittently. All businesses reported that their sales fluctuate greatly from year to year, with some businesses not installing any systems in a given year.

Installers that participated in the CEDF wood pellet boiler incentive program reported combined sales of \$1,125,000 in 2015 and \$640,000 in 2016.<sup>24</sup> Approximately 73 percent of these installations were residential. Including residential maintenance

revenue, BERC estimates average residential annual sales of over \$450,000 (for businesses performing residential installations only, not including businesses offering both residential and commercial installations). The values from the CEDF rebate program and those reported by installers are close and in the right order of magnitude, providing confidence that the revenue estimates are valid.<sup>25</sup>

<sup>&</sup>lt;sup>23</sup> Value includes direct costs of the equipment purchased at wholesale. This value represents gross sales, not the markup portion of the installer's revenue.

<sup>&</sup>lt;sup>24</sup> The CEDF data for 2015 and 2016 only reflects pellet installations, not woodchips.

<sup>&</sup>lt;sup>25</sup> The SSREIP program data does not capture all commercial and institutional installations, because the SSREIP program was not expanded to include commercial and institutional installations until late fall of 2016. Therefore, the revenue of commercial and institutional installations cannot easily be cross-checked with another source of data.





Figure 3: Revenue by system type and business location, based on installer interviews.<sup>26</sup>

The sale, installation, and service of Advanced Wood Heat systems in Vermont provides over 30 full time equivalent (FTE) jobs in Vermont and the Region. Estimates computed from responses to a questionnaire indicate that 18 of these FTE jobs are located in Vermont, most of the remaining jobs being located in New Hampshire and Massachusetts (Figure 4).

<sup>&</sup>lt;sup>26</sup> Best estimate calculated from incomplete data; based on 2016 revenue data for businesses installing systems every year, and the average from recent years for businesses installing systems occasionally; 2016 sales data may not be representative of sales in recent years; not all businesses shared their revenue figures and revenue from key players had to be estimated.





**Figure 4:** Full Time Equivalent Jobs associated with the sale, installation, and service of Advanced Wood Heat in Vermont.<sup>27</sup>

## 2.2 Cumulative Installations and Annual Wood Fuel Consumption

## 2.2.1 Types and Quantities of Installations

Using data from a variety of sources, BERC estimates that there are approximately 480 AWH installed systems in Vermont, the majority of them residential (Table 1 and Figure 5).<sup>28</sup> This total was estimated using data from prior work compiling a database of all schools and multifamily buildings for the State Wood Energy Team (SWET), as well as data from the online BERC database<sup>29</sup>, and incentive data from the Efficiency Vermont and CEDF programs. Details and assumptions used to capture installations not using the rebate, and to avoid double counting are described in the detailed methodology in Appendix D.

<sup>&</sup>lt;sup>27</sup> Best estimate calculated from incomplete data; based on 2016 data for businesses installing systems every year, and the average from recent years for businesses installing systems occasionally; 2016 sales data may not be representative of sales in recent years; not all businesses were able to provide precise FTE figures.

<sup>&</sup>lt;sup>28</sup> Based on the CEDF and Efficiency Vermont pellet boiler incentive data, as well as an estimation of the number of AWH boilers installed prior to the start of the incentive program and estimation of the number of AWH boilers that did not qualify for the incentive program and/or were installed outside of the program

<sup>&</sup>lt;sup>29</sup> <u>http://www.biomasscenter.org/database</u>



## **Table 1:** Cumulative AWH installations in Vermont, 1986-2016

Number of Installed Systems	Pellet	Woodchips
Residential	377	-
Commercial and Institutional		
College/ University	-	5
Commercial/ Offices	7	4
Community Building	3	-
Community District Heat	-	1
Fire/Police	2	-
Government Facility	2	4
Hospital	-	3
Hospitality	1	
Multifamily	31	2
School	26	43
Unidentified	28	-
Total Commercial and Institutional	100	62
Total Number of Installed Systems	477	62





Figure 5: Map of existing commercial and institutional advanced wood heat installations in Vermont

Using data from installer interviews, BERC estimates that between 2014 and 2016, 64 new residential pellet boiler systems were installed in Vermont on average, per year, as well as an additional 9 commercial and institutional AWH systems (Table 2). For comparison, the Efficiency Vermont and CEDF rebate program data indicate 40-70<sup>30</sup> (2011-2016) and 30-45 (2015-2016) installations annually, respectively, within the program. The two programs overlap and therefore BERC estimates there were 30-50 in-program residential installations in 2016.

Estimating an annual revenue value for woodchip systems can be difficult, because some years will see no installations and other years see several. However, one to two systems have been

<sup>&</sup>lt;sup>30</sup> These data may have included outdoor pellet systems for the brief time when they were allowed by the EVT incentive program.



installed each year in Vermont in recent years, on average. Roughly, two-thirds of these were installed by Vermont-based businesses.

**Table 2:** Number of annual bulk pellet system installation by installer type, based on interviews with system installers<sup>31</sup>

			Total Estimated Pellet Systems Annual Installations <sup>32</sup>	
Installer Location	Tier	Business Focus	Residential	Commercial and
				Institutional
Vermont-based installer	Tier 1	Both residential and commercial and institutional installers	8	3
		Residential-only installers	13	
	Tier 2	Residential-only installers	32	
Vermont-based In	staller T	otal	53	3
Installer located outside Vermont, installing in Vermont	Tier 1	Commercial and institutional-only installers	11	6
Grand Total	•	<u>.</u>	64	9

## Typical AWH Systems Configurations

While the quantity of installations is important and has a large impact on the overall health and viability of the AWH sector in Vermont, the quality and performance of installations is also important. In absence of other data, BERC analyzed the SSREIP information to characterize AWH installations to date and used this information, along with information provided by installers during surveys, to establish a baseline against which the CEDF can track how installation configurations may change over time.

For units installed between 2014 and 2016, bulk pellet systems cover domestic hot water demand in 50-70% of cases. Back-up fossil fuel boilers are included in 16-24% of residential installations, and roughly 60% of commercial and institutional installations. Thermal storage is included in 20% of cases in the residential market and 30-40% in the commercial and institutional market. Data from the CEDF incentive program indicates that in-program installations include thermal storage more frequently than what installers report for both inprogram and outside of the CEDF incentive program. Details on system configuration and system sizing and costs are included in Table 3.

<sup>&</sup>lt;sup>31</sup> See methodology in Appendix D for details on which years were used to compile this average.

<sup>&</sup>lt;sup>32</sup> Based on values reported by installers



**Table 3**: Weighted averages of bulk pellet system configurations, by number of residential and commercial and institutional installations, as reported by installers during interviews and as documented in CEDF's incentive program (2014-2016 data).

		Residential	Commercial and Institutional <sup>33</sup>
Percentage of Pellet Systems Covering	Interviews	46%	72%
Domestic Hot Water	CEDF Incentive Data	54%	60%
Percentage of Pellet Systems with	Interviews	16%	58%
Back-up Fossil Fuel Boiler	CEDF Incentive Data	24%	0% <sup>34</sup>
Percentage of Pellet Systems using	Interviews	21%	42%
Thermal Storage	CEDF Incentive Data	24%	33%
Average Boiler Output (Btu/h)	CEDF Incentive Data	78,700	173,800
Average Number of Pellet Boilers per System	CEDF Incentive Data	1.0	1.2
Average Pellet Fuel Storage Capacity (tons)	CEDF Incentive Data	4	8
Average Thermal Storage Size (gallons storage/ thousand Btu of boiler output)	CEDF Incentive Data	1.6	1.8
Average Installed System Costs	CEDF Incentive Data	\$22,400	\$43,700

Starting with 2017, the commercial and institutional values will change considerably because at the end of 2016 the SSREIP was re-structured and offered more incentive support for larger commercial and institutional systems.

In the future, the CEDF may choose to track additional metrics that would help further characterize the evolution of the market, such as the average annual heat consumption per square foot, or the average boiler sizing to peak load, or other.

<sup>&</sup>lt;sup>33</sup> Note: 2014 to 2016 data; the CEDF rebate program used in this analysis were prior to program expansion with incentive amount based on facility size, and therefore represents only smaller commercial and institutional systems <sup>34</sup> Note: data represent only smaller commercial and institutional systems



## 2.2.2 Wood Fuel Consumption

Using the cumulative number of advanced wood heat systems installed in Vermont and applying known or estimated woodchip and wood pellet consumption to these facilities (based on their size), BERC calculated that close to 8,800 tons of bulk wood pellets and 86,000 tons of woodchips are consumed annually in Vermont by installed AWH systems (Table 4). Bulk pellet fuel consumption was dominated by the residential, school, and multifamily sectors (Figure 6).

The estimated wood fuel consumed by Advanced Wood Heat systems avoided the equivalent of 6.4 million gallons of heating oil in 2016.

For woodchip fuels, the college campus, school, and hospital segment account for the majority of the fuel consumption (Figure 7). To account for 2016 being a warmer than average year (91% of Heating Degree Days compared to the average number for the prior 15 years), BERC adjusted the estimated fuel consumption to 8,000 tons of bulk pellets and 79,000 green tons of woodchips consumed by AWH systems. This is equivalent to 6.4 million gallons of heating oil avoided in 2016.

Due to the low price of fossil fuels used for heat in 2016, compared to the prior 5 years, there is anecdotal evidence that some facilities used their "backup" fossil fuel boilers as their primary heating system. Therefore, bulk pellet consumption in 2016 may have been lower than estimated here, which would further explain the discrepancies with the amount of bulk pellet produced and distributed in Vermont (see section 2.2.4 Wood Pellet Fuel Production in 2016).

Category	Bulk Pellet (Tons)	Woodchips (Green Tons)
Residential Sector	2,009	
Commercial and Institutional Sector		
College/ University		35,300
Commercial/ Offices	150	3,340
Community Building	145	
Community District Heat		7,000
Fire/Police	24	
Government Facility	40	4,350
Hospital		12,250
Hospitality	5	
Multifamily	1,830	582
School	4,310	23,578
Unidentified	318	
Subtotal for Commercial and Institutional	6,821	86,400
Grand Total Consumption (Tons)	8,830	86,400
Adjustment for HDD in 2016 (91%)	8,068	78,945

#### Table 4: Annual bulk wood pellet and woodchip consumption by sector





Figure 6: Allocation of bulk wood pellet fuel consumption by sector in Vermont.







## 2.2.3 Trends

## Historical Trends

Examining historical trends can help us better understand the market forces that impact an industry and anticipate how the market may change in the future. While historical trends are not predictive, they can help us establish a "business as usual" trajectory scenario of where the market is likely to be in 5-10 years, if conditions, regulations, and policies remain the same.

On the residential side, the Efficiency Vermont and CEDF incentive programs provide a fairly representative depiction of the overall growth of the AWH market over the past five years (Figure 8). While five-year trends are relatively short term, in the past five years, the trend in residential system installation is flat (i.e. the dashed trend line for annual installations in the graph below is level). These incentive program data were used to estimate the number of installations occurring outside the incentive program and prior to the beginning of the program, as well as to model future trends.





**Figure 8**: Residential installations through the incentive programs (Efficiency Vermont program data for 2011-2014, CEDF program data for 2015-2016).

In the commercial and institutional sector as a whole, the number of woodchip systems installed annually has decreased since 2009, due to the funding moratorium on the School Construction Aid program, administered by the Department of Education. This program at one point provided 90% state cost-share funding for woodchip heating systems in public schools. Shortly thereafter, in 2010/2011, the rate of commercial and institutional bulk pellet systems installation began to increase rapidly, at a rate greater than woodchip system installations (Figure 9). This was primarily due to the introduction of commercial-sized pellet boilers and the availability of bulk pellet fuel. Smaller pellet boilers offered a lower capital cost price point than had been previously available and lower cost pellet fuel storage options helped further lower capital costs. While woodchips are well suited for larger buildings with more demand for heat, smaller buildings have been able to take advantage of this development in the bulk pellet market. This resulted in an increase in installations in the school and multifamily housing sectors, as well as other commercial and institutional installations that took place through the incentive programs (Figure 10).

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Figure 9: Known commercial and institutional installations over the past 10 years



Figure 10: Cumulative bulk pellet system installations over the past 10 years in Vermont



There are several major market and policy changes that have influenced AWH installation trends in recent years.

In 2008/2009 the legislature imposed a funding moratorium for the School Construction Aid program, administered by the Vermont Agency of Education. The impact of that moratorium can be seen for woodchip systems in Figure 9, where the rate of installations of woodchip systems levels off after 2009.

Over the last three decades, public schools in Vermont have been important consumers of woodchips and, more recently, bulk pellets. While any individual school only represents a small fraction of the total consumption of wood fuel (each school is represented by a different color in Figure 11), public schools in Vermont have collectively increased the amount of fossil fuel they displace each year by heating with woodchips and bulk pellets.<sup>35</sup> For the past three years, public K-12 schools in Vermont have displaced the equivalent of over 2 million gallons of heating oil annually by heating with chips and pellets.



Figure 11: Gallons of oil equivalent avoided by wood heated schools

<sup>&</sup>lt;sup>35</sup> Analysis based on data gathered through the Fuel for Schools annual survey.



The spike and then dip of fossil fuel prices in 2008 and 2015, respectively (Figure 12), has also had an impact on historical installation trend lines, with an increase in AWH installations coinciding with a spike in the price of heating oil and propane. The potential impact of the subsequent dip in the price of fossil fuel in 2015/2016 is not evident in historical trends yet.



**Figure 12:** Fossil fuel price trends (data source: oil and propane: VT DPS Residential Fuel Report, natural gas: EIA)<sup>36</sup>

The start of the Efficiency Vermont incentive program for pellet boilers in 2011/2012 and addition of the CEDF's SSREIP incentive program at the end of 2014 had a positive impact of supporting the development of AWH by making systems more cost competitive.

In addition, the warmer heating seasons experienced in recent years (Figure 13) had an overall negative impact on the AWH industry by reducing wood fuel demand and reducing the fuel cost savings associated with burning wood rather than more expensive fossil fuels.

<sup>&</sup>lt;sup>36</sup> Propane prices represented by the data in the DPS fuel report do not reflect the prices for most large and commercial users, with many fuel supply contracts closer to \$15 per MMBtu in 2016.

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### Figure 13: Trends in Heating Degree Days for Burlington, VT, 2001-2016

## Future Trends

Historical trends can be helpful for assessing the effectiveness of a program by periodically looking back and comparing how the real trajectory deviated from what was forecasted through models. Modeling trends into the future allows for an assessment of the trajectory taken by AWH, and whether that path points toward meeting the CEP goals or if modifications are needed.

Using historical trend data for annual and cumulative installations and factoring insights from interviews of installers, BERC projected historical trends into the future. Although the price of fossil fuels used for heat and major changes in policy and regulations may heavily influence these trends, they were not considered because they cannot be reliably forecasted or predicted. The resulting modeled rate of increase, assuming current installation rates remain the same, shows a total of 650 residential installations, 150 commercial pellet installations, and 70 woodchip installations by the year 2021 (Figure 14).

The percent annual growth rate for 2016 is equivalent to 19% for the number of new installed residential and commercial and institutional pellet systems, and only 2% for the number of woodchip systems. While this extrapolated trajectory suggests a doubling of the number of residential installations in the next 5 years, advanced wood heat as a whole would still represent no more than 1% of total wood fuel consumption under that scenario.

The trend line was modeled from calculated cumulative installations to date. The rate of increase was assumed to be constant and was based on the number of annual installations estimated from responses from interviews. In addition, adjustments in the rate of increase were applied, based on participation assumptions for the incentive programs. Therefore, as there is an uncertainty in the modeled trends both in the past and future, the graph includes error bars in



the past and future. The error bars represent a percentage of uncertainty, and therefore grow larger as the number of estimated installations grows.

The margin of error for commercial and institutional systems is smaller because the estimated number of systems was in part based on actual count of these systems and how much fuel they consume annually on average, confirmed by incentive program data.



**Figure 14**: Modeled growth of the number of advanced wood heat installations, if current trends continue (i.e. no significant changes in current market conditions)

Assuming the number of installations modeled above, and applying an average fuel consumption per installation, trends can provide approximations of where future wood fuel consumption may be headed and the anticipated impact (Figure 15).

The critical factors that will affect the development of the AWH market and industry in the future include:

- The price of fossil fuels. That price this will affect the price competiveness of wood fuels.
- Any expansion of natural gas pipeline service to parts of Vermont that do not currently have access to natural gas. Access to natural gas, along with the price of natural gas, will impact the geographic area where AWH can effectively compete.
- The development of the market for other competing technologies such as air-source and ground-source heat pumps. Growth in demand for competing technologies, along with the level of support they receive from utility programs, will impact the demand for AWH.
- Future weather conditions and how cold the heating seasons will be. This will contribute in determining the economic return on the investment of switching to AWH.



- State policies supporting AWH. Policies have the potential to increase the rate of adoption compared to the "business as usual" scenario.
- The rate of AWH technology adoption by early adopters and the broader knowledge and acceptance of the AWH technology. This will affect the pace of the transition of AWH to becoming mainstream.

All these factors combined add considerable uncertainty to the number of installations that can be expected in the next five years.

While modeling the increase of installed units is helpful, it's important to also consider the size of the facility and thus how much wood fuel these installations will use. The amount of wood fuels used and the amount of energy generated from local wood fuels are the most important metrics to track from a market development, climate change mitigation, and forest resource management standpoint. While much of the expected market growth for *the number* of AWH system installations is in the residential sector, a small number of additional larger commercial and institutional installations will likely consume far more bulk pellet fuel annually than the additional residential installations.

Even if bulk wood pellet fuel consumption increased by 50% over the next 5 years, the total amount of roughly 15,000 tons is still only 10% of the amount of bagged pellets sold in Vermont in 2016. As discussed above for Figure 14, bulk pellet fuel consumption trends have uncertainty both in the past and future (Figure 15). In contrast, annual woodchip fuel consumption is easier to accurately quantify due to historic data sets compiled through the Fuels for Schools annual survey and on-going tracking of all woodchip systems installed in Vermont. For this reason, Figure 16 only includes error bars for values in the future. The uncertainty (i.e. error bars) is greater for the commercial and institutional systems, because the estimate is based on persystem consumption assumptions, but in reality there is much more variability in the commercial and institutional systems and annual pellet consumption; the residential market is more consistent in terms of annual fuel consumption per installation.





**Figure 15**: Modeled bulk pellet fuel annual consumption growth if current trends continue (i.e. no significant changes in current market conditions), lighter color shades represent projected future consumption.



**Figure 16**: Modeled woodchip fuel annual consumption growth (lighter shade of grey represents projected future consumption).



## 2.2.4 Wood Pellet Fuel Production in 2016

Vermont's two operational pellet mills reported producing 1,600 tons of bulk pellets and selling 100% of this fuel to Vermont facilities.<sup>37</sup> Another 3,200 tons of bulk pellets were reported by mills outside Vermont (but within 200 miles of the center of Vermont) as sold to facilities in Vermont. However, based on the number of facilities, size of the facilities, and the size of the installed AWH systems, BERC estimates a total bulk pellet demand of 8,000 tons in 2016 (compared to a total of 4,800 tons of bulk pellets reported by the pellet mills surveyed in the Region, Table 5). This discrepancy leaves a large amount of bulk pellets unaccounted for. Some of the discrepancy can be attributed to the data precision issues: 1.) pellet sales for 2016 were reported to be very low due to the very warm winter, and 2.) BERC estimates of bulk pellet fuel demand were based on typical heating seasons, which was then adjusted for Heating Degree Days and this

Evidence suggests that three quarters of bulk pellets burned in VT are imported from outside Vermont. adjustment and associated assumptions made the estimate less precise. Another contributing factor is the low cost of fossil fuel in 2016; some facilities with bulk pellet heating systems chose to burn fossil fuel rather than pellets. As the pellet fuel consumption estimate is based on system capacity, that consumption estimate may be greater than the reality for 2016. Still, evidence suggests that three quarter of bulk pellets burned in VT are imported from outside Vermont.

**Table 5:** Bulk pellets produced regionally (i.e. mills outside Vermont supplying Vermont, yellow markers in Figure 2), and by Vermont mills, and consumed annually in Vermont

Total Tons Delivered in VT and Produced in Vermont and Regional Mills	Production from Vermont and Regional Mills (tons)	Consumption (tons)	Percent from Vermont Mills	Percent from Mills in the Region but Outside Vermont	Percent from Mills Outside the Region	Percent unaccounted for
Bulk	5,000	8,000	25%	38%	<1%	37%
Bags	46,000	138,000	4%	29%	unknown	unknown

BERC developed estimates of the annual production of pellet mills in the Region based on responses from interviews, other published sources on pellet mill production capacity<sup>38</sup>, and other sources. The breakout of production capacity and actual production indicates that the capacity available for the production of pellets is much greater than what was actually produced in 2016. Of the actual production, the large majority (87% for Vermont mills) went to bag pellet production. All bulk pellet fuel produced in Vermont was reported to be sold and consumed in the State. These estimates indicate under-utilized capacity because 2016 was a low-demand year due to the warmer heating season (and lower oil prices). It is important to note that the

<sup>&</sup>lt;sup>37</sup> In 2016, only two pellet mills were operational. However, it is important to note that two additional wood pellet mills are slated to commence pellet fuel production by the end of 2017. It is expected that in 2018, there will be four operational pellet mills in Vermont.

<sup>&</sup>lt;sup>38</sup> <u>http://biomassmagazine.com/plants/listplants/pellet/US/</u>



under-utilized capacity is more directly influenced by bagged product sales than bulk product sales.

While it can be tempting to try to match the Vermont pellet fuel production capacity to the current or future demand from Vermont, it is important to remember that most of the Vermont and Regional mill production is in the form of bagged pellets that is then exported from Vermont and the Region. At the same time, a large share of bagged pellets in Vermont are imported from outside the Region. The bulk pellet supply is a small fraction of the total pellet production and is typically procured relatively locally. Given the large volume of pellets (bags and bulk combined) that are imported and exported across state borders, supply and demand of pellets have to be considered from a broad region rather than at the state level.



Figure 17: Wood pellet fuel production (tons) in 2016 by Vermont pellet mills





### Figure 18: Regional wood pellet fuel production and sales in 2016

Bulk and bagged wood pellet fuels are sold across state and international borders, and it is important to consider the availability of pellets at a Regional level. Figure 18 presents the breakout of mill capacity and production for mills outside of Vermont supplying Vermont, with a breakout of the amount of pellets going to Vermont. Similar to what is happening in Vermont, there is production capacity outside Vermont that is not being utilized (as of 2016). The production that does take place is primarily directed to bagged pellets, with very little of the pellet produced regionally and in Vermont (0.4%) being directed to the Vermont AWH market.

As a consequence of sluggish market conditions in 2016, several mills interviewed reported periodic production shut downs in 2016 and increased inventory of bagged product at the mills. As a direct result of that increase in inventory, many mills reported offering lower prices to help move their inventory build-up.

## 2.3 Economic Impacts of Advanced Wood Heat

Overall, the AWH industry contributes over \$8.6 million in annual sales revenue for installers and wood fuel producers and distributors in Vermont. An additional \$3 million in annual sales from the Vermont AWH market goes to businesses located outside Vermont (Figure 19).<sup>39</sup> The AWH industry directly creates 54 FTE jobs in Vermont, with an additional 10 FTE jobs outside of the state (Figure 20).

<sup>&</sup>lt;sup>39</sup> The share of revenue from pellet and woodchip distribution for businesses located outside of Vermont was not estimated.





**Figure 19:** Sales revenue generated by AWH. Note: Installer Revenue includes the system cost, and is not limited to the markup. Does not include forestry and trucking-related revenue. Woodchip production outside of Vermont imported to Vermont was not estimated.



**Figure 20**: FTE jobs associated with AWH. Does not include forestry and trucking-related jobs. Jobs associated with woodchip production outside of Vermont were not estimated.



## Section 3 - Total Wood Heating in Vermont

## 3.1 Estimate of Heating Met With Wood

Determining the overall thermal energy demand in Vermont was the first step in this analysis. The total thermal energy needs in the state (heating and domestic hot water) were estimated using US Energy Information Administration's (EIA) State Energy Data Systems (SEDS) data exclusively.

Understanding what proportion of Vermont's heating needs are met with wood was the second step in this analysis and two primary sources of data were used for that second step. The EIA SEDS data were used to assess the state's overall thermal energy needs by sector, and the total wood consumed for heat in Vermont. The Vermont Residential Fuel Assessment (RFA) was also used at the state level to calculate the total wood (cordwood and pellets) consumed for residential heat in Vermont and to cross-check the EIA SEDS residential data.

The EIA residential fuel consumption values were higher than expected for Vermont and were twice as high as the values from the RFA. However, as the total thermal energy demand for Vermont came from EIA and as EIA data was available for more consecutive years than the RFA data, BERC used an approach that relied on both data sources rather than choosing one over the other. BERC took the average of the two datasets for years when both were available, and extrapolated using the same annual trends as reported by EIA for years when the RFA was not available.

It appears that there is a correlation between the wood heat consumption as calculated by EIA and the price of heating oil. That correlation remains even after making the adjustments to the EIA values to reflect the data reported in the RFA (Figure 21). It's important to note that EIA data for 2016 were not available and the percent of heating needs met with wood fuel has likely declined from 2014 to 2016 due to the recent decrease in heating oil and propane prices. The correlation between the price of oil and the share of wood heat reflects that wood heat as a whole is a dynamic market that responds fairly quickly to market conditions. The share of thermal energy needs met by wood fuels will likely vary from year to year, depending on how much cordwood Vermont residents decide to burn. This, in turn, is influenced by the price of other heating fuel options (fossil fuel, but also increasingly electricity for heat pumps).

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Figure 21: Share of residential heating needs met with wood vs. price of heating oil



**Figure 22**: Share of thermal energy needs met by wood heat (pellets, woodchips and cordwood combined) by sector in recent years.



Vermont homeowners heating with cordwood and pellet stoves have flexibility to burn more wood and less heating oil and propane when the price of heating oil or propane rises. This, along with the Great Recession, could account for the share of wood heat being twice as high in 2014 as it was a decade earlier (Figure 22). However, a large portion of the stepwise changes in the graph could be attributed to methodology changes, where EIA changed data source used in their calculations in 2001, 2005, and 2008.<sup>40</sup>

As of the most recent year of EIA data available, and factoring in data from the RFA, wood heat (both traditional and AWH) was estimated to account for 21% of heating needs in Vermont in 2014 (Figure 23).<sup>41</sup>

Twenty one percent (Figure 23) is a higher value than previous data have indicated. Previous reporting suggested Vermont met only 15% of its thermal energy needs with wood. Further review of EIA and RFA data suggests that the 15% value was accurate a few years ago, but that the rise in fossil fuel costs around 2008 has likely prompted Vermonters to heat their homes with a greater share of wood heat. For the commercial and institutional sectors the only source of data currently available is the EIA SEDS and the share of advanced wood heat has been steadily increasing for the commercial and institutional sector (Figure 22).

<sup>&</sup>lt;sup>40</sup> EIA residential estimates are developed from: (1) U.S. residential wood consumption estimates published in the EIA Annual Energy Review (AER) or Monthly Energy Review (MER), (2) U.S. total, Census division, and selected state data collected on the EIA triennial/quadrennial survey, Residential Energy Consumption Survey (RECS- data available for 2001, 2005 and 2009), and (3) U.S. Department of Commerce, Census Bureau, annual estimates of number of housing units by state from the Population Census or Annual Housing Survey (prior to 2005) or the number of occupied housing units that use wood as primary heating fuel from the American Community Survey (for 2005 forward). Commercial wood consumption estimates are from the EIA, Annual Energy Review (AER).

Source: State Energy Data 2014: Consumption, Section 5. Renewable Energy, pp. 99-108. https://www.eia.gov/state/seds/sep\_use/notes/use\_renew.pdf

<sup>&</sup>lt;sup>41</sup> EIA SEDS data was not available for 2015 or 2016.





**Figure 23**: Sources used to meet Vermont's space heating and domestic hot water needs for all residential, commercial, and institutional buildings in 2014.

The estimated wood fuel consumption by sector is presented in

*Table 6.* The industrial consumption of wood fuels for process heat is not included as part of this assessment, as the focus is on heating buildings, but it is important to note that considerable amounts of wood fuels are used in Vermont to generate electricity and dry wood at sawmills and pellet mills. Aside from electric generation at McNeil and Ryegate power stations, the industrial use of wood fuels in Vermont is relatively small and is not discussed in any detail in this assessment.



**Table 6**: Estimated tons of wood consumed annually in Vermont by sector and wood fuel type (not adjusted for Heating Degree Days in 2016 being less than typical)

	Traditional Fuels Advanced Wood He Fuels			Vood Heat Is
Sector	Cordwood (green tons)	Bagged Pellet (tons)	Bulk Pellet (tons)	Woodchip (green tons)
Residential	700,000	126,000	2,000	
Commercial and Institutional	940		7,000	86,000
Total	701,000	126,000	9,000	86,000
Total Trillion Btu	5.8	2.1	0.1	0.8

## 3.2 Estimate of Total Wood Heating Provided by Advanced Wood Heat

When considering all the information presented in this assessment, the emergence of the nascent AWH sector in Vermont remains small in comparison to the sheer number of homes that continue to heat (in whole or part) with cordwood stoves. Advanced Wood Heat occupies a share of total wood heat that ranges from 0.5% in the residential sector to approximately 88% for the commercial and institutional sector (in terms of total Btu of energy, Figure 24).<sup>42</sup>



<sup>&</sup>lt;sup>42</sup> The residential error bars represent the difference between the values reported in the EIA SEDs and the values calculated using the Residential Fuel Assessment.



Figure 24: Wood heat consumption (trillion Btu) for traditional and Advanced Wood Heat, by sector

Vermont is small and has only 255,000 households.<sup>43</sup> In the residential sector, approximately 65,000 households<sup>44</sup> heat with wood as their primary source of heat (20% of households heat with cordwood as primary fuel, 12% with pellets as primary and/or supplemental fuel), and only 377 are estimated to have an AWH system, which is equal to only 0.6% of households heating with wood. While there is anecdotal information and BERC is aware of some of the installations, there are no available databases of all commercial, institutional, or industrial installations that use cordwood, sawdust, or other wood heat systems.<sup>45</sup>. While the exact number of buildings using cordwood or sawdust is unknown, the percentage of buildings heated with AWH is likely proportional to the percentage of wood heat consumption provided by AWH, and presented above.

## 3.3 Economic Impact of Total Wood Heat

The annual revenue associated with cordwood production and sale is approximately \$85 million<sup>46</sup>, the annual revenue associated with AWH is \$8.9 million (fuel production and distribution, and system installation). The annual revenue associated with the installation of wood stoves was not estimated as part of this baseline assessment.

If Vermont homeowners, businesses, and institutions were not using wood fuel to heat buildings and burned heating oil or propane instead,<sup>47</sup> millions of dollars more would be spent on heating. The financial savings associated with heating with wood rather than with heating oil or propane were estimated at approximately \$31.5 million annually (based on current fuel prices).<sup>48</sup> This annual savings estimate is subject to change as fossil fuel prices change.

<sup>&</sup>lt;sup>43</sup> US Census, 2015

<sup>&</sup>lt;sup>44</sup> Vermont Residential Fuel Assessment, 2015

<sup>&</sup>lt;sup>45</sup> That do not meet the definition of AWH used in this assessment

<sup>&</sup>lt;sup>46</sup> Assuming \$19/MMBtu and 4.5 Trillion Btu of cordwood are consumed annually in Vermont

<sup>&</sup>lt;sup>47</sup> Assuming wood replaces propane in 42% of cases, oil in 58% of cases.

<sup>&</sup>lt;sup>48</sup> Assuming that wood heat systems replaced the same proportion of oil and propane systems as the proportion of oil and propane systems present in the state overall.





Figure 25: Estimated avoided heating fuel costs in 2016

Wood heating fuels are largely sourced locally (especially for cordwood, bulk pellets, and woodchips), whereas all fossil heating fuels are imported to Vermont. As such, heating with wood is an effective strategy to retain local wealth and reduce the financial drain on Vermont's economy. Factoring that 80 cents of every dollar spent on wood are likely retained in the local economy, but only 22 cents of every fossil fuel heating dollar are,<sup>49</sup> a net \$70 million was retained in the Vermont economy in 2016 as a direct result of heating buildings in Vermont with wood fuels rather than fossil fuels (Figure 26).

<sup>&</sup>lt;sup>49</sup> Heating the Northeast with Renewable Biomass, A Vision for 2025, 2010, <u>https://www.biomassthermal.org/resource/pdfs/heatne\_vision\_full.pdf</u> p.35, based on EIA data





Figure 26: Dollars retained in the Vermont economy, heating fuel only.

Wood heat is the second largest renewable energy generation job creator in Vermont. Wood energy firms employ approximately 1,500 workers across the fields of logging, wood fuels production (chips, pellets, and firewood), combustion systems, and power stations. <sup>50</sup> Wood heat is the second largest renewable energy generation job creator in Vermont, behind solar (Figure 27).<sup>51</sup>

BERC estimates that 54 FTE jobs are generated by Vermont's AWH industry. In addition, bagged pellet

production, for bags distributed in Vermont and out-of-state, generates another 45 FTE jobs in Vermont.<sup>52</sup>

<sup>&</sup>lt;sup>50</sup> Vermont Clean Energy Industry Report 2016. Prepared for the Vermont Clean Energy Development Fund By BW Research Partnership, May 2016

<sup>&</sup>lt;sup>51</sup> Ibid.

<sup>&</sup>lt;sup>52</sup> Includes logging and trucking jobs.





**Figure 27**: Renewable energy jobs by sub-technology (source: Vermont Clean Energy Industry Report, 2016)



## Section 4 - Conclusions

Expanding the use of Advanced Wood Heat is a strategy that helps Vermont make measurable progress toward the goals of the 2016 CEP, the CEDF, Vermont's greenhouse gas reduction goals, and the Working Lands Initiative's economic development targets. Tracking the development of wood heat allows the State of Vermont to measure progress toward these goals.

The impacts of wood heat on Vermont's economy are clear: wood heat creates jobs, lowers energy costs, and retains local wealth. The annual revenue associated with cordwood production and sale is approximately \$85 million. The fuel cost savings associated with heating with wood rather than with heating oil or propane are an estimated \$31.5 million annually. A net \$70 million was retained in the Vermont economy in 2016 by Vermonters and Vermont businesses and institutions choosing to heat with wood rather than fossil fuels.

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Within the wood heat industry as a whole, the emergent AWH sector

contributes over \$8.6 million in annual sales revenue for system installers and wood fuel producers and distributors in Vermont-- with an additional \$3 million to businesses located in the Region.<sup>53</sup> The AWH industry directly creates 54 FTE jobs in Vermont, with an additional 10 jobs outside the state.

Looking into the future, Vermont can expect AWH to continue growing, as this nascent industry goes through the different phases of market adoption to become more mainstream. However, we can also expect periods of stagnation as the industry faces difficulties related to the fluctuating price of competing fuels and technologies. The critical factors that will affect the development of AWH in the future include:

- The price of fossil fuels. That price this will affect the price competiveness of wood fuels.
- Any expansion of natural gas pipeline service to parts of Vermont that do not currently have access to natural gas. Access to natural gas, along with the price of natural gas, will impact the geographic area where AWH can cost effectively compete.
- The development of the market for other competing technologies such as air-source and ground-source heat pumps. Growth in demand for competing technologies, along with the level of support they receive from utility programs, will impact the demand for AWH.
- Future weather conditions and how cold the heating seasons will be. This will contribute in determining the economic return on the investment of switching to AWH.
- State policies supporting AWH. Policies have the potential to increase the rate of adoption compared to the "business as usual" scenario.

<sup>&</sup>lt;sup>53</sup> The share of revenue from pellet and woodchip distribution for businesses located outside of Vermont was not estimated.



• The rate of AWH technology adoption by early adopters and the broader knowledge and acceptance of the AWH technology. This will affect the pace of the transition of AWH to becoming mainstream.

Traditional wood heat is expected to continue being a significant, but highly dynamic share of total heating needs in Vermont, with Vermont residents burning more or less wood depending on the price of competing fuels (and other factors).

While establishing a baseline is important, the next step is to evaluate if the trajectory that wood heat is on will allow Vermont to meet the goals slated in the 2016 CEP, or if some market intervention or additional policies are necessary to meet these goals.



## Section 5 - Appendices

## A. List of All AWH Installers Identified in the Assessment

Installer Location	Business Name	Town
	AMT Inc.	Stowe, VT
	ARC mechanical contractors	Bradford, VT
	Better World Energy***	Marshfield, VT
	Bourne's Energy	Morrisville, VT
	C.K. Construction	Underhill, VT
	Cota & Cota, Inc.	Multiple Locations
	Cutting Edge Systems	West Burke, VT
	Farmyard store	Derby, VT
	Fred's Plumbing and Heating Inc.	Derby, VT
	FW Webb Company- Barre	Barre, VT
	Gary Whiting Plumbing and Heating	Orleans, VT
	Great Bear Renewable Energy	Lunenburg, VT
	Harriman's Heating LLC	Springfield, VT
	Hayden Plumbing and Heating	Bennington, VT
	HB Plumbing and Heating/ HB Energy	Springfield, VT
	Solutions	
	Hill Heating Services, LLC	Waterford, VT
	Innovative Consulting Engineering	North Montpelier, VT
	Integrated Solar Applications	Brattleboro, VT
	J.A. Hammer Jr. Plumbing and Heat	Cabot, VT
Vermont	J.B. Heating LLC	Fairfield, VT
	Lakes Region Mechanical	Wells, VT
	Lloyd Plumbing Heating and Gas Service	Cabot, VT
	(merged with Heating and More LLC)	
	Lynwood Gilberts Plumbing and heating	South Barre, VT
	Montpelier Stove Works	Montpelier, VT
	Natural Heatworks	Bristol, VT
	Pellergy	Montpelier, VT
	Pete Noble Plumbing and Heating	Guilford, VT
	Practical Plumbing	East Randolph, VT
	Roger Carpenter Services Inc.	Thetford Center, VT
	Shattuck Plumbing HVAC	South Burlington, VT
	Simply P+H	South Royalton, VT
	Sunfire Energy Systems	Marshfield, VT
	Sunwood Biomass	Waitsfield, VT
	The Stove Depot	North Clarendon, VT
	Thivierge Heating and A/C	Graniteville, VT
	Timothy Kelly	
	Top to Bottom Contractors	Cabot, VT
	Trombly Plumbing and Heating Inc.	St. Johnsbury
	Vermont Renewable Fuels	Manchester Ctr., VT
	Waterworks Plumbing and Heating	Morrisville, VT



	Watson Research	Fairfax, VT
	Abbott Plumbing and Heating	Littleton, NH
	AFS***	Lemoyne, PA
	Colebrook Plumbing & Heating	Colebrook, NH
	EcoHeat Solutions LLC	Medfield, MA
Outside Vermont	Froling Energy	Peterborough, NH
	Lyme Green Heat	Lyme, NH
	New Day Energy	Greenfield, NH
	Roland Abbott P+H	Littleton, NH
	Sandri Energy LLC	Greenfield, MA
	Smart Energy of New England	Colebrook, NH

\*\*\* Woodchip system installer

## B. List of All Pellet Mills Serving Vermont Identified in the Assessment

Mill Location	Business Name	Town
	Vermont Wood Pellet Company	North Clarendon, VT
Vormont	Renewable Fuels of Vermont	West Windsor, VT
Vernont	Richford Wood Products LLC (pending)	Richford, VT
	Kingdom Pellet (pending)	Gilman, VT
	Curran Renewables	Massena, NY
	Energex	Lac Magentic, QC
	Corinth Wood pellets	Corinth, ME
Outside Vermont	Lignetics of Maine	Strong, ME
	Maine Woods Pellet Co.	Athens ME
	New England Wood Pellets	Jaffrey, NH
	New England Wood Pellets	Deposit, NY
	New England Wood Pellets	Schuyler, NY

# C. List of All Bulk Pellet Fuel Distributors Serving Vermont Identified in the Assessment

Headquarter Location	Business Name	Town
Vormont	Vermont Renewable Fuels	East Dorset, VT
vermont	Bourne's Energy	Morrisville, VT
	Bourdeau Brothers	Middlebury, VT
	Sandri	Greenfield, MA
Outoido Vormont	Maine Energy Systems (MeSys)	Bethel, ME
	Lyme Green	Lyme, NH
	Curran Renewable	Massena, NY
	Vincent's Heating	Poland, NY



## D. Detailed Methodology

## **Overall Assumptions**

Conversion from MMBtu to cords of wood, tons of pellets, or tons of woodchips assumed the following:

	Wood, cord (green)	Pellets, ton	Chips, green ton (42% MC)
BTU/unit	16,200,000	16,400,000	9,500,000
Adjusted Seasonal Efficiency	65%	80%	75%

Unit conversion between cords and tons assumed 2.0 green tons per cord.

System configuration: average percentages were calculated from the CEDF program data for all installations between 2014 and 2016. Data from installer interviews was weighted by the number of systems installed to calculate the average number of systems serving DHW, with thermal storage, and with backup fossil fuel systems. Only Tier 1 installers were asked those questions, and therefore even a weighted average may be skewed, but this should be compensated by also looking at CEDF incentive program data.

This baseline assessment was compiled primarily from existing sources of data, the precision and accuracy of the resulting estimates are only as good as the initial data it was based on. All the findings presented here are BERC's best estimate with the data that was available. There are some remaining inconsistencies in the findings documented in this assessment that the reader should keep in mind.

First, there are discrepancies between the reported production of bulk pellets sold to Vermont customers, and the estimated consumption of bulk pellet by Vermont customers; 37% of the estimated bulk pellet consumption is not accounted for in the estimate of bulk pellet production destined to Vermont. This could be due to a few factors:

- This could be due to lack of precision in the data and assumptions used to mesh disparate sources of data.
- BERC's estimate may be double-counting some of the commercial and institutional installations because there is no complete and regularly updated repository of all installations to date that is connected to the incentive programs data. This can lead to potential errors where a system receiving an incentive is counted twice because not enough information is known to match it to a separate list of existing systems.
- This could also be due to the fact that 2016 was a warmer year and while we corrected for this whenever possible, estimates and assumptions may not be as applicable to that year.
- Another important factor is that with the low cost of fossil fuel in 2016, some facilities using bulk pellets have chosen to burn fossil fuel rather than pellets, and as the pellet consumption estimate is based on system capacity, that consumption estimate may be greater than the reality for 2016.
- BERC does not believe that this discrepancy is the result of bulk pellets being imported from outside the Region, as there are no companies that we are aware of that ship bulk pellet by rail to Vermont, and trucking bulk pellets from outside the Region would be cost-prohibitive and BERC is not aware of any company doing this.



Second, two primary source of data were used to assess how much of Vermont's heating needs are met with wood. The Energy Information Administration (EIA) State Energy Data Systems (SEDS) were used to assess the state's overall thermal needs by sector, and the total wood consumed for heat in Vermont. The Vermont Residential Fuel Assessment (RFA) was used at the State level to cross-check the EIA SEDS residential data. As the EIA residential fuel consumption appeared to be higher than one would expect for Vermont, the RFA was used to calculate the total residential wood heat consumption from the bottom up. Results from the RFA were lower of the values EIA reported for the residential sector, and BERC decided to use the average of the two data sources as the best approximation available. However, this estimate may need to be revised if more accurate data becomes available.

## A. Advanced Wood Heat

## A.1. Quantify the number of wood heating businesses in Vermont identified by subsectors (sales, installation, service, etc.)

A list of installers were compiled from CEDF and EVT incentive program data, a list of preferred installers for the CEDF rebate program, a list of boiler installers provided by MESys, and BERC knowledge of the installer base. The list of installers was divided into two tiers, Tier 1 being key market players that install several systems in Vermont annually, or install large commercial systems, Tier 2 being either large HVAC installers for which automated, central wood systems make up only a small proportion of their business dealings, or are one-person operations that do not strongly focus on AWH. A large majority of market players in the Tier 1 category were interviewed. Due to time and budget constraints, a smaller proportion of Tier 2 businesses were interviewed and the average of their responses was applied to other Tier 2 installers.

Twenty-five percent of the businesses were interviewed or responded to an email questionnaire, to gather information on the volume of their businesses. To accurately describe the industry in Vermont, a larger proportion of Tier 1 businesses serving Vermont were interviewed. Only Tier 2 businesses located in Vermont were interviewed.

Business Location	Tier	Primary Focus	Number of Businesses	Number of Businesses Interviewed	Percentage of Businesses Interviewed
Vermont	1	Pellet	8	5	63%
		Woodchips	1	1	100%
	2	Pellet	32	4	13%
Outside Vermont	1	Pellet	3	2	67%
		Woodchips	1	1	100%
	2	Pellet	6		0%
Total			51	13	25%

**Table 7:** Businesses focusing on the sale, installation, and service of Advanced Wood Heat (AWH)



# A.2. and A.3. Quantify the number of employees and sales revenue of the businesses identified in subtask

The average revenue of Tier 1 and Tier 2 businesses interviewed was compiled separately for instate and out of state businesses, and for businesses offering residential only, commercial only or both types of installations. Each average was then applied to other businesses that were not interviewed and that fit in the same category, to come up with the total revenue from sales, installations, and services. The same method was used to estimate the number of Full Time Equivalent (FTE) employed directly for central, automated wood heating systems sales, installation, and service.

The number of rebates redeemed by installers under the CEDF incentive program (total, residential, and commercial and institutional) was added up over the number of months that the program was offered, and averaged for a 12 month period. That average was compared to what installers reported during interviews, as a cross-check. The total revenue calculated through interviews was compared to the residential total installation costs reported in the CEDF incentive program data, to cross-check the revenue associated with residential installations.

The list of pellet mills and fuel providers was compiled from BERC in-depth knowledge of the fuel production and delivery market players.

To quantify the pellet distribution activities, BERC interviewed all the market players in Vermont and attempted to reach all market players in the Region (Table 8).<sup>54</sup>

Pellet Delivery Service Headquarter Location	Number of Businesses	Number of Businesses Interviewed	Percentage of Businesses Interviewed
Vermont	3	3	100%
Outside Vermont	6	4	71%
Grand Total	9	7	78%

**Table 8:** Bulk wood pellet delivery companies serving Vermont

To quantify the pellet fuel production activities, BERC interviewed all the existing mills and developers of planned new mills in Vermont and a majority of all the other mills in the Region (Table 9).<sup>55</sup>

Table 9: Wood pellet mills serving Vermont

Pellet Mill Location	Number of Businesses (incl. facilities planned for 2017)	Number of Businesses Interviewed	Percentage of Businesses Interviewed
Vermont	4	4	100%
Outside Vermont	8	4	50%

<sup>&</sup>lt;sup>54</sup> In cases were the businesses did not provide specific information, BERC estimated the volume delivered, number of employees, and revenue based on what was available, and averages from similar businesses.

<sup>&</sup>lt;sup>55</sup> In cases where the pellet mills did not provide specific information, BERC estimated the production, number of employees, and revenue based on what was available, and averages from similar mills.



# A.4. Estimate of the quantity of wood pellets (bulk and bagged) and woodchips for heating fuel produced and consumed annually in VT and <u>Consumption:</u>

BERC compiled a list of all known residential and commercial and institutional installations (see details under section A.5.) and assumed a per-installation consumption value based on actual consumption data when known (e.g. schools or college campuses), based on the system size, or square footage (for multifamily). When unknown a small commercial and institutional installation was assumed to use 15 tons per year. The per-installation value for residential buildings was unknown but was estimated assuming a 2,000 sq ft home with annual thermal and DHW needs of 35 kBtu/sq ft/year, and 80% seasonal efficiency.

## Production:

When pellet mills did not provide any data, BERC assumed 25 FTE, volume produced in 2016 was assumed to be 80% of mill output capacity, pellets were assumed to be sold at wholesale at \$175 /ton, and 3% of production was assumed to be bulk pellets and 20% of the bulk production was assumed to be sold to Vermont (based on the average from other Regional mills that provided data).

## A.5. Estimate the number of central, automated woodchip and pellet heating units sold and installed in VT annually (and cumulative if possible), separated by customer type: residential, commercial, municipal & institutional Cumulative Installations to Date

## BERC added up all residential installations having received an Efficiency Vermont incentive prior to the launch of the CEDF rebate, and having received a CEDF rebate since program inception, and assumed that historically (i.e. prior to program inception *and* while program was running) 50% of all AWH systems in Vermont took place outside the incentive program. This value was based on comparing program data on number of installations by installer, to the installer responses provided during the interviews. BERC assumed that once the CEDF rebate started, all customers that received the CEDF rebates also received the EVT rebate, therefore, BERC used EVT rebate data up to the point when the CEDF program started, then used CEDF data

Data on known commercial and institutional installations was compiled from a number of sources, to compile a list of all known installations cumulatively to date. The sources included: the BERC online database, the CEDF incentive program, the Efficiency Vermont Incentive Program (count of installations by town), Fuel For School survey mailing list, and data compiled in the State Wood Energy Team (SWET) database for schools and multifamily facilities.

#### Annual Installations

exclusively, to avoid double-counting installations.

The average number of installations compiled through installer interviews was compiled separately for installers that install pellet vs. woodchip systems, residential vs. commercial systems vs. both types of systems, and for installers based in Vermont and outside Vermont. For



installers that install AWH systems as a core component of their business and could provide values for 2016, those were used, otherwise an estimated number averaged over the previous few years was provided by the installer. The average number of installation was multiplied by the number of installers in each of the category. The total revenue that would result from installing these annual installations, assuming an average installation cost, was cross-checked with the total revenue reported by installers, and the CEDF average annual total installation costs, to verify the magnitude of the estimates are consistent and appropriate.

A comparison of the number of installations reported by installers during interviews and the average number of rebates received annually through the CEDF program indicated that, cumulatively, approximately 50% of residential pellet system installations received a CEDF rebate, including installations that took place before the CEDF incentive program programs was in place. <sup>56</sup> While there is a discrepancy between real incentive data and more subjective answers to interview questions, it is reasonable to conclude that assuming 60-100 advanced wood heat residential installations annually, within and outside of the incentive program, is a reasonable estimate.

# A.6. Develop annual wood fuel use and central, automated woodchips and pellet heating system installation trends (10 year history) and estimated growth if trend continue over next 5 years.

To estimate trend lines for wood fuel use and number of advanced wood heat installations in the residential sector, BERC used:

- historical installation data for commercial and institutional systems, where the installation date is known for most installations. The number of commercial and institutional installations each year since 2006 were compiled and plotted, trend lines into the future were modeled assuming that current installation rates remain the same.
- for residential installations, the cumulative installations to date as a starting point, and extrapolated in the past and future using an adjustment factor from year to year to account for installation rates having likely increased since the CEDF and Efficiency Vermont program inception. BERC compiled a historical data trend assuming that the installation rate as percent of current installation rate ranged from 5% in 2006 before the price of oil flared and before the Efficiency Vermont and CEDF incentive was offered, to 80% of current rate in 2012- 2013, and assuming current installation rate from 2014 through 2021.

The bulk pellet and woodchip consumption modeled trends were calculated using a per-system assumption of 5.3 ton per system for residential installations, 68.2 ton per system for commercial and institutional bulk pellet systems, and 1,394 green ton per system per year for commercial and institutional woodchip systems, based on averages calculated for 2016.

## B. Wood Heat Overall

Fuel cost savings: Assumes wood replaces propane in 42% of cases, oil in 58% of cases, and assumes cost per MMBtu after combustion of \$32/MMBtu for propane and \$18/MMBtu for oil.

<sup>&</sup>lt;sup>56</sup> This percentage was factored into calculations of cumulative number of residential systems installed in Vermont.



## B.1. Estimate percentage of total heating met with wood

BERC used EIA SEDS data to compile total Btu consumed for heating buildings with distillate oil, propane, natural gas, and wood. Residential thermal needs met through electric heat are not directly available from EIA and were estimated by:

- 1. Using the share of households using each fuel type from EIA state profile for Vermont (latest year available, 2017)
- 2. Using EIA table CT3: trillion Btu consumed by residential customers for natural gas, fuel oil, LPG (latest year available, 2014)
- 3. Calculating the total thermal energy from the percentage of households using each fuel and total Btu consumed statewide for that fuel (for oil, propane, and natural gas). The average of the three values calculated was used in the analysis.
- 4. That average was used along with the share of households using electric heat (4.6%) to calculate Btu used statewide for electric heat.
- 5. For historical trends, BERC assumed electric heat consumption (Btu) was constant from 1960-2014, which is not accurate but likely within the margin of error for the last 10 years trend.

Total thermal needs (trillion Btu) were compiled by adding the statewide consumption for each fuel type: oil, propane, natural gas, kerosene, and electric heat (residential only).

EIA data for wood consumption has at times been noted for not being representative of the actual consumption in Vermont. Therefore, rather than directly using EIA data to calculate the share of heating needs met with wood, BERC adjusted the estimate using the following methodology:

- 1. BERC calculated the statewide wood consumption from the bottom-up, using the Residential Wood Survey for 2014-2015, and data on total number of households from the census data.
- 2. The number of households using cordwood and pellets was multiplied by the number of cords and tons of pellets, respectively, used annually by these households (cordwood: average of 1998, 2008, 2015: 2.3 cords per household; pellets: 3.5 tons per year assumption, based on professional judgment).
- 3. The trillion Btu calculated using this method was averaged with the trillion Btu reported by EIA in SEDS to come up with the total residential wood heat consumed in Vermont.

Historical trends were compiled using the same year-to-year trends as in EIA SEDS's wood consumption data, but adjusted proportionally to the wood consumption calculated using the method described above.

In absence of better data, EIA's commercial consumption data for total wood heat were taken directly from EIA SEDS. It was disaggregated between AWH and traditional wood heat using the percent advanced wood heat of C&I total wood heat (see B.2.) and applying that to the consumption figure. Industrial wood heat consumption was not estimated.

## B.2. Estimate the percentage of total heating met with Central, Automated Woodchip and Bulk Pellet

The percentage of total heating needs met by Central, Automated Woodchip and Bulk Pellet was calculated using values calculated in A.4. and B.1.



## B.3. Estimate the number and percentages of buildings heating with wood and Central, Automated Woodchip and Bulk Pellet

The percentage and number of buildings heating Central, Automated Woodchip and Bulk Pellet was calculated using values form B.1. and A.5. The percentage of building using non-AWH as primary heat is unknown and was not estimated due to lack of existing information on this topic.

B.4. Estimate the amount of wood fuel (pellets, chips, cord) consumed for heating in Vermont. Include information on bagged pellets vs. bulk pellets

The residential consumption estimate for traditional wood systems is based on the Residential Fuel Assessment, assuming 2.3 cords of wood annually per household heating with wood and 3.5 tons of bagged pellet annually per household heating with wood pellets. The advanced wood heat estimate is as described under section A.4. The traditional wood heat estimate for commercial and institutional systems is based on the assumption that 88% of wood heat consumption is advanced wood heat in the sector (section B.2.). Industrial wood heat consumption was not estimated. The totals were crossed checked, in terms of trillion Btu, with the EIA data and the Residential Fuel Assessment data.

## E. Interview Questions

## Fuel Manufacturer

Company name: \_\_\_\_\_\_ Interviewee Name: \_\_\_\_\_ Date of interview: \_\_\_\_\_

## Feel free to estimate or provide a range if you do not know the exact value off the top of your head, rather than leave the question blank.

- 1. How many tons of pellets did you produce in 2016 at all your Vermont mills? \_\_\_\_\_ How many mills does that include?\_\_\_\_
  - a. How is that broken out between
    - i. Bulk pellets\_\_\_
    - ii. Bagged pellets\_\_\_\_
- How many tons of pellets do you plan to produce in 2017 at all your Vermont mills?
   \_\_\_\_\_ How many mills does that include?\_\_\_\_ How many tons of pellets did you <u>sell in</u> <u>Vermont</u> at all your Vermont mills in 2016? \_\_\_\_\_
  - a. How is that broken out between
    - i. Bulk pellets\_\_
    - ii. Bagged pellets\_\_\_\_\_
    - iii. If unknown :
    - iv. Bulk
      - 1. How many tons do you sell annually to distributors in VT? \_
      - 2. How many tons do you sell annually to distributors outside VT?
      - 3. How many tons do you sell annually directly to VT customer?
      - 4. How many tons do you sell annually directly to customer outside VT? \_\_\_\_\_
      - 5. How many mills do those numbers represent? \_\_\_\_
    - v. Bags



- 1. How many tons do you sell annually to distributors in VT? \_
- 2. How many tons do you sell annually to distributors outside VT?
- 3. How many tons do you sell annually directly to VT customer?
- 4. How many tons do you sell annually directly to customer outside VT? \_\_\_\_\_
- 5. How many mills do those numbers represent?\_\_\_\_
- 3. What is your total annual revenue in 2016 from selling bulk and bagged pellets? \_\_\_\_\_
- •
- 4. How many FTE (Full Time Equivalent) employees do you employ? \_\_\_\_\_
- 5. How many FTE will you employ in 2017, if any change is expected?

## Pellet Distributor

Company name: \_\_\_\_\_\_ Interviewee Name: \_\_\_\_\_ Date of interview: \_\_\_\_\_

## Feel free to estimate or provide a range if you do not know the exact value off the top of your head, rather than leave the question blank.

- 1. How many tons of pellets do you distribute to end users annually in total (<u>VT and outside VT</u>): \_\_\_\_\_
  - a. How is that broken out between
    - i. Bulk pellets \_\_\_\_
    - ii. Bagged pellets \_\_\_\_
- 2. How many tons of pellets do you distribute to end users annually in Vermont?
  - a. How is that broken out between
    - i. Bulk pellets \_\_\_\_\_
    - ii. Bagged pellets \_\_\_\_\_
      - 1. If unknown :
        - a. How many tons of <u>bulk</u> pellets do you sell to customers <u>in</u> <u>Vermont annually?</u>
        - b. How many tons of <u>bulk</u> pellets do you sell to customers annually <u>outside VT?</u>
        - or
        - c. Average tons delivered per delivery: \_\_\_
- 3. What is the source of the pellets you distribute, what is the of the mill/distributor that you use and what percentage of your pellets come from that source
  - a. Bulk: 1<sup>st</sup> Mill \_\_\_\_\_\_ % \_\_\_\_, 2<sup>nd</sup> Mill % \_\_\_\_\_\_ 3<sup>rd</sup> Mill \_\_\_\_\_ %
  - b. Bag: 1<sup>st</sup> Mill or distributor \_\_\_\_\_\_ % \_\_\_\_, 2<sup>nd</sup> Mill \_\_\_\_\_%
- 3<sup>rd</sup> Mill \_\_\_\_\_% \_\_\_\_
- 4. Do you use any storage silos or bins for bulk pellets or warehouse for bagged pellet distribution in Vermont?
  - a. What size? \_\_\_\_,
  - b. How many? \_\_\_\_\_,
- •

•

5. What is your total annual revenue from delivering bulk and bagged pellets? \_\_\_\_\_



- 6. How Many trucks do you use for pellet delivery and what type of trucks are they?
- •
- a. Total: number of trucks: \_\_\_\_\_ type of trucks \_\_\_\_\_
- b. serving VT: number of trucks: \_\_\_\_\_ type of trucks \_\_\_\_\_
- c. outside VT: number of trucks: \_\_\_\_\_ type of trucks \_\_\_\_\_
- 7. How many FTE (Full Time Equivalent) employees do you employ? \_\_\_\_\_
- •

Vermont Based Woodchip Supplier Focused on Heating Market

Company name: \_\_\_\_\_\_ Interviewee Name: \_\_\_\_\_ Date of interview: \_\_\_\_\_

Feel free to estimate or provide a range if you do not know the exact value off the top of your head, rather than leave the question blank.

- 1. How many tons of woodchips do you distribute annually to the heating market (VT and outside VT): \_\_\_\_\_
- 2. How many tons of woodchips do you distribute annually to the heating market (VT only): \_\_\_\_\_
- 3. What is your total annual revenue from supplying woodchips for the heating market?
  - a. If unknown, what is your business's total revenue? \_\_\_\_ And what percentage of your operations are dedicated to the wood heat market? \_\_\_\_
- 4. How many FTE (Full Time Equivalent) employees do you employ in total? \_\_\_\_\_
  - a. What proportion of your employees' work hours are dedicated to the wood heat market, as opposed to logging/chipping for other markets such as power plants, etc.? \_\_\_\_\_% dedicated to wood heat market

Installation/ Service – Tier 1

Company name: \_\_\_\_\_\_ Interviewee Name: \_\_\_\_\_ Date of interview: \_\_\_\_\_

1. Do you install or service pellet or woodchip central, automated wood heat systems (not including stoves, manually fed systems, cordwood systems, or outdoor wood boilers)?

If not, thank you for your time, you do not need to answer any further question.

<u>If yes, please answer the following questions</u>, feel free to estimate or provide a range if you do not know the exact value off the top of your head, rather than leave the question blank.

### Pellets

- 1. What is the total number of central, automated **pellet** systems you install annually?\_\_\_\_\_
- 2. What is the total number of central, automated **pellet** systems you install annually in <u>Vermont</u>?
  - a. Residential-size (up to 300,000 Btu/h) \_\_\_\_
  - b. Commercial and Institutional-size (greater than 300,000 Btu/h) \_\_\_\_\_
- 3. <u>Cumulatively</u>, what is the total number of central, automated **pellet** systems you have installed <u>in Vermont</u>?
  - a. Residential-size (up to 300,000 Btu/h) \_\_\_\_
  - b. Commercial and Institutional-size (greater than 300,000 Btu/h) \_\_\_\_\_



## Woodchips

- 1. What is the total number of central, automated **woodchip** systems you install annually?\_\_\_\_\_
- 2. What is the total number of central, automated **woodchip** systems you install annually <u>in Vermont</u>?
  - a. Residential-size (up to 300,000 Btu/h) \_\_\_\_
  - b. Commercial and Institutional-size (greater than 300,000 Btu/h) \_\_\_
- 3. <u>Cumulatively</u>, what is the total number of central, automated **woodchip** systems you have installed <u>in Vermont</u>?
- 4. Types and configurations of installations: what was the percent of installations that : a. pellets
  - i. Covered Domestic Hot Water? \_\_\_\_% (for residential) \_\_\_\_% (for commercial/institutional)
  - ii. Included back-up fossil fuel boilers? \_\_\_\_% (for residential) \_\_\_\_% (for commercial/institutional)
  - iii. Used thermal storage? \_\_\_\_% (for residential) \_\_\_\_% (for commercial/institutional)
  - b. woodchips
    - iv. Covered Domestic Hot Water? \_\_\_\_\_% (for commercial/institutional)
    - v. Included back-up fossil fuel boilers \_\_\_\_\_% (for commercial/institutional)
    - vi. Used thermal storage? \_\_\_\_% (for commercial/institutional)

General:

- 5. How many maintenance contracts do you have annually in Vermont for the maintenance of central, automated pellet or woodchip systems? \_\_\_\_\_
- 6. What is your total annual revenue from installing and servicing central wood heat system? \_\_\_\_\_
  - a. Or, if unknown: what is your total annual revenue? \_\_\_\_ and what proportion of your business relates to central, automated pellet or woodchip wood heating systems, roughly? \_\_\_\_\_
- 7. How many FTE (Full Time Equivalent) employees do you employ? \_
  - a. What proportion of your business relates to central, automated pellet or woodchip wood heating systems in Vermont, roughly? \_\_\_\_

### Installation/ Service - Tier 2

Company name: \_\_\_\_\_\_ Interviewee Name: \_\_\_\_\_ Date of interview: \_\_\_\_\_

1. Do you install or service **indoor pellet boilers** with automated bulk pellet feed (i.e. <u>not</u> including stoves, cordwood systems, or outdoor wood boilers)? \_\_\_\_\_

<u>If not</u>, thank you for your time, you do not need to answer any further question, please email us back your answer to the first question.

<u>If yes, please answer the following questions, feel free to estimate or provide a range if you do not know the exact value off the top of your head, rather than leave the question blank.</u>

- 2. What is the total number of indoor pellet boilers you install <u>annually in Vermont</u>, on average?
  - a. Residential-size (up to 300,000 Btu/h) \_\_\_\_
  - b. Commercial and Institutional-size (greater than 300,000 Btu/h) \_\_\_\_\_



- 3. How many maintenance contracts do you have annually in Vermont for the maintenance of indoor pellet boilers? \_\_\_\_\_
- 4. What is your total annual revenue from installing and servicing indoor pellet boilers in Vermont? \_\_\_\_\_
- 5. How many FTE (Full Time Equivalent) employees do you employ in total? \_\_\_\_\_
  - b. what proportion of your business relates to indoor pellet boilers in Vermont, roughly? \_\_\_\_\_