2022 Update:

Wood Heat Use in Vermont

Prepared for:

Clean Energy Development Fund at the Vermont Department of Public Service

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Authors

The lead authors of this report were Adam Sherman and Damon Lane with research and analysis from Sean Parker. VEIC is a mission driven non-profit organization focused on developing and implementing market solutions to expand the use of energy efficiency and renewable energy.

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Terminology

This report uses specific terms to describe various forms of wood heating that need to be clarified:

Term	Definition
Total wood heating	Includes all wood fuels (cordwood, pellets, and chips) and all heating appliance (stoves, furnaces, and boilers) without regard to the efficiency or sophistication of the combustion equipment. Legacy wood heating equipment such as outdoor wood boilers and old non-EPA certified stoves are included in this definition.
Advanced wood heating	Includes all wood fuels (cordwood, pellets, and chips) and all high-efficiency heating appliance (stoves, furnaces, and boilers) installed indoors. Generally representative of all new appliances incentivized by the State of Vermont programs.
Automated wood heating	A subset of advanced wood heating that includes high-efficiency boilers and furnaces that are automatically fueled with either wood pellets or chips and can sustain automated operations for several days at a time.

Disclaimer

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Section 1 - Introduction

This report summarizes the findings of an assessment of the total use of wood fuels and appliances to meet Vermont's thermal energy needs in 2022 and is a follow up to **the original 2016 Wood Heat Baseline** report. A separate companion report, entitled "*2022 Update: Advanced Wood Heat Sector in Vermont*" provides an assessment of the advanced wood heat industry and market in Vermont in 2022. Both the 2022 update reports and the original 2016 Baseline Report can be found on the Public Service Department's website.

1.1 Background

Wood heat has a been a mainstay of providing thermal energy for buildings in Vermont for a very long time. While heating homes with woodstoves has been common for generations, using automated woodchip and wood pellet systems to heat entire buildings in Vermont only started a little over three decades ago. 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 VEIC's assessment of this market across the US and Canada, Vermont remains home to the greatest density of installed automated wood heating systems in North America.

The expanded use of wood heat has a vital role to play in the future in meeting the State of Vermont's renewable energy, climate mitigation, economic development, and forest management goals and objectives.

Meeting Renewable Energy Goals

The State of Vermont has set a goal of meeting 90% of Vermont's total energy needs from renewables by 2050. Thermal energy makes up approximately one third of total energy use in Vermont and relies heavily on fossil fuels. The 2022 Comprehensive Energy Plan (CEP) specifically calls for increasing the amount of space heating met with wood from 21% to 35% by 2030[1] to make progress toward the broader renewable energy goal.

The 2022 Comprehensive Energy Plan (CEP) specifically calls for increasing the amount of space heating met with wood to 35% by 2030.

If Vermonters turn more to wood heating in the years ahead, it will require additional sourcing of wood fuels from Vermont forests. Recent studies have concluded Vermont's forests are growing over twice as much new wood than is harvested each year and traditional markets for low-grade wood like pulpmills are declining. The most recent estimates indicate that Vermont forests have capacity to sustainably support an additional 939,000 green tons of harvested wood fuel annually.[2] This has the equivalent energy value of approximately 50 million gallons of heating oil.

[1] **2022VermontComprehensiveEnergyPlan_0.pdf** Page 197 in Section 6.4.2.2.
[2] Vermont Wood Fuel Supply Study, 2018 Update, **https://fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Wood_Biomass_Energy/Library/2018%20VWFSS%20Final%20Report%20with%20Letter.pdf**

Wood heating can also serve as complementary strategy to building electrification. Expanding the use of wood heating in addition to installing heat pumps can provide grid benefits by alleviating new winter peaks during the coldest times when even cold-climate air-source heat pumps perform less efficiently and require more electricity to provide the same amount of heat.

Meeting Climate Change Mitigation Goals

In 2020, the Vermont Legislature passed the Global Warming Solutions Act (GWSA - Act 153 2020), which created legally binding emission reduction targets. The Act was created in response to concerns around Vermont's changing climate and the magnitude of what must be done to reduce greenhouse gas emissions in Vermont. The Act requires Vermont to reduce greenhouse gas pollution to 26% below 2005 levels by 2025. Emissions would need to be 40% below 1990 levels by 2030 and 80% below by 2050.

Wood heating plays a vital role in the Vermont Climate Action Plan (the "Plan"). In the Plan, ***Pathway 2: Reduce Building Emissions by Reducing the Carbon Content of the Fuels they Use,*** is where wood heating fits. Under this, ***Strategy 1 – Implement a Clean Heat Standard,*** is where wood heat comes into play.

Wood heat can serve as an integral strategy for meeting the GWSA's Greenhouse Gas (GHG) emission reduction requirements. Cutting trees and combusting wood fuels (which releases CO_2) may seem counterintuitive as a GHG emission strategy, but forests are naturally and continuously both absorbing and releasing carbon to and from the atmosphere – this is the biogenic carbon cycle. Periodic and sustainable harvesting of wood can help stimulate new wood growth in the forest, and burning wood releases biogenic carbon that would otherwise be eventually released back to the atmosphere – thus creating a slightly shorter cycle time between forest and atmosphere, but far less long-term net increase in atmospheric CO_2 levels than compared to the continued use of fossil fuels. Using locally sourced wood fuels from well-managed forests to displace fossil heating fuels yields significant long-term benefits by reducing net atmospheric levels of carbon dioxide.[3]

Periodic and sustainable harvesting of wood can help stimulate new wood growth in the forest, and burning wood releases biogenic carbon that would otherwise be eventually released back to the atmosphere.

While the carbon emission benefits of replacing fossil fuels with wood are less when viewed in the short-term, there is consensus among experts that strategies that offer long-term emission reductions are vital. The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change and is widely respected as a source of objective GHG emission information. The IPCC's most recent (2018) update to the fourth assessment report summarized the wood fuel CO_2 emission issue succinctly:

[3] For further discussion refer to - *Clean Energy Development Fund, Carbon Summary Bulletin* - **https://fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Wood_Biomass_Energy/Library/CEDF%20AWH%20Carbon%20Summary%20Bulletin%20-%20FINAL.pdf**

"In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fiber, or energy from the forest, will generate the largest sustained [carbon emission] mitigation benefit."[4]

The most recent (2022) IPCC Sixth Report further elaborates on the potential for bioenergy to play a contributing role in mitigation of GHG emissions –

"Bioenergy and other bio-based products provide additional mitigation through the substitution of fossil fuels fossil-based products. Wood used in construction may reduce emissions associated with steel and concrete use. The agriculture and forestry sectors can devise management approaches that enable biomass production and use for energy in conjunction with the production of food and timber, thereby reducing the conversion pressure on natural ecosystems."[5]

Meeting Energy Affordability Goals for Low-income Vermonters

Wood fuels are typically lower cost than fossil heating fuels. Many Vermonters heat with wood to keep their heating fuel cost low and often cut their own firewood. Heating with wood can also help improve energy security and local resilience as more homes and businesses electrify and become increasing dependent on the electric grid for larger portion of their energy.

Meeting Economic Development Goals

In addition to helping lower heating costs for Vermont residents, businesses and institutions, wood fuels, especially cordwood and woodchips, are predominately sourced and used locally in Vermont. Wood pellets also provide this advantage, but a larger portion of pellets are sourced regionally (New York, New Hampshire, Maine and Quebec). When Vermonters purchase fossil heating fuels, a large portion of the expenditure is exported out of the Vermont economy. In contrast, when local wood fuels are used, a large portion of the dollars stay and recirculate in the local economy.

The *Vermont 2020 Comprehensive Economic Development Strategy* has set goals to preserve the environmental and economic benefits of the working landscape by ensuring that it can provide economic value. The strategy identifies action areas 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."[6]

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, creating the Working Lands Enterprise Fund and a board whose goal is to support agriculture and forestry-based businesses.[7]

[4] 2018 update to the IPCC Fourth Report, Page 543 - **https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg3-chapter9-1.pdf [ipcc.ch]**
[5] IPCC Sixth Report 2022, page 751 - **https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf**
[6] **https://outside.vermont.gov/agency/ACCD/ACCD_Web_Docs/ED/MajorInitiatves/CEDS/2020FullReport.pdf**
[7] **https://workinglands.vermont.gov**

Meeting Forest Management Goals

Sustainable forest management requires viable local markets for wood products otherwise unsuitable for higher quality dimensional lumber. Periodically cutting crooked, diseased, or blemished trees from a stand can reduce the competition and invigorate growth for the remaining nearby trees. Historically, regional pulp and paper markets have served as the main stay for a large volume of "low-grade" harvested wood, but in the last two decades, there has been significant declines in the regional pulp and paper markets. Local wood heat markets can serve as a vital alternative to pulp and paper mills.

The 2017 Vermont Forest Action Plan states "the economic viability of Vermont's working lands is challenged by changing land use, development pressure, and macroeconomic trends in the forest product economy. Maintaining focus and investment in Vermont's working lands will grow forest businesses, improve our economy, and keep forests as forests."[8] Local wood heat aligns with this key objective of the Forest Action Plan as well as the various strategies laid out in the recently released Vermont Forest Future Strategic Roadmap[9].

Summary of Vermont Programs that Support Advanced Wood Heat

Given the alignment of wood heating with various state goals, there have been numerous programs and initiatives to support the expanded use of advanced wood heat.

Several State-funded programs support the development of the advanced wood heat industry, in line with the goals stated in the CEP as well as greenhouse gas and economic development plans. These current and past programs include incentives and grants:

- CEDF's Small Scale Renewable Energy Incentive Program (SSREIP),
- Efficiency Vermont incentive program, also targeted at the most efficient AWH bulk pellet systems,
- CEDF's Statewide wood stove change-out program (no current funding)
- The Windham Wood Heat Initiative (CEDF)
- CEDF's competitive grants for bulk pellet supply infrastructure and for pellet installations in school and public serving institutions.

Additional training programs support workforce development for the advanced wood heat industry:

- The CEDF participates in the organization of trainings targeted at advanced wood heat installers and system designers,
- The Energy Efficiency Network (administered by Efficiency Vermont) offers advanced wood heat installer trainings,

The Vermont State Agency 2021 Energy Plan (a part of the 2022 Comprehensive 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."

[8] https://fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Vermont_Forests/Library/2017_VT_ForestActionPlan.pdf
[9] VFF-Roadmap-Report-Final.pdf (future-iq.com)

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.[10]

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 Vermont Superintendents' Association regularly collaborate under a variety of funding sources. These partners coordinate Advanced Wood Heat programs, activities, training programs, and public outreach and education to increase the awareness of the benefits and availability of advanced wood heat.

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 - **http://www.rd.usda.gov/vt**
- Vermont Public Service Department's Heat Saver Loan for residential customers – now operated by Efficiency Vermont- **https://www.efficiencyvermont.com/services/financing/homes/home-energy-loan/**

1.2 Assessment Purpose

Wood heating is aligned with and supports the goals of the CEP, Vermont's greenhouse gas reduction requirements, the Climate Action Plan, 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 goal of this assessment update is to determine and document the state of the wood heat market and sector in Vermont at the end of 2022, so that further market development progress can be measured against a specific point in time. This 2022 update 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 inform adjustments in response to changes in the market. Changes in the market are better understood using baseline information.

This is an update to the first advanced wood heat assessment of 2016. That report explored the state of the advanced wood heat sector at the time, and this is a chance to check in on progress since then.

1.3 Scope of Assessment

VEIC was tasked with conducting an updated assessment of both the advanced wood heat sector in Vermont and the broader use of wood heating in Vermont. This report covers the 2022 assessment of the broader wood heat sector. The second companion report, entitled *"2022 Update: Advanced Wood Heat Sector in Vermont"* provides a deeper dive into advanced wood heat industry and market.

This assessment focusses on wood heat and does not include any data for wood-fueled electricity generation (e.g., from either McNeil or Ryegate Stations), aside from including the small amount of wood

[10] **http://bgs.vermont.gov/sites/bgs/files/files/energy-environment/2016-State-Agency-Energy-Plan.pdf**

consumed at facilities with thermal-led combined heat and power systems, which is a very small market and is difficult to exclude.

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. To be efficient and make the most of various sources of existing data, VEIC 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.

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 and 2018-2019) administered by the Department of Forests, Parks & Recreation, in partnership with the Department of Public Service
- 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.

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

- Advanced wood heat system installers and importers/distributors
- Wood pellet fuel manufacturers and suppliers
- Wood pellet fuel distributors

To conduct this assessment, 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.

Section 2 - Total Wood Heating in Vermont

2.1 Estimate of Heating Met with Wood

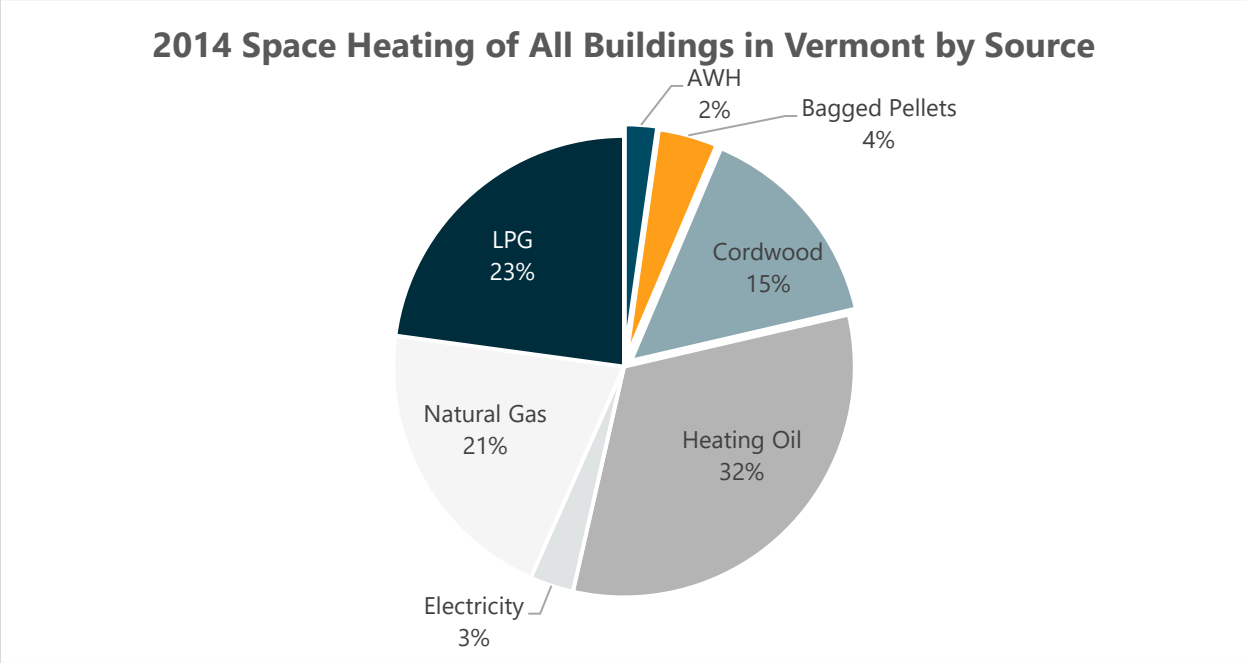
Determining the overall thermal energy demand in Vermont was the first step in this analysis. The total thermal energy needs in the state (heating and domestic hot water) were estimated using US Energy Information Administration's (EIA) State Energy Data Systems (SEDS) most recent data from 2020.

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 - the thermal energy by sector from EIA SEDS and the Vermont Residential Fuel Assessment (RFA). The thermal energy by sector data from EIA SEDS 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. 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, VEIC used an approach that relied on both data sources rather than choosing one over the other. VEIC 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.

2016 Baseline Wood Heat Recap

The 2016 Baseline Assessment provided results from 2014 and total wood heating was estimated to account for 21% of heating needs in Vermont in 2014 (Figure 1 below).

Figure 1 – Total Space Heating of Buildings by Fuel type in Vermont – as presented in the 2016 Baseline Report

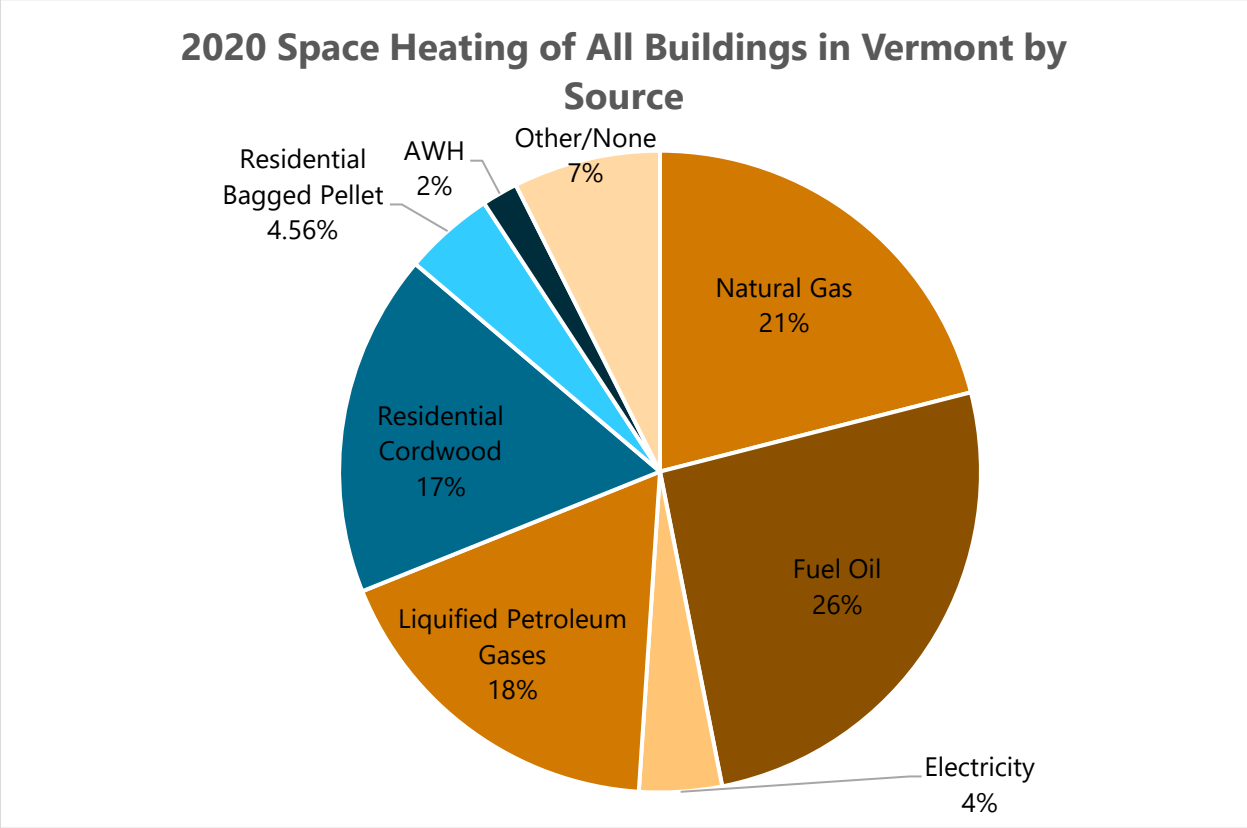


Twenty one percent was a higher value than previous data have indicated. Earlier reporting from 2008 suggested Vermont met only 15% of its thermal energy needs with wood.

2020 Update - Results for Total Space Heat

In the six years since the Baseline Study, the portion of the total space heating needs in Vermont met with wood fuels has increased from 21% in 2014 to 23.5% in 2020.

Figure 2: Sources used to meet Vermont's space heating and domestic hot water needs for all residential, commercial, and institutional buildings in 2020.



As in 2016, the estimate of residential wood use from EIA were higher than the results from the RFA. Interestingly, for 2020, the EIA number was about 10% higher than RFA, whereas in 2016 it was double.

To compare the change in the fuel use between the 2016 baseline and 2022 update, Table 1 shows the percentage of the total thermal energy for each respective year and the change.

Table 1 - Difference in each fuel type from 2014 to 2020

	2014	2020	Net change
Natural Gas	21%	21%	0%
Heating Oil	32%	26%	-19%
Propane	23%	18%	-21%
Electricity	3%	4%	+33%
Residential Cordwood	15%	17%	+13%
Bagged Pellets	4%	4.5%	+13%
AWH	2%	2%	0%
Other/None[11]	0%	7%	+700%
TOTAL Trillion Btu	45.3	53.7	+19%

[11] The "Other/None" category was recently added by EIA and accounts for the portion of buildings either not heated or heated with other fuels such as Kerosene.

It is important to note that the percentages for each fuel can change based on changes in the total amount of energy. In 2014 the data indicate there were 45.3 trillion Btu of space heating need in Vermont buildings. Whereas there were 53.7 trillion Btu of total space heating in 2020. This difference is mostly attributed to the addition of the "none/other category" in the source EIA data and possibly the amount of new construction added in the six years. The number of heating degree days was not a contributing factor. There were 7,379 heating degree days for Burlington, Vermont in 2020 whereas 8,312 in 2014.

Another interesting trend is the decrease in the percentages for delivered fossil heating fuels – heating oil and propane with 19 and 21 percent decreases. While natural gas saw more use in actual amounts, the percentage of the total remained the same between 2014 and 2020.

The percentage of total space heating met with wood heat increased by 12% between 2014 and 2020, however gains were mostly attributed to increased use of cordwood in woodstove appliances.

As a result of the dramatic increases in heat pump adoption, the percentage of electricity as a heating fuel increased by 33%).

The percentage of total space heating met with wood heat increased by 12% between 2014 and 2020, however gains were mostly attributed to increased use of cordwood in woodstove appliances. While residential cordwood and bagged pellets increased by 13%, advance wood heat market share remained constant at 2%.

2020 Update - Results for Wood Fuels used for Space Heating

The estimated wood fuel consumption by sector is presented in ***Table 2***. 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 very large amounts of wood fuels are used in Vermont to generate electricity. However, aside from electric generation at McNeil and Ryegate power stations, the industrial use of wood fuels to dry wood at sawmills and pellet mills in Vermont is relatively small and is not discussed in any detail in this assessment.

Table 2: 2016 Estimated tons of wood consumed annually in Vermont by sector and wood fuel type as reported in the 2016 Baseline study.

Sector	Traditional Wood Fuels		Advanced Wood Heat Fuels	
	Cordwood (green tons)	Bagged Pellets (tons)	Bulk Pellets (tons)	Woodchips (green tons)
Residential	700,000	126,000	2,000	0
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**

Table 3: 2022 Estimated tons of wood consumed annually in Vermont by sector and wood fuel type.

Sector	Traditional Wood Fuels		Advanced Wood Heat Fuels	
	Cordwood (green tons)	Bagged Pellets (tons)	Bulk Pellets (tons)	Woodchips (green tons)
Residential	857,676	148,968	1,686	0
Commercial and Institutional	45,140	0	8,301	81,910
Total	**902,817**	**148,968**	**9,987**	**81,910**
Total Trillion Btu	**9.3**	**2.4**	**0.16**	**0.8**

Discussion of Trends

Based on the findings of the Vermont Residential Fuel Assessment, there was a 29% increase in the amount of cordwood fuel used in 2018/2019 as compared to 2014/2015. This increase is likely a result of continued, steady sales of wood heating appliances and higher usage of cordwood per household due to higher oil and propane prices in 2018/2019. It is important to note that the increase in cordwood use predates the onset of the COVID-19 pandemic. Anecdotal evidence indicates that cordwood use increased further during the pandemic when more Vermonters were at home during the day and were able to tend their wood stoves.

Like cordwood, there was moderate growth in the use of both bagged and bulk wood pellets between 2014/2015 and 2018/2019. Bulk pellet fuel increases are likely due to steady pellet boiler sales driven in part by incentive programs. Bagged pellet fuels are estimated to have increased due to the same reasons as cordwood, but the 148,968-ton value is an estimate due to an apparent error in the University of New Hampshire's data used for the Residential Fuel Assessment.[12]

[12] *The Vermont Residential Fuel Assessment for the 2018-2019 Heating Season* reported a dramatic decrease of residential wood pellet fuel usage in Vermont from 126,156 tons in 2014/2015 to only 51,550 in 2018/2019. Based on further examination, this is believed to be an error in the University of New Hampshire's sampling method and does not reflect market trends. VEIC applied the same rate of increase seen in cordwood fuel usage to pellets to develop a revised estimate for this update.

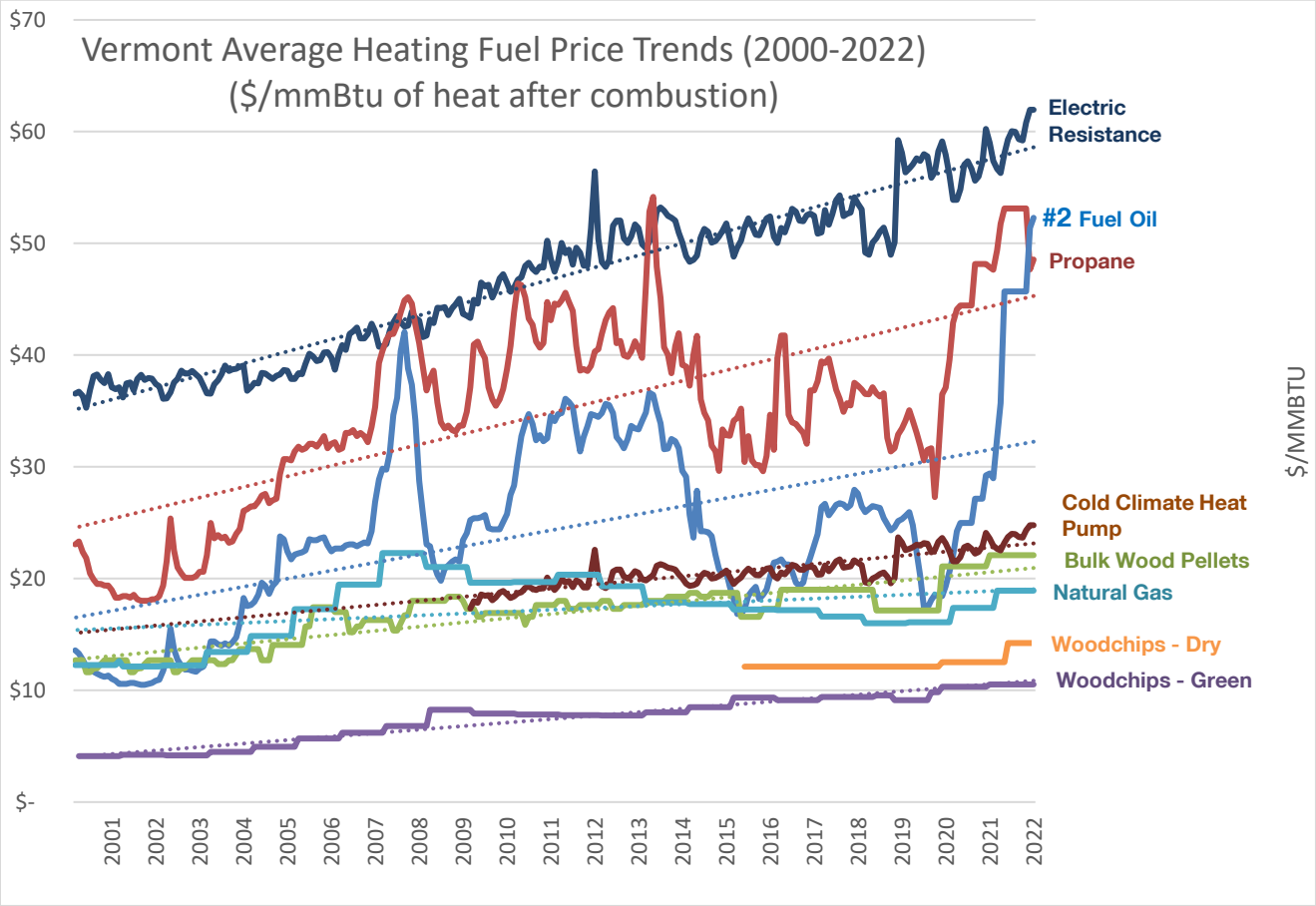
Woodchip fuel use shows a slight decrease in the annual estimates but is not thought to be significant or due any specific trend. Between the 2016 Baseline and the 2022 Update there were no major changes in the number of large woodchip heated facilities – just the addition of a handful of small systems using dry woodchips.

There is no publicly available data on woodstoves sales, but the growth in wood fuel use aligns with national and regional trends for wood stove sales.[13] Although the BTU Act and resulting federal tax credit on stoves and boilers has had a positive impact on appliance sales in recent years, it is important to note that it was not enacted until 2021, so did not directly cause the change because it happened after the 2020 timeframe of this analysis.

While programs and incentives play a contributing role on market adoption rates, the prices and volatility of prices of fossil heating fuels like oil and propane play a major role in both wood fuel use and wood fueled heating appliance sales. Figure 3 below illustrates the comparative pricing of different technologies and fuel types over time in Vermont.

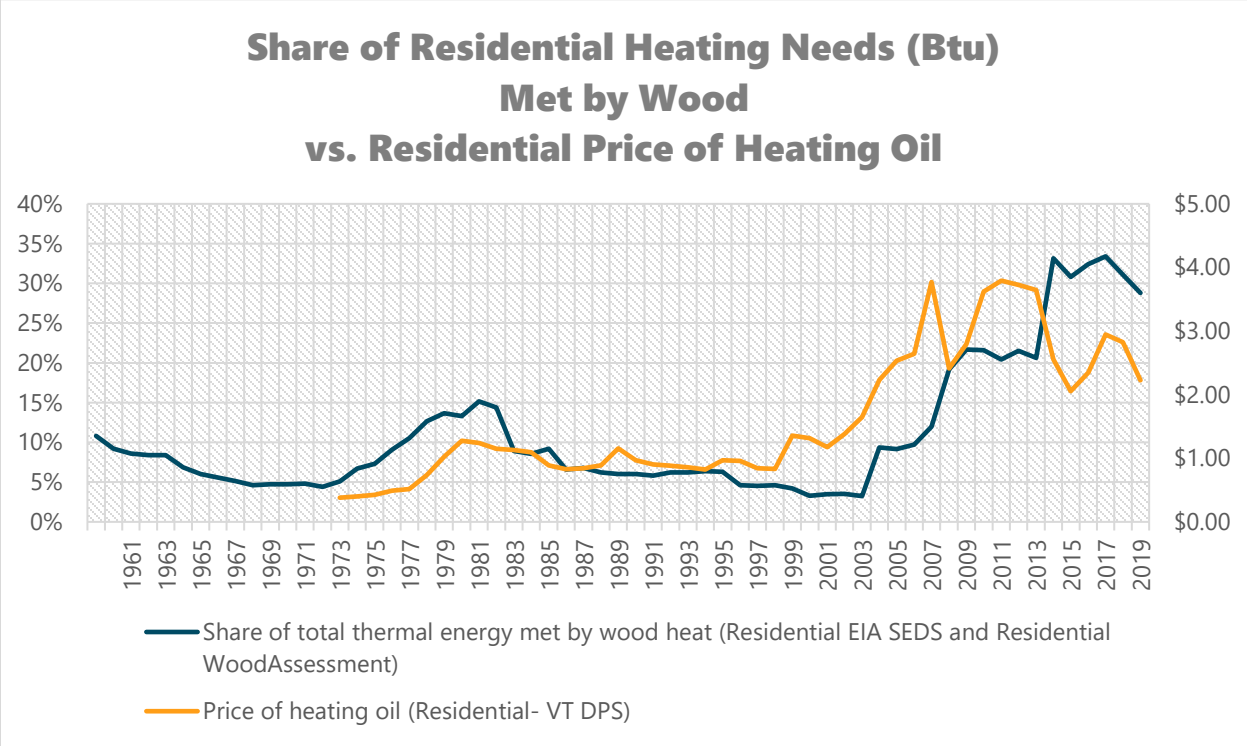
[13] **https://forgreenheat.blogspot.com/2022/06/wood-and-pellet-appliance-sales-surge.html**

Figure 3 – Historic heating fuel price trend graph



Over the past 21 years, wood fuels have been reliably lower cost fuels, saw less price volatility and increased in price at a slower pace than fossil heating fuels.

Figure 4 – Graph showing the historic trend correlation between oil prices and EIA estimates of wood fuel use in Vermont.



While the graph above shows a high degree of correlation between oil prices and estimates of wood heating usage, it does not mean there is causality. EIA methods are also opaque and may factor heating oil prices in their methodology to estimate how much wood is used in given regions.

2.2 Estimate of Total Wood Heating Provided by Advanced Wood Heat

When considering all the information presented in this assessment, the emergence of the nascent advanced wood heat sector in Vermont remains small in comparison to the sheer number of homes that continue to heat (in whole or part) with cordwood and bagged pellet stoves. Automated wood heat (automated systems using bulk wood pellets and woodchips) occupies a share of total wood heat that ranges from 0.5% in the residential sector to approximately 98% for the commercial and institutional sector (in terms of total Btu of energy, Figure 5).

Figure 5- Wood heat consumption (trillion Btu) for traditional and advanced wood heat, by sector in 2014.

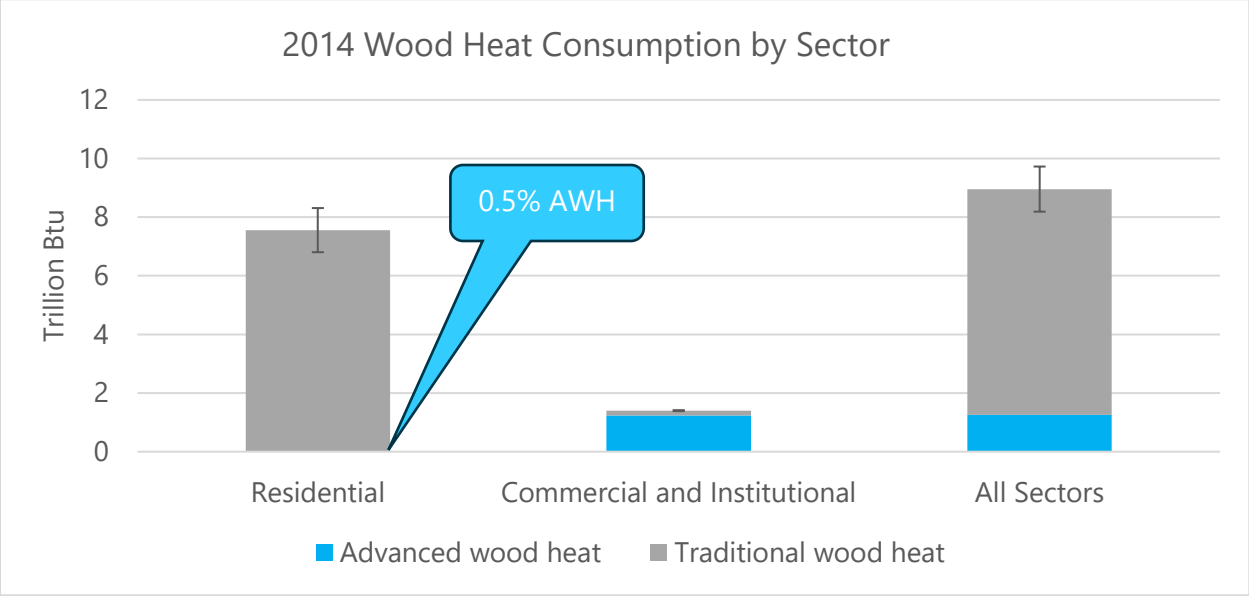


Figure 6 - Wood heat consumption (trillion Btu) for traditional and Advanced Wood Heat, by sector in 2020.

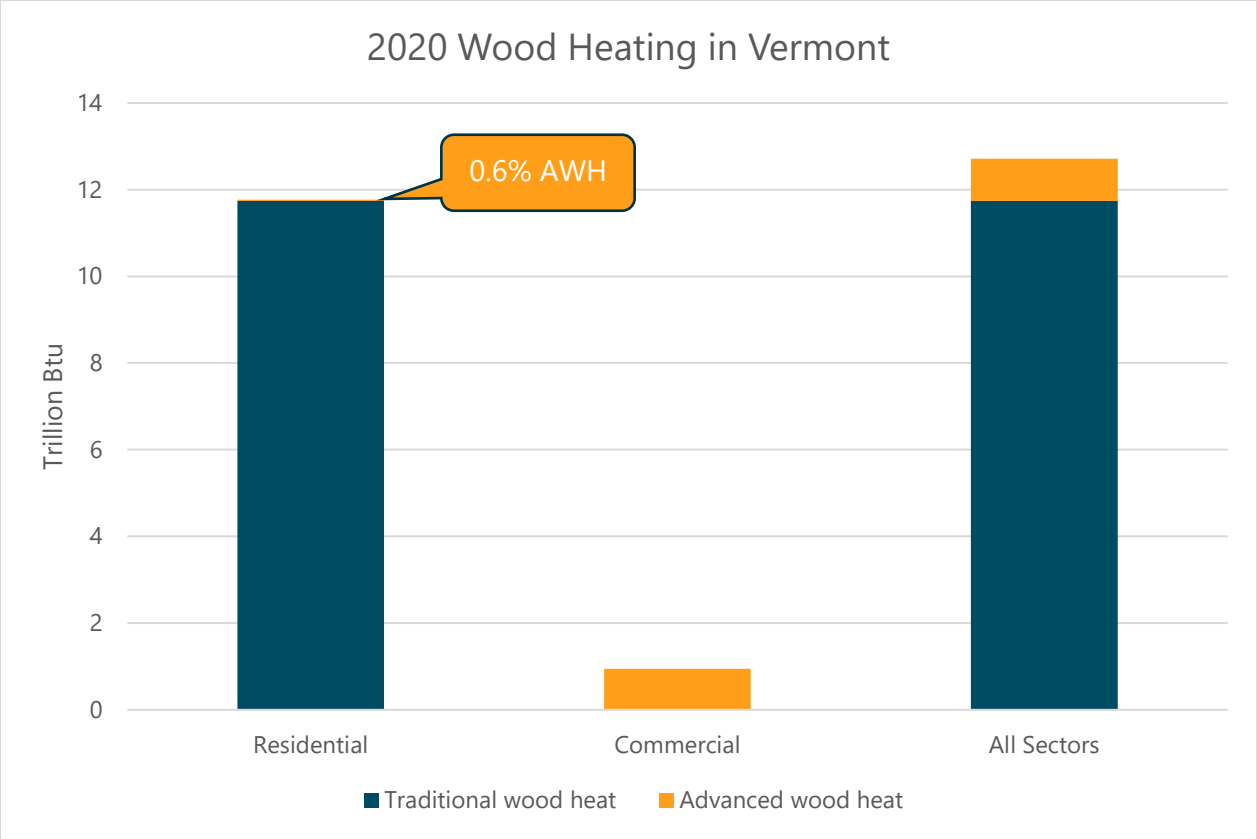


Figure 6 illustrates that residential heating market segment is dominated by traditional wood fuels and appliances -- there is a thin sliver of yellow at the top of the residential bar, but it is almost imperceptible. By contrast, the commercial sector almost exclusively uses automated wood heat fuels and systems.

Vermont has an estimated 262,500 households.[14] In the residential sector, approximately 111,856 households[15] heat with wood as their primary source of heat and only 680 are estimated to have an automated wood heat system, which is equal to only 0.6% of households heating with wood.

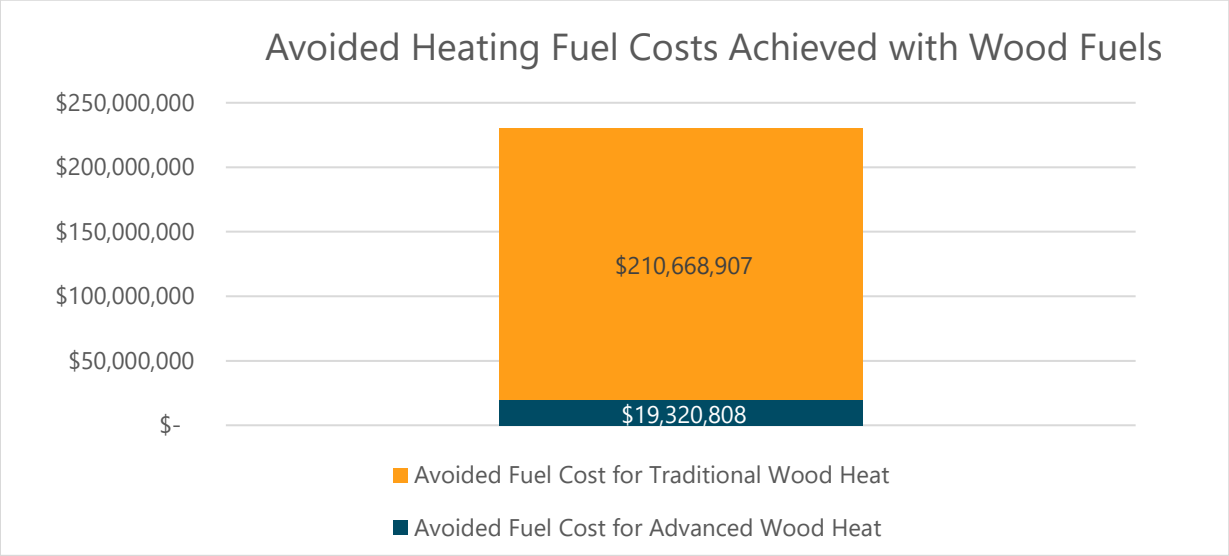
2.3 Economic Impact of Total Wood Heat

The price of cordwood fluctuates widely from cut-your-own with no direct cost to kiln-dried firewood at a premium cost. Applying an average cost per cord of firewood of $250, annual revenue associated with cordwood production and sale is approximately $90 million. Bagged pellet fuel annual expenditure is estimated at nearly $45 million. The cordwood and bagged pellet stove markets account for approximately $135 million in annual fuel expenditure. By comparison, bulk pellets and wood chips fuels used in heating systems in Vermont account for an estimated $9 million in annual sales.

If Vermont homeowners, businesses, and institutions were not using wood fuels to heat buildings and burned heating oil instead, millions of dollars more would be spent on heating. The financial savings associated with heating with all forms of wood fuel rather than with heating oil were estimated at approximately $230 million annually (based on current fuel prices) as illustrated in Figure 8. This annual savings estimate is subject to change as fossil fuel prices change continuously.

[14] US Census, 2017-2021
[15] Vermont Residential Fuel Assessment, 2018/2019

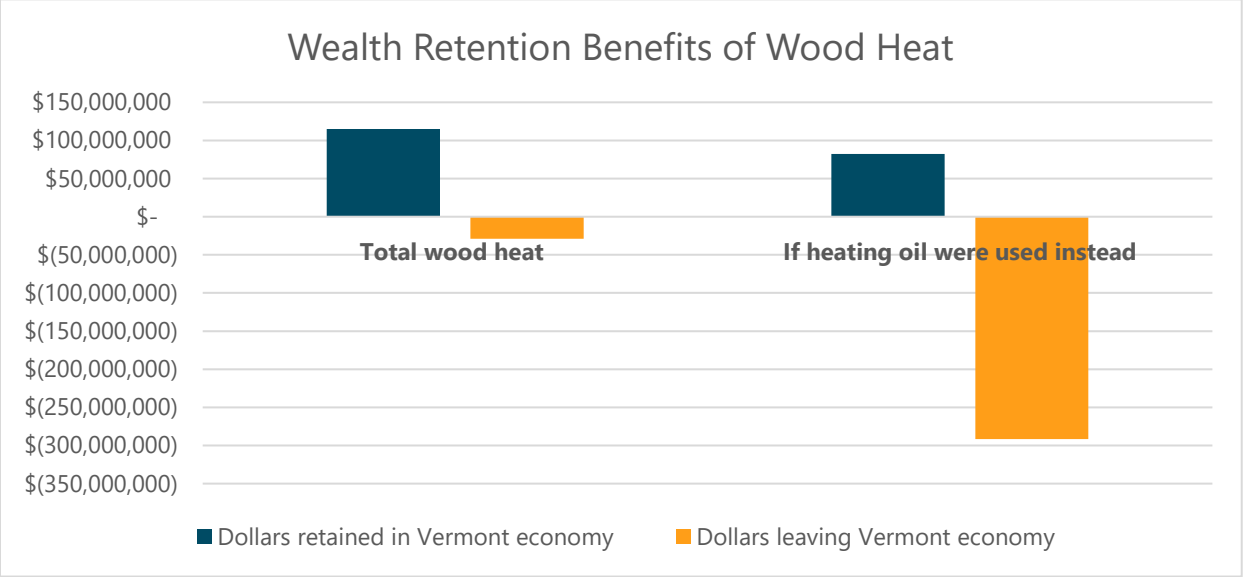
Figure 7: Estimated avoided heating fuel costs in 2020.



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,[16] a net $70 million was retained in the Vermont economy in 2020 as a direct result of heating buildings in Vermont with wood fuels rather than fossil fuels (Figure 9).

Figure 8: Dollars retained in the Vermont economy, heating fuel only.



[16] Heating the Northeast with Renewable Biomass, A Vision for 2025, 2010, **https://www.biomassthermal.org/resource/pdfs/heatne_vision_full.pdf** p.35, based on EIA data

Section 3 - Conclusions

In the six years since the original 2016 Wood Heat Baseline Assessment, the portion of the total space heating needs in Vermont met with wood fuels has increased from 21% to 23.5%. While the use of wood fuels has increased in recent years and there has been modest growth in the number of new heating appliances installed, a large portion of the increase is likely due to higher consumption of wood fuel per household. The 2018/2019 Residential Fuel Assessment reported increases in both the primary heating category (from 4.8 to 5.7 cords per home from 2014/2015 to 2018/2019) and the supplemental heating households (from 2.1 to 2.3 cords per home from 2014/2015 to 2018/2019).

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 $90 million. The fuel cost savings associated with heating with all wood fuels rather than with heating oil are an estimated $230 million annually. A net $86 million was retained in the Vermont economy in 2022 by Vermonters and Vermont businesses and institutions choosing to heat with wood rather than fossil fuels.

Between 2014 and 2020, oil and propane prices were consistently low, and this sustained period of low fossil heating fuel prices likely curbed the rate of market adoption of advanced wood heat. Further review and analysis of the wood heating industry is presented in the separate companion report entitled, "*2022 Update: Advanced Wood Heat Sector in Vermont*" that can be found at the Public Service Department's website.

Expanding the use of advanced wood heat is a strategy that helps Vermont make measurable progress toward the goals of the 2022 CEP, Vermont's greenhouse gas reduction goals, forest management and economic development targets. Tracking the development of wood heat allows the State of Vermont to measure progress toward these goals.

Looking into the future, the State of Vermont can help advanced wood heat 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 the advanced wood heat market in the future include:

- The price of fossil fuels. That price this will affect the price competitiveness 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 advanced wood heat 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 advanced wood heat.

- Future weather conditions and how cold the heating seasons will be. This will contribute to determining the economic return on the investment of switching to advanced wood heat.
- State policies supporting advanced wood heat. Policies have the potential to increase the rate of adoption compared to the "business as usual" scenario.
- The rate of automated wood heat technology adoption by early adopters and the broader knowledge and acceptance of the automated wood heat technology. This will affect the pace of the transition of automated wood heat 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 wood depending on the price of competing fuels (and other factors).