



Vermont Clean Energy Development Fund - Wood Heating Programs

ADVANCED WOOD HEAT PROGRAM EVALUATION FINAL REPORT

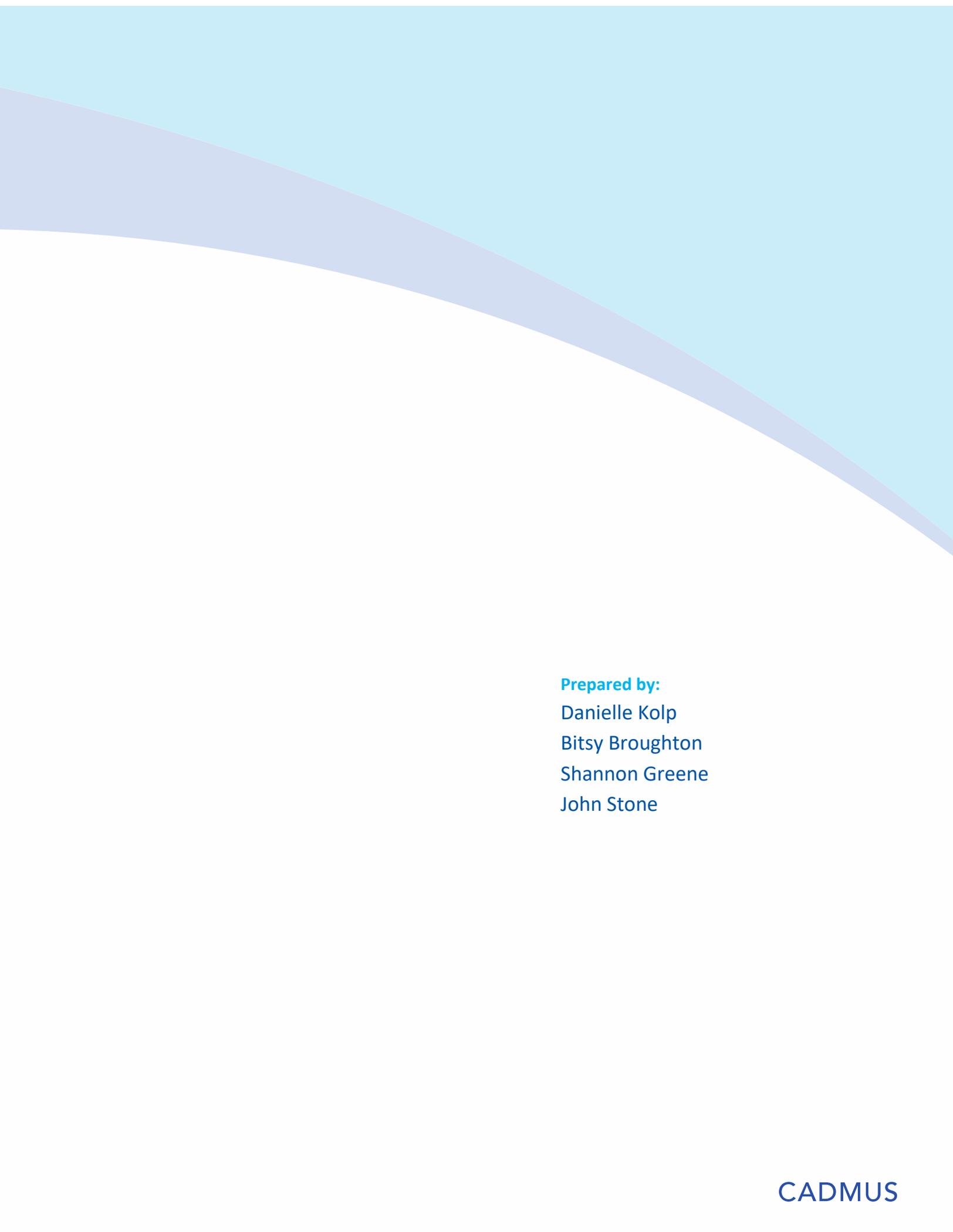
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Table of Contents

Executive Summary	1
Key Findings.....	1
Impact Evaluation	1
Process Evaluation	2
Conclusions.....	3
Impact Evaluation	3
Process Evaluation	3
Introduction	5
Program Description.....	5
Evaluation Objectives and Activities	6
Data Collection Methods	8
Impact Sampling and Methodology	8
Process Data Collection Methods.....	8
Advanced Wood Heating Impact Evaluation	10
Residential Analysis	10
Fuel Savings.....	10
Non-GHG Emissions Savings (Residential)	12
Greenhouse Gas Savings (Residential).....	13
Effect of Incentive Dollars (Residential).....	14
Residential Customer-Facing Cost-Effectiveness.....	14
Nonresidential Analysis	15
Fuel Savings.....	15
Non-GHG Emissions Savings (Nonresidential)	15
Greenhouse Gas Savings (Nonresidential).....	16
Effect of Incentive Dollars (Nonresidential).....	16
Overall Program Savings.....	17
Advanced Wood Heating Process Evaluation	18
Program Implementation.....	18
Program Administration.....	18
Program Outreach and Marketing.....	19

Program Funding.....	19
Data Collection and Management	19
Market Actor Experience.....	20
Changes in Vermont’s AWH Market	21
Business Impacts of the Market Changes	22
CEDF’s Impact on the Market	22
Market Actors’ View of Advanced Wood Heating Going Forward	22
Market Actor Recommendations to CEDF	23
Participant Experience.....	23
Participant Characteristics and Awareness.....	23
Equipment Selection and Installation	24
Participant Satisfaction	28
Program Benchmarking.....	34
Update of Program Recommendations – 2015 Evaluation	37
Conclusions and Recommendations.....	38
Impact Evaluation	38
Process Evaluation	38
Appendix A. Impact Assumptions	A-1
Appendix B. Status of Past Program Recommendations	B-1

Tables

Table 1. Evaluation Objectives and Activities	7
Table 2. Interview and Survey Sample and Completes.....	9
Table 3. Total Advanced Wood Heating Program Summary (Program Years 2015-2018)	10
Table 4. Annual Per-Unit Average Fuel Usage of Replaced Equipment (Based on 2015-2018 Program Respondents)	11
Table 5. Annual Per-Unit Average Fuel Usage of New Equipment (Based on 2015-2018 Program Respondents)	11
Table 6. Annual Per Unit Residential Average Fuel Savings and MMBtu Equivalents (Based on 2015-2018 Program Respondents)	12
Table 7. Total Annual Residential AWH Fuel Savings and Usage Summary (Based on 2015-2018 Program Respondents)	12
Table 8. Net Per Unit and Total Annual Emissions Savings (Program Years 2015-2018 Participation)	13
Table 9. Average Annual Per Unit and Total CO ₂ e Savings, Fossil Fuel and Net Savings ¹	14
Table 10. Total Annual Residential Fossil Fuel Savings and Net MMBtu Saved per \$1,000 Incentive Dollars (Program Years 2015-2018)	14
Table 11. Annual Residential Fossil Fuel and Net Carbon Equivalent Savings per \$1,000 Incentive Dollars (Program Years 2015-2018)	14
Table 12. Net Residential Participant Cost-Effectiveness (2015-2018)	15
Table 13. Total Annual Nonresidential Pellet Boiler Fuel Savings and Usage Summary (2015-2018 Program Years).....	15
Table 14. Fossil Fuel and Net Total Nonresidential Annual Non-GHG Emissions Savings (Program Years 2015-2018 Participants).....	16
Table 15. Average Annual Total CO ₂ e Savings, Fossil Fuel and Net Savings	16
Table 16. Annual Nonresidential Fossil Fuel Savings and CO ₂ e Saved per \$1,000 Incentive Dollars (2015-2018)	16
Table 17. Annual Fossil Fuel Savings, and CO ₂ e Saved for Residential and Nonresidential Systems (2015-2018 Program Years).....	17
Table 18. Annual Particulate Emissions Reduction for Residential and Nonresidential Systems (2015-2018 Program Years).....	17
Table 19. AWH Sales by Business Sector	21
Table 20. Benchmarked Programs	35
Table 20. Descriptions of Benchmarked Programs.....	36

Table A-1. Cost, Energy Capacity, and Carbon Equivalents Conversions.....A-1

Table A-2. Particulate Matter and Emissions Factors by FuelA-1

Table C-1. Summary and Status of 2015 Program Evaluation RecommendationsB-1

Figures

Figure 1. Key Factors Considered in Residential Participation 24

Figure 2. Benefits of Installing Equipment for Residential Participants 25

Figure 3. Where the Residential Boiler Customer Purchased Equipment 26

Figure 4. Where the Residential Stove Customer Purchased Equipment 26

Figure 5. Residential Stove Customers Previous Equipment Replaced 27

Figure 6. Residential Boiler Customers Previous Equipment Replaced 28

Figure 7. Residential Customer Previous Fuel Replaced 28

Figure 8. Satisfaction – Residential Stove Customers 29

Figure 9. Satisfaction – Residential Boiler Customers 30

Figure 10. Satisfaction – Nonresidential Boiler Customers 30

Figure 11. Likelihood of Recommendation – Residential Stove Customers 31

Figure 12. Likelihood of Recommendation – Residential Boiler Customers 32

Figure 13. Likelihood of Recommendation – Nonresidential Customers 32

Figure 14. Would the Residential Customer Purchase Again? 33

Executive Summary

Vermont Department of Public Service (PSD) contracted with Cadmus to conduct an evaluation of the Small Scale Renewable Energy Incentive Program (SSREIP), and the Advanced Wood Heat (AWH) grant programs, offered to Vermont residents from July 2013 through June 30, 2018, and to create an Access database that contains program metrics from all Clean Energy Development Fund (CEDF) wood heat projects, as well as all other CEDF program and project data. PSD sought to achieve four objectives through the evaluation:

- Estimate CEDF SSREIP AWH achievements (i.e., energy savings, environmental benefits, economic benefits, and impacts from development of an AWH systems' market)
- Assess lessons learned from CEDF program experiences
- Improve CEDF's ability to evaluate program impacts and delivery effectiveness
- Identify the role CEDF programs can play in developing a self-sustaining Vermont market for AWH systems

To achieve these stated objectives, the evaluation consisted of a materials and database review, participant surveys, program staff interviews, stakeholder interviews, and data analysis to determine fuel savings, CO₂e reductions, and cost reductions for participants.

Key Findings

Cadmus used responses to a survey of 105 Vermont residents and nine stakeholder interviews to analyze program impacts and distill process findings. Because a sample was used, and not all analysis categories achieved a high level of responses, the findings presented in this report should be viewed as approximate.

Impact Evaluation

Fuel and Greenhouse Gas (GHG) Savings

- Overall, the AWH programs have contributed to the reduction of over 500,000 gallons of heating oil and propane annually, translating into over 6,400 metric tons of CO₂e avoided emissions. In aggregate, the programs reduced particulate matter (PM) 2.5 by 43,000 pounds and sulfur dioxide by 20,000 pounds every year, with a net increase in nitrogen dioxide.
- Residential wood stove participants mainly offset cord wood use with their new systems, reporting an average reduction of nearly a whole cord annually, plus a small amount of fuel oil. Pellet stove participants replaced nearly four cords of wood with just under three tons of pellets. Pellet boiler¹ participants saved on use of a wider variety of fuels, including fuel oil and

¹ In this report, the term pellet boiler is used for all pellet central heating systems and therefore includes pellet furnaces.

propane. Pellet boiler participants reduced on average nearly two cords, over 500 gallons of oil, and over 80 gallons of propane annually.

- Residential wood stoves reduced more PM 2.5, carbon monoxide, nitrogen dioxide, and volatile organic compounds (VOCs) than did pellet stoves and boilers. Pellet boilers reduced the greatest amount of sulfur dioxide emitted but increased the amount of nitrogen dioxide emissions. Overall, the evaluation estimated that the 329 residential units that received incentives from 2015 to 2018 reduced a total of over 50,000 pounds of PM 2.5, 370,000 pounds of carbon monoxide, 2,500 pounds of sulfur dioxide, and 89,000 pounds of VOCs (while increasing nitrogen dioxide by 6,000 pounds) every year.
- Per unit, residential pellet boilers offset the most carbon dioxide equivalent (CO₂e), saving an order of magnitude more CO₂e for fossil fuel and overall net per \$1,000 incentive dollars than did wood and pellet stoves.
- Because residential pellet boilers offset so much fossil fuel usage, the program offset 200 gallons of fossil fuels for every \$1,000 incentive dollars, followed by 23.5 gallons from wood stoves. However, because of the increase in pellet usage, the overall MMBtu savings was greatest for pellet stoves (26/\$1,000) and wood stoves (19/\$1,000), but only 4 MMBtu/\$1,000 for pellet boilers.
- After factoring in the incentive, residential wood stoves exhibited a payback period for customers of seven years, pellet stoves of 14.5 years, and pellet boilers of 41 years (due to the low cost of oil and propane).
- The AWH programs provided incentives to 45 nonresidential systems that together had an output of 18.6 million Btu/hr. Annually, these systems saved over 450,000 gallons of oil and 9,000 gallons of propane. The local pellet market is now bolstered by over 5,000 tons burned by these systems. Net carbon equivalent savings are estimated to be around 4,200 metric tons CO₂e.

Process Evaluation

Customer Participation and Satisfaction

- Residential customers said their top three considerations for participating in the program were efficiency, rebates, and environmental benefits/reduced emissions. These considerations aligned with the reported benefits of installing equipment. Note that customers also frequently reported an increase in comfort.
- Nonresidential customers said their top three considerations for participating in the program were receiving incentives, receiving new technologies, and reducing environmental impacts.
- Satisfaction was high across stove and boiler customers. The average satisfaction rating for the residential stove customers' overall experience was 9.1 (out of 10) and the average rating for likelihood of recommending the program was 9.4. The average satisfaction rating for the residential boiler customers' overall experience was 9.4, and the average rating for likelihood of recommending the program was 9.7.

- Eighty-three percent of customers said they would definitely purchase the same AWH equipment again, and 16% said *maybe*. The majority of customers who responded with *maybe* stated they would want to look into newer technology.

Program Implementation and Delivery

- The program functioned as it was designed, and both participants and market actors are satisfied with program administration. Nevertheless, both groups would like to see more marketing and information about the program.
- The CED Board is aware that consistent, permanent funding for the program is needed but currently unlikely.
- CEDF AWH program managers did not work on the program fulltime and thus prioritized their limited time and program funding to program delivery (funding of grants and incentives) over program management (data collection, program marketing, vendor engagement).
- Data collection and retention practices were inconsistent. CEDF staff recognized that past data management and reporting have been less than optimal and did not meet CED Board expectations.

Conclusions

Impact Evaluation

Fuel and Greenhouse Gas (GHG) Savings

- Cord wood stoves were the most popular measure among residential customers and exhibited the shortest payback period of seven years, given current fuel prices, and the greatest overall particulate emissions reductions. Although not responsible for the greatest CO₂e savings (in total or per incentive dollar like the pellet boilers), cord wood stoves do produce sizable GHG emission reductions and the highest non-GHG reductions and were the most cost-effective option for residential measures.
- If the priority is to offset the greatest amount of fossil fuels, then pellet boilers (both residential and nonresidential) are the primary measure to achieve that goal. In addition, the pellet manufacturing and distribution market experiences the greatest benefit.
- The AWH program sufficiently tracked program spending, system costs, incentive costs, and leveraged funds but could be better at tracking savings impacts.

Process Evaluation

Customer Participation and Satisfaction

- CEDF staff have been able to influence AWH equipment installation, satisfy customers and vendors, and support the market for AWH while working within the constraints of limited staff hours and fluctuating funding sources.

- AWH participants were highly satisfied with the program, their new equipment, and the incentive. Vermonters are driven to program participation for efficiency and environmental reasons, and market actors are committed to furthering the market in Vermont.
- The AWH market continues to see large benefits from the program activities. Program equipment and service providers are satisfied with the program, and some reported that sales would not be able to maintain current levels without the program.

Program Implementation and Delivery

- CEDF staff's prioritization of program delivery over data collection hindered their ability to evaluate and report on program performance. Although evaluation and reporting should benefit significantly from the new Access database currently being developed, the data collected for each project should be as consistent and complete as possible.
- Program data tracking and evaluability is significantly improved when project data for each customer are tied to a unique anonymous identifier such as a number. This identifier allows customers to be tracked across multiple sources of data and reduces duplication of projects or leaving out a project.
- Reevaluation of program data collection and tracking is warranted in one year. Should the AWH program receive additional funding, CEDF may want to reevaluate data collection in one year to document improvements and identify any lingering data issues to be addressed.
- The program will benefit from documentation and tracking of key performance indicators (KPIs). CEDF commissioned a baseline study in 2016 that tracked program lagging and leading indicators as suggested in its 2015 program evaluation. CEDF is not consistently tracking either, although it plans to contract a new study in 2021 (if funding is available) to better understand progress in the market. In the interim, if CEDF and the CED Board identify a few key indicators and CEDF regularly tracks these it can more easily identify and report year-over-year program accomplishments, adjust the program focus to target specific equipment, or redirect its funding to areas of the market requiring additional support.

Introduction

The Vermont Small Scale Renewable Energy Incentive Program (SSREIP) is an incentive program designed and funded by the Clean Energy Development Fund (CEDF), currently providing incentives for advanced wood heating. Vermont Department of Public Service (PSD) tasked Cadmus to focus on the AWH program and provide a data driven estimate of the SSREIP AWH achievements as measured by energy savings, environmental benefits, and economic benefits of developing the advanced wood heating market in Vermont. Additionally, the PSD and CEDF staff sought Cadmus' perspective of lessons learned from CEDF program experience and how those could be applied to improve CEDF's ability to evaluate program impacts and delivery going forward, as well as identify the role of CEDF programs in developing a self-sustaining market for advanced wood heat in Vermont.

Program Description

Through SSREIP, participants in CEDF's AWH Program who purchased an eligible efficient wood pellet boiler for their homes or small businesses (<5,000 square feet of heated space), could qualify to receive a flat rate AWH incentive in the form of a discount to the cost of the equipment when installed in the State of Vermont by an Efficiency Excellence Network contractor.² These projects were also eligible for an additional incentive through Efficiency Vermont (EVT) operated by Vermont Energy Investment Corporation (VEIC) as one of three energy efficiency utilities authorized in Vermont.³ CEDF also offered incentives to customers who purchased through a participating retailer, new EPA-certified cord wood or pellet stoves, to replace old non EPA-certified wood stoves. The incentive was paid to the retailer, who provided an equivalent discount to the customer. Additionally, CEDF offered Vermonters of moderate and low income, located in Windham and Rutland counties, incentives to change out old cord wood stoves (or propane or kerosene heaters) for new pellet stoves, or when no prior stove existed.

During the evaluation period, CEDF also offered grants to local schools and housing groups to support clean, renewable biomass heat, and additional grants for improving bulk wood pellet infrastructure and delivery.

From 2015 to 2018 CEDF offered non-residential customers an incentive of \$1.25 per square foot of heated space. In 2018 EVT began offering a similar non-residential incentive and CEDF ended their program. As a result, non-residential participants installing qualifying pellet or boiler systems that served over 5,000 square feet of heated space can now qualify for incentives directly from EVT and a discount on equipment paid by CEDF to the contractor who passes that through to the participant.

² A network of independent contractors, who are experts in advanced technologies and building sciences. Customers participating in the EVT or CEDF AWH programs must use an Efficiency Excellence Network member contractor to install their advanced wood heating equipment.

³ Efficiency Vermont operates an advanced wood heating program similar to that offered by CEDF. Participants installing qualifying equipment may receive incentives from both programs.

Evaluation Objectives and Activities

CEDF and VEIC provided program documents and participant databases, spanning July 2013 through June 2018. Cadmus reviewed these documents to identify gaps in information, as well as calculate the customer-facing cost-effectiveness of different stoves and boilers rebated through the program.

Cadmus then conducted in-depth interviews with CEDF staff; AWH program stakeholders (i.e., past and present CED Board members, VEIC program management staff); and market actors (i.e., AWH equipment and fuel vendors, a Biomass Energy Resource Center [BERC] program consultant).⁴ BERC is a program of VEIC and consults with VEIC AWH program management and CEDF staff.

To determine the customer's experience participating in the AWH incentives, Cadmus conducted an online survey with residential and nonresidential participants who received rebates for installing advanced wood heating equipment. Cadmus also benchmarked CEDF's SSREIP AWH offering against similar programs offering incentives for implementing wood and biomass in the northeastern United States and southeastern Canada.

Working directly with CEDF, Cadmus' subcontractor, Stone Environmental, Inc., began developing a Microsoft Access database to hold all CEDF historical and future project data.

Table 1 describes activities taken to meet the evaluation's objectives, as outlined by Vermont PSD and CEDF staff.

⁴ The Biomass Energy Resource Center (BERC) is a program of VEIC. BERC works to advance the use of community-scale biomass energy throughout North America and beyond by providing technical consulting services, biomass energy program design and delivery, and education and outreach on benefits and best practices. Retrieved from <https://www.biomasscenter.org/company/about-us>

Table 1. Evaluation Objectives and Activities

PSD Evaluation Objectives	Program Documents and Database Review	CEDF Staff Interviews	Stakeholder Interviews	Market Actor Interviews	Participant Online Surveys	Program Savings Analysis	Customer-Facing Cost Effectiveness	Benchmark AWH Program	Meeting with CEDF	Reporting
1. Evaluate CEDF activities related to AWH	✓	✓	✓				✓			✓
2. Assess CEDF AWH program benefits (energy, environmental, economic, market benefits)	✓		✓	✓	✓	✓	✓	✓		✓
3. Evaluate program design and management effectiveness				✓		✓		✓		✓
4. Assess lessons learned		✓	✓	✓	✓					✓
5. Create Access database for all CEDF awards	✓								✓	✓

Data Collection Methods

Impact Sampling and Methodology

The impact evaluation, designed to determine fossil fuel savings, relied on three main activities:

- The online participant surveys
- The participant database review
- The data analysis (designed to determine average fuel usage after installation of new advanced wood heating equipment, when compared to the fuel usage of the replaced equipment)

Cadmus determined averages for each sector and measure, and then extrapolated the averages to the population to determine the full annual realized savings. This method was the most reasonable and feasible given the varied participants and availability of tracking data and contact information, however, when using sampled data for very small populations, nonresponse can contribute to higher variation and therefore less precision. The results presented in this report are estimates and should therefore be interpreted as such.

Process Data Collection Methods

Given the small participant population sizes, Cadmus did not perform sampling, instead attempting the full census of available unique participants with contact information. Response rates between ten and twenty percent for on-line surveys are typical. Low participant response rates for the residential pellet stoves and nonresidential systems presented a challenge to the evaluation. For example, the residential pellet stove participants did not report any fossil fuel usage offset, and therefore those results are used but may not accurately reflect the greater population. The nonresidential responses were also low, but presented less of an issue because CEDF program tracking data recorded expected post-fuel usage more consistently that was used to calculate savings. Table 2 provides details of the interview and survey activities.

Table 2. Interview and Survey Population and Completes

Data Collection Activity	Population ^a	Achieved Completes	Response Rate
CEDF Program Management Staff Interviews	N/A	2	N/A
CED Board Members and VEIC Staff Interviews	N/A	3	N/A
Market Actor Interviews	9	4	44%
Participant Online Survey - Residential Cord Wood Stove	219	68	31%
Participant Online Survey - Residential Pellet Stove	28	4	14%
Participant Online Survey - Residential Pellet Boiler	82	25	30%
Participant Online Survey - Nonresidential Systems	45	5	11%

^a Not all participants had valid contact information, but Cadmus attempted to contact all who did.

Advanced Wood Heating Impact Evaluation

The impact evaluation focused on annual fuel savings produced from program incentives, GHG reduction, particulate reductions, and customer payback. Fuel savings is the difference between the quantity and type of fuel used prior to program participation and the quantity and type now used with the program incentivized efficient unit. All of the post-usage data for residential measures come from survey response estimates, and the majority of the nonresidential usage was pulled from program tracking which is also an estimate. The findings and analysis presented in this section are therefore based on imprecise estimates. Table 3 summarizes total systems, rated capacity, and incentives dispersed.

Table 3. Total Advanced Wood Heating Program Summary (Program Years 2015-2018)

Sector/Measure	Number of Systems	Total Rated Capacity (Btu/Hr)	Total Incentives
Residential Cord Wood Stoves	219	Not Available	\$266,000
Residential Pellet Stoves	28	Not Available	\$40,500
Residential Pellet Boilers	82	6,202,150	\$257,345
Nonresidential	45	18,639,918 ^a	\$1,494,574
Total	374		\$2,058,419

^aThis is a conservative value, as four projects' capacity were not listed.

Results are provided for the residential and nonresidential analysis separately in the following sections.

Residential Analysis

Fuel Savings

To determine annual fuel savings for each measure, Cadmus utilized available data gathered by the program implementer that addressed pre-installation equipment fuel usage, combined with and verified through the online participant surveys. Though the response rate was reasonable for a data collection effort of this size and program age, the population was quite small and not all analysis categories had robust responses (such as residential pellet stoves and nonresidential systems) and therefore overall analysis results should be viewed as approximate. Cadmus derived post-installation fuel usage estimates solely from the survey responses. Table 4 provides the fuel usage of the old, replaced equipment (on average) for each measure type installed.

**Table 4. Annual Per-Unit Average Fuel Usage of Replaced Equipment
(Based on 2015-2018 Program Respondents)**

Sector	Measure Installed	Survey Responses ^a	Cords	Fuel Oil (gal)	Propane (gal)	Pellet (ton)
Residential	Wood Stove Respondents	68	4.0 ^b	28.5 ^b	-	-
	Pellet Stove Respondents	4	3.9 ^c	-	-	-
	Pellet Boiler Respondents	25	1.8 ^b	540.9 ^b	86.3 ^b	0.3 ^b

^a Survey respondent counts may vary from counts discussed in the Process section due to non-response to fuel usage questions.

^b Value derived from survey responses.

^c Value derived from program tracking data.

Table 5 shows average fuel usage of the new equipment, per unit. All values were derived from the survey.

**Table 5. Annual Per-Unit Average Fuel Usage of New Equipment
(Based on 2015-2018 Program Respondents)**

Sector	Measure Installed	Survey Responses	Cords	Pellet (ton)
Residential	Wood Stove	68	3.2	-
	Pellet Stove	4	-	2.9
	Pellet Boiler	25	-	7.1

Table 6 shows average per-unit fuel savings for each residential measure type (note: for pellet stoves and boilers, the negative tons of pellets indicates the usage increase). For residential wood stoves, residents went from using, on average, 4.1 cords of wood to using 3.2 cords with the new unit. Consequently, average savings were 0.9 cords per wood stove. In addition, a few participants offset their oil usage as well, accounting for an average of 28.5 gallons per stove.

The pellet stove participants indicated previously using cord wood for heat, then reported (on average) pellet usage around 2.9 tons annually. Prior to using a pellet unit, boiler participants used a combination of cord wood, fuel oil, propane, and pellets. Currently, pellet boiler participants report using an average of 7.1 tons of pellets. MMBtu reduction from fossil fuels,⁵ overall reduction, and net MMBtus reduced (this includes the additional pellets burned) are also shown for an average unit.

⁵ MMBtu conversions used include: 22.0 MMBtu/cord of wood, 16.4 MMBtu/ton of pellets, 0.138 MMBtu/gallon of fuel oil #2, 0.092 MMBtu/gallon of propane. These values are taken from the 2016 Vermont Fuel Price Report, January 2016, available online: https://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Fuel_Price_Report/2016/January%202016%20Fuel%20Price%20Report.pdf.

**Table 6. Annual Per Unit Residential Average Fuel Savings and MMBtu Equivalents
(Based on 2015-2018 Program Respondents)**

Measure Installed	Average Per Unit Fuel Savings			Pellet (ton)	Fossil Fuel MMBtu Reduced	All Fuel MMBtu Reduced	Net MMBtu Reduced
	Cords	Fuel Oil (gal)	Propane (gal)				
Wood Stove	0.9	28.5	-	-	4	23	23
Pellet Stove ^a	3.9	-	-	-2.9	N/A	64	16
Pellet Boiler	1.8	540.9	86.25	-6.78	83	128	17

^a Although pellet stoves routinely offset fossil fuels, two survey attempts did not yield any respondents that reported previous fossil fuel usage and is therefore not included in this analysis.

Table 7 shows extrapolated average unit results by measure type to the population of each residential measure. Per year, the program saved 219 wood stove participants 193 cords of wood (i.e., pre-usage of 767 and post-usage of 681) and 6,233 gallons of fuel oil. The 28 pellet stoves offset 109 cords of wood by burning 81 tons of pellets, and the 82 pellet boilers offset 150 cords of wood, 44,354 gallons of fuel oil, and 7,073 gallons of propane annually, with an increase of 556 tons of pellets burned. MMBtu reduction from fossil fuels, overall reduction, and net MMBtus (this includes the additional pellets burned) reduced are also shown.

**Table 7. Total Annual Residential AWH Fuel Savings and Usage Summary
(Based on 2015-2018 Program Respondents)**

Measure Installed	Count	Cords	Fuel Oil (gal)	Propane (gal)	Pellet (ton)	Fossil Fuel MMBtu Reduced	All Fuel MMBtu Reduced	Net MMBtu Reduced
Wood Stove	219	193	6,233	-	-	861	5,103	5,103
Pellet Stove ^a	28	109	-	-	-81	N/A	2,402	1,071
Pellet Boiler	82	150	44,354	7,073	-556	6,778	10,070	952
Total	329	452	50,587	7,073	-637	7,639	17,575	7,126

^a Although pellet stoves routinely offset fossil fuels, two survey attempts did not yield any respondents that reported previous fossil fuel usage and is therefore not included in this analysis.

Non-GHG Emissions Savings (Residential)

Table 8 quantifies net annual emissions of particulate matter 2.5 micrometers or less in diameter (PM 2.5), carbon monoxide (CO), nitrogen dioxide (NOx), sulfur dioxide (SO₂), and volatile organic compounds (VOCs), including emissions from pellet burning, in total and per-unit values (see Appendix A for assumptions). Note that the table shows the emissions on average per unit before the newly installed equipment, then the new equipment emissions, then the difference between the two. Negative values indicate increased emissions for a given variable. The annual total for all program installations is shown last for each residential measure.

On a per-unit basis, a residential wood stove produces the greatest reduction in all emissions metrics except for SO₂, though pellet stoves are a close second in regard to PM 2.5, CO, and VOCs. The pellet boilers exhibit the largest decrease in SO₂, however it is the only measure that had any sizable SO₂

emissions (from the fossil fuels used in the old boilers), and had smaller decreases for PM 2.5, CO and VOCs because the previous emissions were not as high as the other measures. Both pellet stoves and pellet boilers exhibit an increase in NOx emissions, more so for pellet boilers given the greater amount of pellets used. Overall, PM2.5, CO, SO₂, and VOCs are reduced from the previous equipment usage as a result of the program.

Table 8. Net Per Unit and Total Annual Emissions Savings (Program Years 2015-2018 Participation)

Measure	Metric	PM 2.5 (lbs)	CO (lbs)	NOx (lbs)	SO ₂ (lbs)	VOC (lbs)
Residential Wood Stove	Per Unit - Previous Equipment Emissions	197.5	1,489.8 ^a	18.6	3.8	342.1 ^a
	Per Unit - New Equipment Emissions	3.6	102.5 ^a	12.1	2.0	4.3 ^a
	Per Unit - Particulate Reduction	194.0	1,387.3	6.5	1.8	337.8
	Annual Total for 219 Units	42,485	303,829	1,425	387	73,978
Residential Pellet Stove	Per Unit - Previous Equipment Emissions	187.5	1,414.5	17.2	2.5	324.8
	Per Unit - New Equipment Emissions	12.9	120.9	42.3	1.2	0.1
	Per Unit - Particulate Reduction	174.6	1,293.6	-25.2	1.2	324.7
	Annual Total for 28 Units	4,890	36,220	-705	34	9,091
Residential Pellet Boiler	Per Unit - Previous Equipment Emissions	90.0	668.7 ^a	17.0	29.0	72.2 ^a
	Per Unit - New Equipment Emissions	31.5	295.1 ^a	103.4	3.0	0.3 ^a
	Per Unit - Particulate Reduction	58.6	373.6	-86.4	26.0	71.9
	Annual Total for 82 Units	4,803	30,634	-7,085	2,132	5,898
Residential	Annual Grand Total	52,178	370,684	-6,365	2,553	88,967

^a CO and VOC emissions not available for fuel oil or propane and are omitted.

Greenhouse Gas Savings (Residential)

To accurately reflect the GHG life cycle of each fuel, the carbon dioxide equivalent (metric ton CO₂e / MMBtu) included four elements: extraction and recovery, processing and refinery, transportation, and end-use combustion (see Appendix A for details).

Table 9 provides the average annual CO₂e savings for each advanced wood heat unit installed and the overall program total. It also shows the avoided CO₂e for the fossil fuels saved, as well as the net overall CO₂e, which includes the additional pellets burned. Cord wood stoves offset .352 metric tons of CO₂e per unit from fossil fuels, and .622 metric tons overall when the cord wood is included. Pellet stove respondents reported no fossil fuel savings; however, they save .328 metric tons per unit overall from the difference between reduced cord wood and increased pellets. Because the pellet boilers offset a great deal of oil and propane, the savings are the greatest for that measure across the board.

Table 9. Average Annual Per Unit and Total CO2e Savings, Fossil Fuel and Net Savings^a

Measure Installed	Per AWH Unit (metric tons CO2e)		Total (metric tons CO2e)	
	Fossil Fuel Savings	Net Fuel Savings	Fossil Fuel Savings	Net Fuel Savings
Wood Stove	.352	.622	77	136
Pellet Stove	N/A	.328	N/A	9
Pellet Boiler	7.296	5.830	598	478
Total	N/A	N/A	675	623

^a Fuel savings derived from participant surveys.

Effect of Incentive Dollars (Residential)

Table 10 shows the gallons of fossil fuels (fuel oil and propane) offset by \$1,000 incentive dollars, as well as the net MMBtus saved per \$1,000 incentive dollars. The pellet boiler measure saves the most fossil fuels per dollar, followed by wood stoves (pellet stove participants reported no fossil fuel usage offset). However, pellet stoves followed by wood stoves have the highest overall net MMBtus saved, with pellet boilers trailing behind due to the higher amount of pellets burned in the new system.

Table 10. Total Annual Residential Fossil Fuel Savings and Net MMBtu Saved per \$1,000 Incentive Dollars (Program Years 2015-2018)

Measure	Fossil Fuel Gallons/ \$1,000 Incentive	Net MMBtu/ \$1,000 Incentive
Wood Stove	23.5	19.2
Pellet Stove	N/A	26.4
Pellet Boiler	199.8	3.7

Table 11 shows the CO2e offset per \$1,000 incentive dollars spent, for both the fossil fuel derived offset, as well as net CO2e (accounting for pellet burning). In both cases, the pellet boilers offset the most CO2e, followed by wood stoves.

Table 11. Annual Residential Fossil Fuel and Net Carbon Equivalent Savings per \$1,000 Incentive Dollars (Program Years 2015-2018)

Measure	Fossil Fuel Metric Tons CO2e/ \$1,000 Incentive	Net Metric Tons CO2e/ \$1,000 Incentive
Wood Stove	.290	.512
Pellet Stove	N/A	.227
Pellet Boiler	2.325	1.858

Residential Customer-Facing Cost-Effectiveness

Table 12 provides total incentives granted by the programs, total reported system costs, net fuel costs (including fuel savings and new fuel costs) and payback period (calculated as the system cost less the incentive, divided by net fuel cost savings per year). This high-level analysis did not capture an important

element: increased comfort or reliability of new advanced wood heating systems, as perceived by participants (reported qualitatively in the Participant Experience section), as well as a historically stable pellet fuel price. Cord wood stoves offered the best payback (seven years), a perception apparently realized by the market given the largest number of systems installed by residents.

Table 12. Net Residential Participant Cost-Effectiveness (2015-2018)

Measure	Count	Total Incentives	Total System Cost	% of Upfront Cost Incentivized	Leveraged Funds (Private \$/CEDF \$)	Net Annual Fuel Savings ^a	Payback Period (Yrs)
Wood Stove	219	\$265,750	\$726,968	36.6%	1.74	\$65,780	7.0
Pellet Stove	28	\$40,500	\$124,460	32.5%	2.07	\$5,782	14.5
Pellet Boiler	82	\$257,345	\$1,879,040	13.7%	6.30	\$38,854	41.7

^a Cost assumptions: cord of wood \$250, ton of pellets \$265, gallon of fuel oil \$2.82, and gallon of propane \$3.35.

Nonresidential Analysis

Fuel Savings

As noted above, only five surveys were completed for the nonresidential projects. Like residential, the survey asked about pre- and post-installation fuel type and quantity. A fairly large proportion of projects had fuel savings and expected pellet usage recorded in the tracking data. As such, Cadmus used these data and filled in missing values with an extrapolation of averages from the present data. Lastly, because these projects are so heterogeneous in size, per project averages are not as illustrative as on the residential side, and therefore Table 13 shows totals for fuel offset and usage (negative pellet/chip values indicate usage).

Table 13. Total Annual Nonresidential Pellet Boiler Fuel Savings and Usage Summary (2015-2018 Program Years)

Sector	Count	Fuel Oil Offset (gal)	Propane Offset (gal)	Net Pellets & Chips Burned (tons) ^a	Approximate Fossil Fuel MMBtu Reduced
Affordable Housing	15	115,687	9,188	-969	16,830
School	15	119,998	-	-1,914	16,584
Other	15	222,872 ^b	-	-2,274	30,801
Total	45	458,557	9,188	-5,157	64,214

^a Due to missing usage data, Cadmus employed extrapolation using averages to fill in blanks; these values should be viewed with caution.

^b The Other group includes one very large project of 164,000 gallons of fuel oil savings not used to extrapolate average savings for blank projects.

Non-GHG Emissions Savings (Nonresidential)

Table 14 quantifies net annual PM 2.5, nitrogen dioxide, and sulfur dioxide, including emissions from pellet burning, for the fossil fuels offset and net total values. Negative values indicate increased emissions for a given variable. The decrease in fossil fuels produces a large amount of savings for all

metrics. When pellet burning is incorporated, PM 2.5 and NOx emissions increase, however SO₂ still shows an overall annual decrease of over 17,000 pounds.

Table 14. Fossil Fuel and Net Total Nonresidential Annual Non-GHG Emissions Savings (Program Years 2015-2018 Participants)

Sector	Count	Fossil Fuel Offset			Net Total		
		PM 2.5 (lbs)	NOx (lbs)	SO ₂ (lbs)	PM 2.5 (lbs)	NOx (lbs)	SO ₂ (lbs)
Affordable Housing ^a	15	98	2,202	4,929	-5,782	-500	4,519
School ^b	15	100	2,160	5,112	-1,479	-7,317	4,327
Other ^b	15	185	4,012	9,494	-1,691	-7,248	8,562
Total	45	382	8,373	19,535	-8,952	-15,064	17,408

^a Emissions factors utilized a residential pellet boiler for pellet usage (see Appendix A for details).

^b Emissions factors utilized a pellet boiler for a school (see Appendix A for details).

Greenhouse Gas Savings (Nonresidential)

To accurately reflect the greenhouse gas life cycle of each fuel, the carbon dioxide equivalent (metric tons CO₂e / MMBtu) included four elements: extraction and recovery, processing and refinery, transportation, and end use combustion (see Appendix A for details).

Table 15 provides the average annual savings for avoided CO₂e for the fossil fuels saved, as well as the net overall CO₂e, which includes the additional pellets burned.

Table 15. Average Annual Total CO₂e Savings, Fossil Fuel and Net Savings

Sector	Total Metric Tons CO ₂ e	
	Fossil Fuel Savings	Net Fuel Savings
Affordable Housing	1,496	1,207
School	1,485	914
Other	2,759	2,080
Total	5,740	4,200

Effect of Incentive Dollars (Nonresidential)

Table 16 shows the gallons of fossil fuels (fuel oil and propane) offset by \$1,000 incentive dollars, as well as the net MMBtus saved per \$1,000 incentive dollars. The table also shows the CO₂e offset per \$1,000 incentive dollars spent, for both fossil fuel derived offset, as well as net CO₂e (accounting for pellet burning).

Table 16. Annual Nonresidential Fossil Fuel Savings and CO₂e Saved per \$1,000 Incentive Dollars (2015-2018)

Sector	Fossil Fuel Gallons/ \$1,000 Incentive	Fossil Fuel Metric Tons CO ₂ e/ \$1,000 Incentive	Net Metric Tons CO ₂ e/ \$1,000 Incentive
Nonresidential	.313	3.841	2.810

Overall Program Savings

Table 17 summarizes the annual fossil fuel savings due to the AWH programs, metric tons of CO2e for both the fossil fuels saved, and the overall net savings with additional pellet burning factored in.

Table 17. Annual Fossil Fuel Savings, and CO2e Saved for Residential and Nonresidential Systems (2015-2018 Program Years)

Sector	Number of Systems	Fuel Oil Offset Annually (gal)	Propane Offset Annually (gal)	Fossil Fuel Metric Tons CO2e Savings (Annual)	Net Metric Tons CO2e Savings (Annual)
Residential	329	50,587	7,073	675	623
Nonresidential	45	458,557	9,188	5,740	4,200
Total	374	509,144	16,261	6,416	4,824

Table 18 presents the annual particulate emissions for all systems in the AWH programs. PM 2.5 has an overall reduction of over 40,000 pounds, and sulfur dioxide of nearly 20,000 pounds every year. Nitrogen dioxide emissions are estimated to increase by around 20,000 pounds annually.

Table 18. Annual Particulate Emissions Reduction for Residential and Nonresidential Systems (2015-2018 Program Years)

Sector	Number of Systems	PM 2.5 (lbs)	NOx (lbs)	SO ₂ (lbs)
Residential	329	52,178	-6,365	2,553
Nonresidential	45	-8,952	-15,064	17,408
Total	374	43,226	-21,429	19,961

Advanced Wood Heating Process Evaluation

Cadmus designed the process evaluation to assess the effectiveness of program design and implementation, the program's impact on the market for advanced wood heat in Vermont, and where opportunities exist to further expand the market. To do this, Cadmus focused on the experiences of CEDF staff who designed and managed the AWH program, participants who received incentives through the program, and contractors and retailers providing and installing advanced wood heating equipment.

Additionally, participants were asked about their awareness of the program, barriers they may have encountered while purchasing boilers or stoves and fuel, and about their levels of satisfaction with contractors and the equipment they purchased. Contractors and retailers were asked about the role of the program in the advanced wood heating market in Vermont. Finally, Cadmus spoke to two of the CED Board members who have worked with CEDF staff over time, staff at BEREC who consult to VEIC and CEDF about the AWH program, and the VEIC staff person who has administered the program paperwork day to day to gain their perspectives on program delivery and to answer questions that may determine whether AWH is funded going forward.

Program Implementation

CEDF's overall goal for the AWH program is to use an underutilized local resource (wood) and develop a self-sustaining market for advanced wood heat in Vermont, ideally, similar to the national market transformation achieved by solar. As stated by a prior CED Board member, the program also can help the state meet its energy and greenhouse gas emissions reduction goals.

To achieve the desired market transformation, CEDF applies funds to build supply-side interest in AWH (paying incentives to contractors to buy down advanced wood heating equipment costs making it more competitive against lower cost heating equipment such as fuel oil and natural gas fired boilers, furnaces and electric heat pumps). CEDF stimulates demand-side interest through grants to institutions and incentives to homeowners to purchase and install advanced wood heating systems. However, as noted by Board members, advanced wood heating does not currently enjoy the same uprising of support from interested market actors, private sector investors, or utilities that benefited solar.

Program Administration

Two PSD staff members at CEDF plan, design, budget, manage, and report on SSREIP to the CED Board, legislature, and Governor's office. The Renewable Energy Resource Center (RERC), a project of VEIC, manages the day-to-day administration of the AWH program under a contract with the PSD, providing information to consumers, processing application forms, and providing weekly reports to CEDF of incentives to be paid. Contractors fill out and submit incentive application forms to RERC along with invoices showing incentives have been passed through to the customer.

VEIC, through EVT, runs a similar wood heating program and through RERC, CEDF leverages the program similarities and VEIC's day-to-day program management efforts.

The three equipment and service providers interviewed by Cadmus considered the program well managed, stating that information proved timely and professional. One AWH equipment and service provider said the program does a particularly good job at making the rebates easy to receive for the customers.

Program Outreach and Marketing

Equipment sales and service providers and contractors provide the only marketing of the AWH program. A Board member pointed out there seems to be some discomfort in Vermont about spending money on messaging. The prevailing opinion has been to get equipment installed rather than “publish one more brochure that will land in the trash.” However, three AWH equipment and service providers interviewed by Cadmus said that they knew very well what opportunities CEDF offered and were able to easily stay informed through CEDF emails, through organizations such as Renewable Energy Vermont, meetings with the Vermont Statewide Wood Energy Team, or as members of EVT’s Efficiency Excellence Network. These three providers believed that the program could be doing a better job at marketing the incentives to customers.

Program Funding

Funds currently available for the AWH program will be expended by the end of 2020. CEDF staff and CED Board said that additional legislative funds are not included in the budget, and without a continuing funding source, it will be difficult for the program to operate beyond 2020. One Board member noted that unlike the earlier solar program in which “the money flew out the door,” uptake for AWH has been slow and begs the question: *how much money do you need to sustain AWH?* Per CEDF staff, contractors have said they would prefer a lower incentive that extends over five years to help build the market for advanced wood heating, versus a single-year incentive at a higher dollar level.

The CED Board is not under the illusion that the available funds will transform the market, but one member would like to see a modest infusion rather than “pack up the bags and go home.” A previous Board member expressed frustration over the lack of resources behind AWH compared to the level of effort being invested, noting CEDF staff are knowledgeable and well-grounded with a good strategy, but there is so little money it is difficult to know if the program is effective. This Board member further explained, “Wood heat is complicated, and it is hard to raise money.”

Data Collection and Management

CEDF data collection and management are ongoing issues for the program, and according to CEDF staff, has not improved since the last program evaluation in 2015. This is primarily due to the time and expense required to acquire software and design a new database. Database development needs to compete with other CEDF and PSD staff time priorities. CEDF staff has managed using Excel spreadsheets but said that accessing the data they need can take substantial time to assemble. CEDF staff realized the need for a new data management system, and as part of this current evaluation, contracted a new Access database to contain all historic and future program data. This new database will improve data management and allow easier reporting eliminating the need for CEDF to request analysis reports from VEIC.

VEIC manages two data systems, one for pellet boilers and one for wood stoves. The same incentive form is used for EVT and CEDF allowing VEIC to process one form for both programs. VEIC enters all rebate data into their Access database and sends CEDF a weekly report identifying the recipients to be paid by CEDF.

VEIC described the data collection process as “fine and very positive” since combining CEDF and EVT forms and reducing the amount of data collected. VEIC plans to further improve its process making it easier to input data and remove unused queries.

According to staff at VEIC, they do not use a formal quality control process with the project data; however, according to CEDF staff, VEIC reviews all paperwork and photos submitted. VEIC said prior to December 2018, it conducted site visits on 10% of installed projects. However, now that contractors are familiar with the technology and how to correctly installation it, VEIC inspects only the first two projects in the program by any contractor unless it receives complaints or has other reasons for a site visit.

Data Evaluability

Data provided by CEDF was particularly difficult to compile and evaluate, due in part to the number and types of programs, incentives and grants CEDF offered over the evaluation period, the inconsistency of the data recorded for each project, changes between years, and the manual intervention required by CEDF staff to pull together the reports needed.

Due to the many different workbooks of customer information provided by CEDF and VEIC, it was a challenge to compile all of the data. Some, but not all, data sources provided a unique customer identifier. This made it difficult for Cadmus to assess who was enrolled in the program, who they could contact for surveys, and what were the total incentive levels of the program. In total, however, the data provided were sufficient to conduct the surveys necessary to draw and support the conclusions found in this report.

Market Actor Experience

Cadmus interviewed three companies that provided some or all the equipment and services necessary to install residential and nonresidential advanced wood heating systems—primarily, but not exclusively, pellet systems. These services include system design, equipment sales, installation and servicing, financing, and wood fuel sales. To gather more whole-market information, Cadmus also interviewed staff with wood heating expertise from BEREC, who advises EVT and RERC, and whose expertise has been tapped by CEDF and the State of Vermont. Through these interviews, Cadmus asked these market actors their opinions about changes in the AWH market, past and future, about their awareness of and experience with the program and its staff and gathered their recommendations of how CEDF might improve the AWH program.

Two of the three equipment and service providers sold primarily to the residential sector (90% each); the third provider reported 75% of its sales were to the commercial sector (shown in Table 19). Each have provided AWH services and products in Vermont for more than 10 years. These providers described their interactions with CEDF staff and the program as positive, collaborative, and easy.

Table 19. AWH Sales by Business Sector

	Commercial	Residential	Years Selling in Vermont
Company 1	10%	90%	12
Company 2	10%	90%	25
Company 3	75%	25%	15

Source: VT Wood Market Actor Guide. A2. How many years have you been providing these services and products to customers in Vermont? N=3. A3. What percentage of your sales of advanced wood heat equipment, services, or fuel are to residential customers __%, to commercial customers__%? n=3.

Changes in Vermont’s AWH Market

As described by the consultant from BEREC, since 2004 there have been substantial changes with the advanced wood heating market maturing dramatically. Adding that as the market for pellet storage and boilers emerged, it became clear the State needed to incentivize procurement of commercial and residential systems and support development of the supply chain. Market growth, which started slowly in the early 2000s, experienced rapid growth from 2011 to 2016. “The expansion,” noted the consultant, “started by policy but was mostly driven by the spike in the price of oil. When oil prices dipped back down in 2016, the market slowed down a bit, but the industry knew pellet systems had gone mainstream when gas suppliers began obtaining pellet delivery systems and started servicing boilers.”

The three equipment and service providers also described how the market for advanced wood heat has changed in Vermont during the years each company had been selling equipment or services there. Their perspectives varied.

One of the equipment and fuel providers explained that more people now know about wood heating but fewer people have confidence in it, saying, “There is a lot of momentum behind heat pumps and solar, but people are confused about wood pellets and how they can be used to reduce carbon.” This provider is trying to inform customers that switching to high-efficiency wood pellet boilers can reduce one’s carbon footprint, but the national conversations about solar, electrification, and heat pumps has eclipsed this. The company attributed this to an electricity-centric federal energy policy that is driving people away from a solution they can have now (advanced wood heat) in favor of electrification. This provider added that “Only in the Northeast, U.S., is oil so heavily used for heating, so [replacing fuel oil heating] is a unique local issue that does not fall easily into the national solution, and oil remains less expensive than biomass options.”

A second equipment and services provider said the market for advanced wood heat has been “all over the map,” noting that more recently it has changed as a result of climate change awareness. Historically, this provider explained, the market was driven by the price of oil, but that has become less of a factor. Now, people are trying to both reduce their carbon footprint through local solutions and, “feeling helpless due to the current national political situation, they want to do something, and they can get rid of oil.”

The third provider said technology and customer awareness have both increased, but, according to this provider, “Not at the rate it should.”

Business Impacts of the Market Changes

All three equipment and service providers felt the impacts of the market changes in their own businesses. One saw a pellet mill in Vermont go bankrupt and close. This loss, the provider said, disheartened people and sales at the provider’s company decreased. Two employees retired and the positions will not be refilled.

The other two providers reported an increase in sales—primarily installations at one business, and a 30% increase in sales at the other, although this provider said they have “flatlined” and sales will decrease without additional incentives. They expect they will likely see an increase in sales if additional incentives are provided to bring the cost basis of advanced wood heating systems somewhat closer to fossil fuel systems, which plays a large part in decision makers commitment to switch.

CEDF’s Impact on the Market

BERC emphasized CEDF has been “absolutely critical” in bolstering the market. Since 2011, EVT had a small rebate on the cost of expensive boilers. Furthermore, BERC noted that CEDF stepped in and brought more resources to the table and increased their incentive amount which resulted in increased pressure on EVT to increase their subsidy. BERC added that CEDF has also stimulated the small commercial market by working to increase sales to businesses so that one location can provide significant savings rather than needing to supply multiple residences. BERC strongly expressed the opinion that without CEDF’s effort there would be no growth in the sector today. “CEDF has promoted market growth of best-in-class systems.”

“It [CEDF] has had an effect, without funding we would have seen the market evaporate, it is very rare to sell without a rebate. Extremely important.”

- Equipment and Service Provider

Equipment and service providers also credited CEDF incentives with generating a strong increase in market development and raising market awareness through the use of data. One provider explained, “The financial incentives absolutely help, they [CEDF] do their best job here.” Another provider said, “It [CEDF] has had an effect, without funding we would have seen the market evaporate, it is very rare to sell without a rebate. Extremely important.”

Market Actors’ View of Advanced Wood Heating Going Forward

The equipment and services providers did not uniformly agree on the market’s future, as it ranged from slow growth to decreased sales, though all agreed that a great deal of uncertainty exists. One provider had no idea and said that it is impossible to know even year to year, but cited a general trend away from combustion toward electrification.

Although one provider said the market will not grow barring a major unknowable change such as a major war that decreases fossil fuel imports, another provider noted that Dartmouth, a very respected institution with a well-established environmental department, is installing a wood chip system, and this could help the image of wood heating.

Market Actor Recommendations to CEDF

The consultant from BEREC suggested the program calculate emissions as net carbon emissions because of the way forests work over time where release of biogenic carbon is different than unlocking geologic sources of carbon all at once.

The three equipment and service providers were generally quite positive about CEDF and provided only a few recommendations to improve the AWH program. Two providers recommended CEDF increase incentives to lower initial costs to home owners, pointing out that advanced wood heating is still competing with fossil fuels, and in one provider's opinion, "wood is more expensive". In a follow-up conversation, CEDF noted that wood, as one consultant stated, is not more expensive than heating oil or propane. Rather it is the equipment (automated pellet boilers/furnaces) that is more expensive than oil or propane boilers/furnaces. One provider also encouraged CEDF to advocate for themselves at the legislature and publicly.

And finally, to address the general public's lack of understanding about the environmental impact of wood heating or the work that CEDF is doing, one provider recommended CEDF create a "balanced" report that describes how each of their incentivized technologies reduces carbon, saves energy, and utilizes local resources, providing customers with the information needed to make an informed decision. This stakeholder said that "the perfect is getting in the way of good," meaning that people are often working toward a perfect solution that is often unattainable instead of acting on what they can be doing now.

Participant Experience

Cadmus surveyed 105 participants—100 residential (74 wood/pellet stove customers and 26 boiler customers) and 5 nonresidential (all of whom installed a pellet boiler)—to assess their awareness of the program, how information and products flowed to customers, influences on their participation decisions, any barriers encountered during the process, and their satisfaction with program, equipment, and installation contractors. Additionally, Cadmus asked participants about their perceived non-energy benefits accrued from installing the new equipment.

Nonresidential participant opinions frequently mirrored those of residential participants. For this reason, and because nonresidential responses were few, Cadmus combined responses in some cases below. When nonresidential responses were different, we reported those separately.

Participant Characteristics and Awareness

Cadmus collected demographic information about customers surveyed.

Residential

Surveyed residential customers reported the following characteristics:

- 96% lived in a single-family home (n=100)
- 81% of responding residential customers lived in homes built prior to the 1990s (n=94)
- 88% reported living in a home between 1,000–3,000 square feet (n=96)

- 97% interviewed customers reported occupying their homes year-round (n=94)

Nonresidential

The five nonresidential customers participated in the following industries:

- Public administration/government services (1 customer)
- Arts/entertainment/recreation (1 customer)
- Food process (1 customer)
- Education (2 customers)

All occupied buildings were 100,000 square feet or less. Four of the five participant businesses were open all days of the week, including holidays, and all five operated year-round.

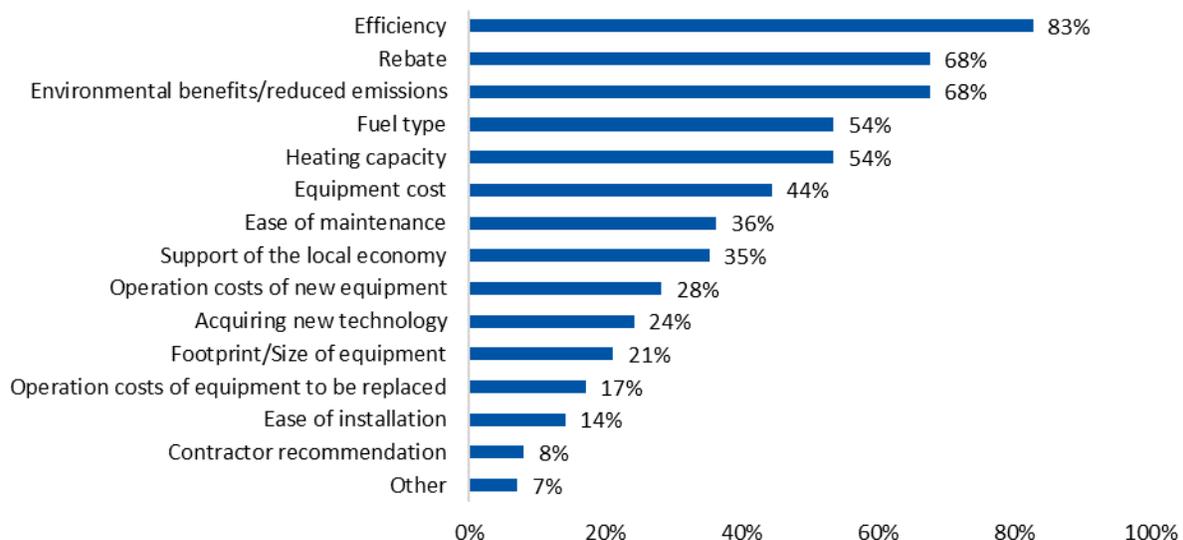
Participant Awareness

Of 105 residential and nonresidential participants interviewed, all but two were aware that they received an incentive for the equipment purchased, learning about incentives through stores where they purchased the equipment, their contractors, online, or radio or newspaper media. Of surveyed customers, 99% (n=98) of residential customers and all five surveyed nonresidential customers still had their equipment installed; a home fire prevented one stove from being installed.

Equipment Selection and Installation

When asked to select all factors influencing their decisions to participate in the program, residential customers most frequently selected efficiency, rebate amounts, and environmental benefits as shown in Figure 1. Nonresidential participants ranked environmental benefits, efficiency, and fuel types as their top factors.

Figure 1. Key Factors Considered in Residential Participation



Source: VTPSD Wood Survey. C1. Before purchasing your equipment, what were the key factors you considered in your purchase decision? n=99. Multiple responses allowed.

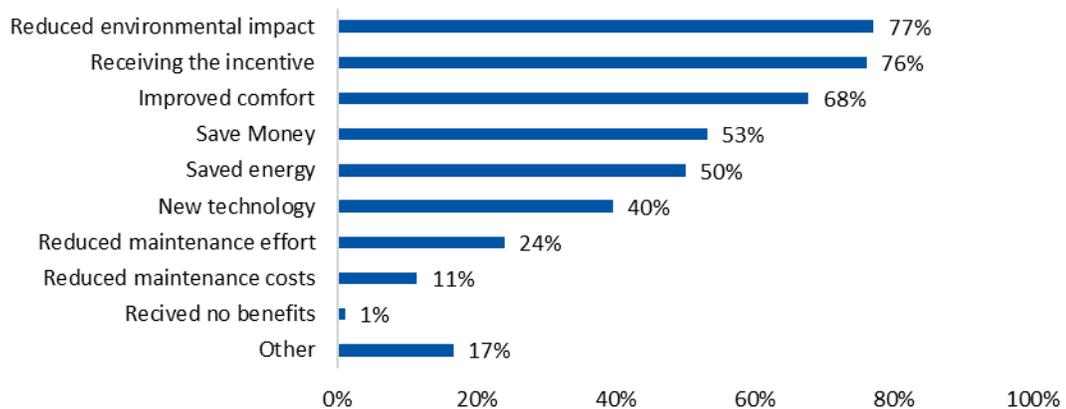
As shown in Figure 2, residential customers reported realizing a variety of benefits after installing their equipment, most frequently reporting reduced environmental impacts, receiving incentives, and improving comfort. These responses were similar to those which customers reported as their motivations for installing wood heating, with environmental benefits and incentives topping both lists.

“This has been an extraordinary investment!! Thank you!!”

- Nonresidential Customer

Nonresidential customers reported the top three benefits: receiving incentives, receiving new technologies, and reducing environmental impacts. Two customers surveyed reported no benefits—one nonresidential customer and one residential stove customer. Additionally, one customer stated, “This has been an extraordinary investment!! Thank you!!”

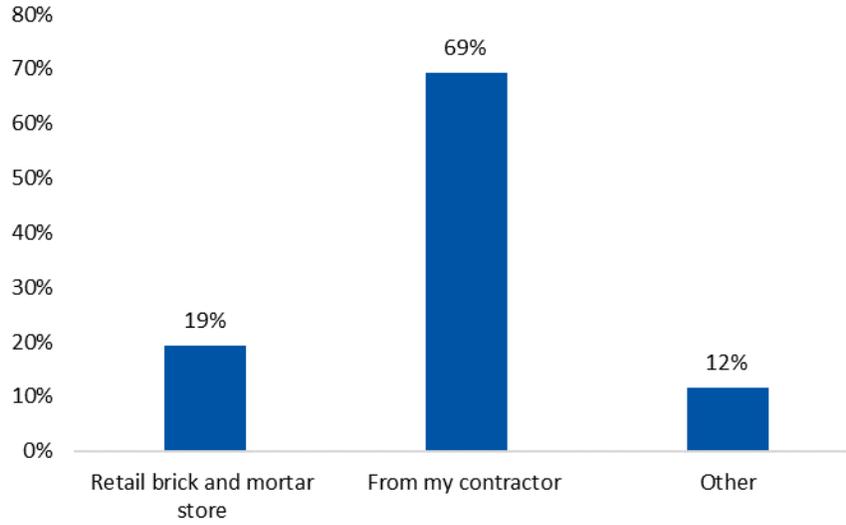
Figure 2. Benefits of Installing Equipment for Residential Participants



Source: VTPSD Wood Survey. F4 What benefits have you received as a result of installing this equipment? n=96.
Multiple responses allowed.

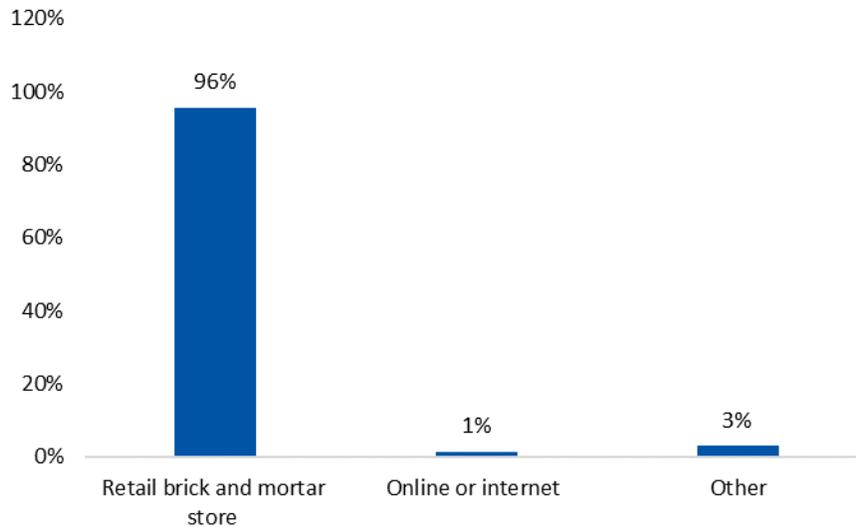
As shown in Figure 3, 69% of residential boiler customers surveyed bought their equipment directly from contractors and 19% bought their equipment in a brick and mortar store. As shown in Figure 4 of residential stove customers surveyed 96% bought their equipment in a brick and mortar store. The top two stores most commonly cited by the residential participants were Chimney Sweep and Woodstock Soapstone. All five nonresidential customers reported buying directly from their contractors.

Figure 3. Where the Residential Boiler Customer Purchased Equipment



Source: VTPSD Wood Survey. C3 Where did you purchase your [MEASURE INSTALLED]? (n= 26)

Figure 4. Where the Residential Stove Customer Purchased Equipment



Source: VTPSD Wood Survey. C3 Where did you purchase your [MEASURE INSTALLED]? (n= 69)

The majority of residential customers (96%, n=98) had the equipment installed by a contractor or by the store where they purchased it. Four customers installed the equipment themselves. The five nonresidential customers had their contractors install the equipment. The new equipment served as the primary heat source in the installation area for 76% of residential customers (n=97) and 100% of nonresidential customers (n=5).

Equipment Maintenance Requirements

When asked if they knew of the maintenance required to keep the new systems performing well, 91% of all residential customers (n=96) and 100% of the nonresidential customers (n=5) claimed they were aware of this. Majorities of respondents—80% of residential customers (n=96) and 100% of nonresidential customers (n=5)—reported finding maintenance about what they expected, while 7% of residential customers claimed it was more than expected, and 12% reported it was less than they expected.

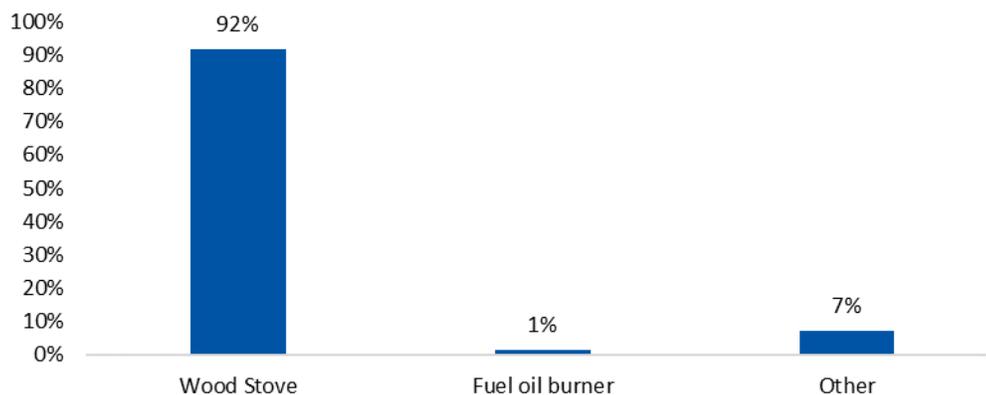
Fuel Acquisition

Ninety-three percent of residential customers and 100% of nonresidential customers reported they did not face issues in acquiring fuel for the equipment. Of seven residential customers reporting such issues, six were customers purchasing boilers. Issues included truck access to the driveway, reaching a dealer, the high cost of wood, issues with finding bulk fuel, and low-quality pellets.

Equipment Replaced

As shown in Figure 5, 92% percent of residential stove customers (n=71) reported replacing an old wood stove with a new wood stove.

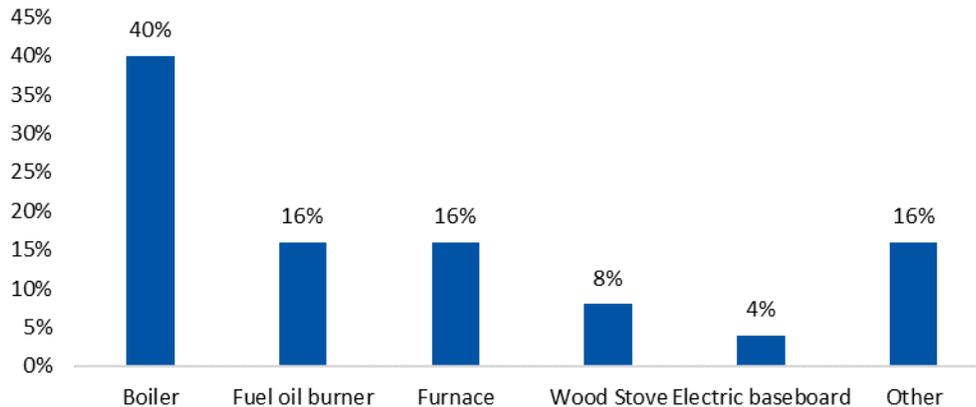
Figure 5. Residential Stove Customers Previous Equipment Replaced



Source: VTPSD Wood Survey. E1 What equipment was replaced by your new stove? (n=71).

Of residential boiler customers (n=25), 40% reported replacing an old boiler with a new boiler. Fuel oil burners, furnaces, and “other” each made up 16% of respondents, with wood stoves and electric baseboards accounting for the remainder of respondents. Residential wood stove customers tended to replace stoves with stoves, while residential boiler customers replaced a variety of heat sources, as shown in Figure 6.

Figure 6. Residential Boiler Customers Previous Equipment Replaced

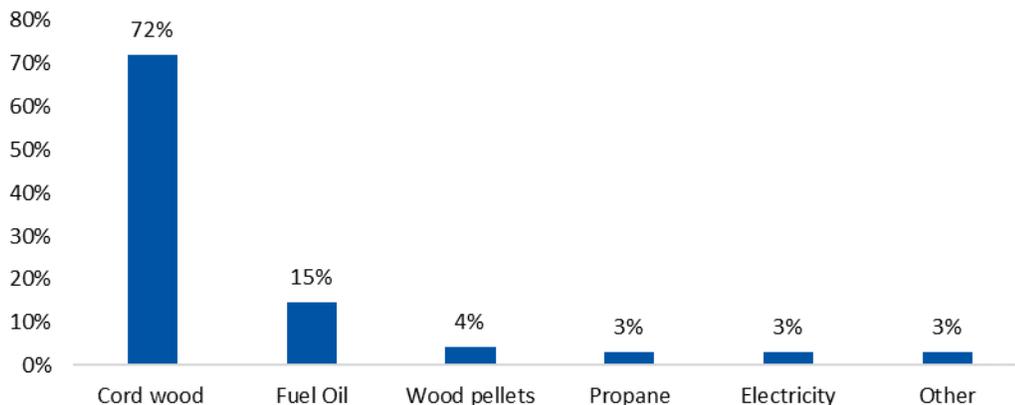


Source: VTPSD Wood Survey. E1 What equipment was replaced by your new boiler n=25.

Three of five nonresidential customers reported replacing fuel oil burners with pellet boilers, one replaced an existing boiler, and one did not replace any equipment (the new unit was purchased for new construction).

Figure 7 presents fuel sources replaced. Of 96 residential customers interviewed, 72% said their previous equipment burned cord wood. Four of five nonresidential customers reported replacing equipment using oil, and one customer reported not replacing a fuel (as their unit was in a new construction).

Figure 7. Residential Customer Previous Fuel Replaced

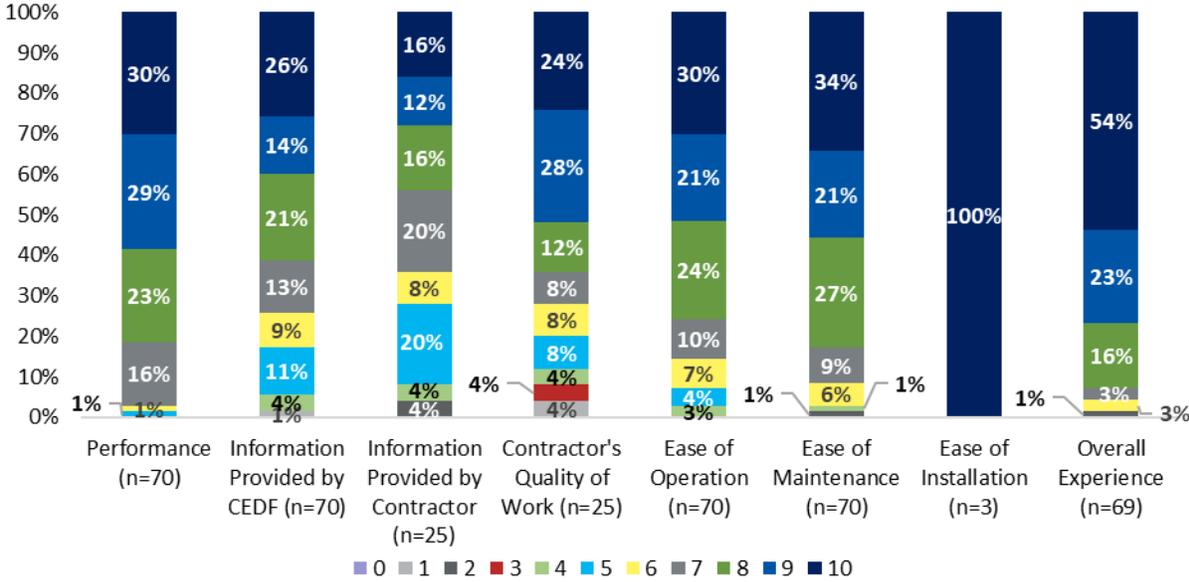


Source: VTPSD Wood Survey. E2 What fuel source was used by the old replaced equipment? n=96.

Participant Satisfaction

Cadmus asked customers to rate their satisfaction level on a scale of 0 to 10, where 0 was unacceptable and 10 was outstanding. Figure 8 presents satisfaction results across the seven metrics and overall satisfaction for residential customers who installed stoves. Participants reported high overall satisfaction levels, with average satisfaction scores ranging from 7.1 (information provided by a contractor) to 10 (ease of installation for those self-installing units). The average overall experience rating was 9.1.

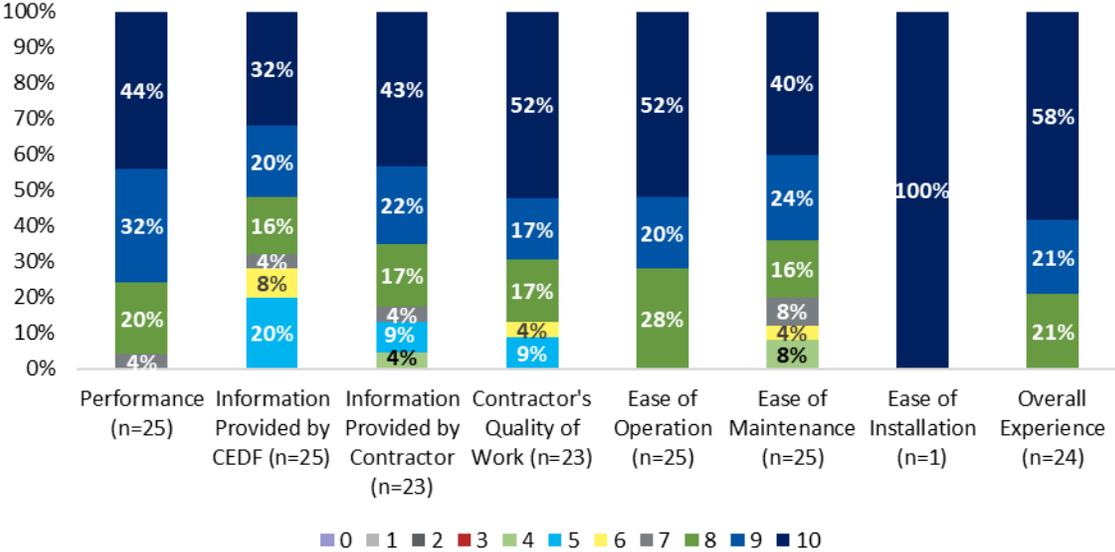
Figure 8. Satisfaction – Residential Stove Customers



Source: VTPSD Wood Survey. G1 On a scale of 0 to 10, where 0 is unacceptable and 10 is outstanding, how would you rate the following? G3 Taking everything into consideration, on a scale of 0 to 10, where 0 is unacceptable and 10 is outstanding, how would you rate your overall experience with the Small-Scale Renewable Energy Incentive Program?

Figure 9 presents satisfaction results across the seven metrics and overall satisfaction for residential customers who installed boilers. Participants reported high overall satisfaction levels, with average satisfaction scores ranging from 8 (information provided by CEDF) to 10 (ease of installation for those self-installing units). The average overall experience rating was 9.4.

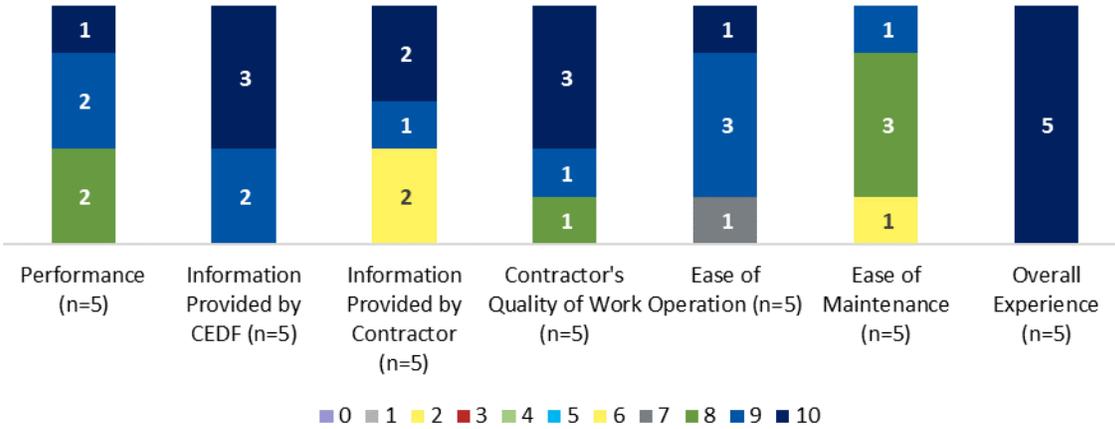
Figure 9. Satisfaction – Residential Boiler Customers



Source: VTPSD Wood Survey. G1 On a scale of 0 to 10, where 0 is unacceptable and 10 is outstanding, how would you rate the following? G3 Taking everything into consideration, on a scale of 0 to 10, where 0 is unacceptable and 10 is outstanding, how would you rate your overall experience with the Small-Scale Renewable Energy Incentive Program?

Figure 10 presents satisfaction results across the seven metrics and overall satisfaction for nonresidential customers. Since there were only five nonresidential customers interviewed, Cadmus presented the count (rather than percentage), of customers who reported each rating.

Figure 10. Satisfaction – Nonresidential Boiler Customers

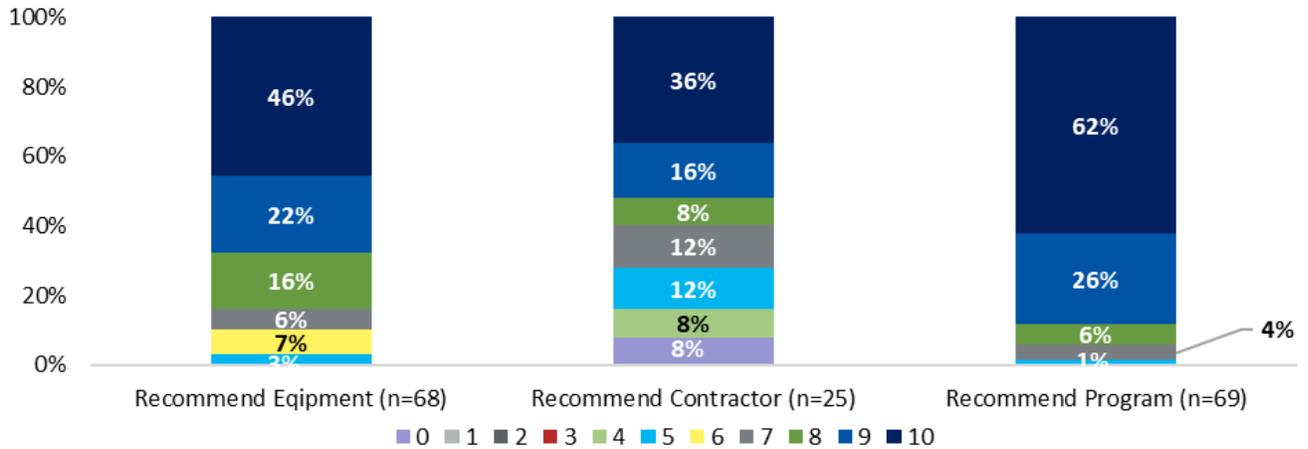


Source: VTPSD Wood Survey. G1 On a scale of 0 to 10, where 0 is unacceptable and 10 is outstanding, how would you rate the following? G3 Taking everything into consideration, on a scale of 0 to 10, where 0 is unacceptable and 10 is outstanding, how would you rate your overall experience with the Small-Scale Renewable Energy Incentive Program?

Cadmus asked customers, using a scale of 0 to 10, to rank how likely they would be to recommend some key program features to a friend or family member, with 0 as highly unlikely and 10 as very likely. As

shown in Figure 11, the average response rate for the residential stove customer’s likelihood of recommending the equipment was 8.8; for the customer’s likelihood of recommending their contractor, the rate was 7.4. Customers reported an average rating of 9.4 for their likelihood of recommending the program to a friend or family member.

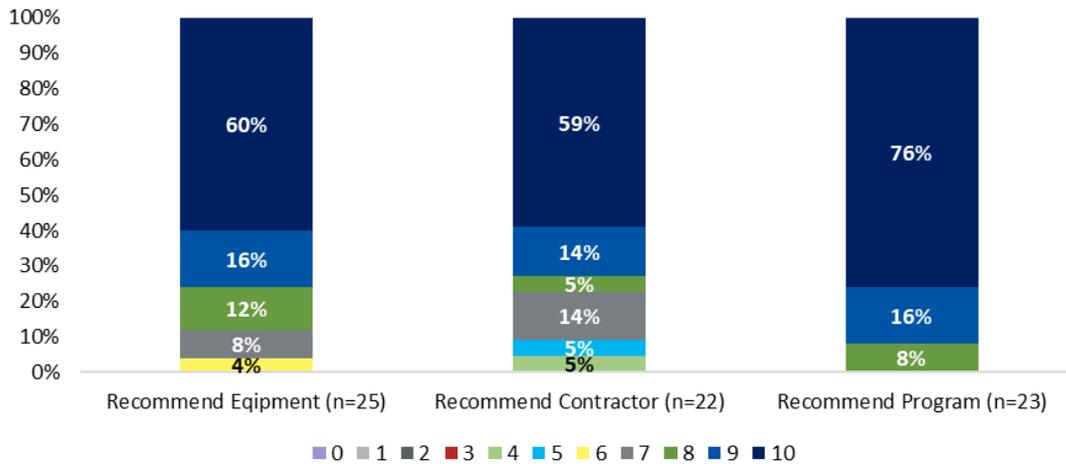
Figure 11. Likelihood of Recommendation – Residential Stove Customers



Source: VTPSD Wood Survey. G1 Using a scale of 0 to 10, where 0 is highly unlikely and 10 is very likely? G4 Using a scale of 0 to 10, where 0 is highly unlikely and 10 is very likely, based on your experience with the Small-Scale Renewable Energy Incentive Program, how likely would you be to recommend it to a friend or colleague

As shown in, Figure 12 the response rate for the residential boiler customer’s likelihood of recommending the equipment was 9.2; for the customer’s likelihood of recommending their contractor, the rate was 8.9. Customers reported an average rating of 9.7 for their likelihood of recommending the program to a friend or family member.

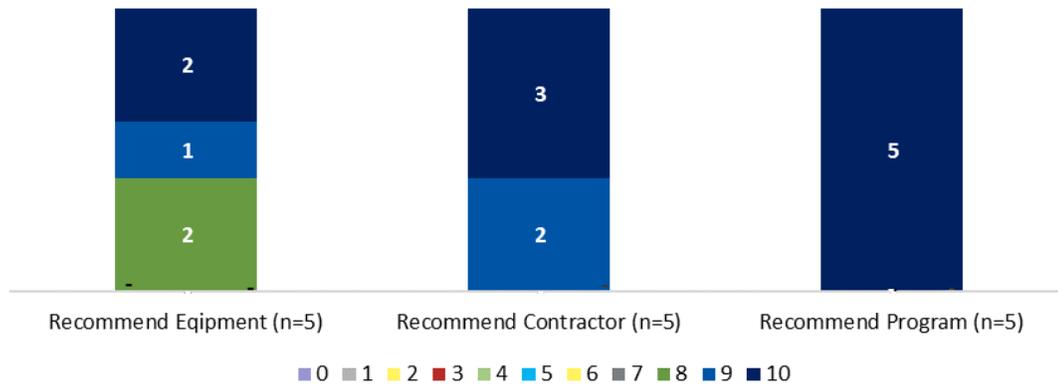
Figure 12. Likelihood of Recommendation – Residential Boiler Customers



Source: VTPSD Wood Survey. G1 Using a scale of 0 to 10, where 0 is highly unlikely and 10 is very likely? G4 Using a scale of 0 to 10, where 0 is highly unlikely and 10 is very likely, based on your experience with the Small-Scale Renewable Energy Incentive Program, how likely would you be to recommend it to a friend or colleague

Figure 13 presents likelihood of recommendation results across for nonresidential customers. Since there were only five nonresidential customers interviewed, Cadmus presented the counts of customer who reported each rating.

Figure 13. Likelihood of Recommendation – Nonresidential Customers

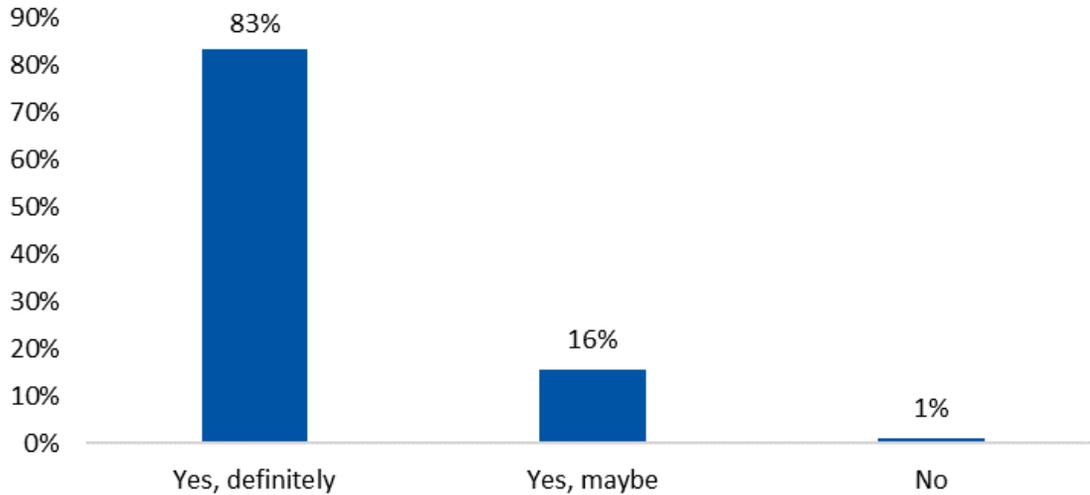


Source: VTPSD Wood Survey. G1 Using a scale of 0 to 10, where 0 is highly unlikely and 10 is very likely? G4 Using a scale of 0 to 10, where 0 is highly unlikely and 10 is very likely, based on your experience with the Small-Scale Renewable Energy Incentive Program, how likely would you be to recommend it to a friend or colleague

Across all customers, 10 customers indicated that the program was not advertised well, and seven indicated that wanted a higher incentive. Two customers indicated specific dissatisfaction with the maintenance required for their equipment. Eight customers, highly satisfied with the program, said they already had recommended the program to others.

Most customers reported they would purchase the same equipment again. As shown in Figure 14, 83% of residential customers said “Yes, definitely”; 16% said “Yes, maybe”; and 1% said “No.” Five of the customers reporting “Yes, maybe” said they would investigate newer stove/boiler technologies if making a similar purchase. All five nonresidential customers reported “Yes, definitely” to buying the equipment again.

Figure 14. Would the Residential Customer Purchase Again?



Source: VTPSD Wood Survey. F5 Given your experience with this equipment, would you purchase it again?
n=96.

As a final question, Cadmus asked customers if they had recommendations to improve the program. Of 49 who responded, 10 customers said increasing advertising to get the word out about the program, and seven customers reported they would like a higher rebate amount—not an uncommon request from customers participating in rebate programs.

Program Benchmarking

Cadmus and CEDF identified six organizations and one government agency (NYSERDA) that offer a wood pellets/biomass rebate program.⁶ All were in northeast United States or southeast Canada. Cadmus gathered information on program target customers, fuel types, years offered, incentive amounts, program costs, program savings, lifetime savings, and enrollment, though this information was not always available for each program. The programs incentives ranged from \$500 to \$200,000. Four utilities offered to pay 30% to 40% of the cost (up to a cap).

All of the benchmarked organizations offered rebates to residential customers. Five utilities offered rebates for transitioning from any fuel type to wood pellets/biomass, while four utilities offered rebates only for electric to wood pellets/biomass. Table 20 shows the details of all benchmarked categories.

⁶ Cadmus gathered the benchmarking material using our ESource database resource, through Google searches, and information provided by the Biomass Energy Resource Center.

Table 20. Benchmarked Programs

	CEDF	Efficiency Vermont	NYSERDA				Efficiency Maine Trust		Massachusetts Clean Energy Center	Prince Edward Island Office of Energy Efficiency	Efficiency Nova Scotia	New Hampshire Public Utilities Commission
Program Name	Small Scale Renewable Energy Incentive Program	Central Wood Pellet Furnaces & Boilers Rebates	Renewable Heat NY–Small Biomass Boilers				Home Energy Savings Program	Biomass Boiler and Furnace Rebates	Massachusetts Renewable Heating and Cooling	Equipment Upgrade Rebate	Residential Rebates–Green Heat	Residential Bulk-Fed Wood-Pellet Central Boilers and Furnace Rebates
Nonresidential	Residential and commercial	Residential and commercial	Residential and commercial				Residential	Residential and commercial	Residential and commercial	Residential and Res low-income	Residential	Residential and commercial
Fuel Type	Electric to biomass	Electric to biomass	Oil replaced with Biomass	Propane replaced with Biomass	Electric replaced with Biomass	Thermal Savings	Any to Wood	Electric to biomass	Electric replaced with Pellets. GHG reductions	Other to wood pellet	Other to wood pellet	Other to wood pellet
Year	2018	2018	2018				2011	2018	2018	2016	2017	2018
Incentive	\$3,000 per installed pellet boiler	\$3,000 cash back after purchase/ Custom (~\$1.25 per square foot)	45% up to \$36,000/ 40% of installed cost – max. \$200k for single boiler				Up to \$3,000	33% up to \$3,000	40% of installed system cost up to \$12,000/ 35% of installed cost – max. \$500,000 per project	\$1,000-\$3,500	\$500-\$1,000	40% up to 10,000
Program Cost							\$6 mil (all parts of HESP)					\$65,000 (max)
Enrollment	46 residential rebates and another 14 commercial rebates		17 residential pellets boilers						22 residential and 2 commercial	55 residential pellet boilers		20 residential and 9 commercial

Table 21. Descriptions of Benchmarked Programs

CEDF	Efficiency Vermont	NYSERDA	Efficiency Maine Trust		Massachusetts Clean Energy Center	Prince Edward Island Office of Energy Efficiency	Efficiency Nova Scotia	New Hampshire Public Utilities Commission
Small Scale Renewable Energy Incentive Program	Central Wood Pellet Furnaces & Boilers Rebates	Renewable Heat NY–Small Biomass Boilers	Home Energy Savings Program	Biomass Boiler and Furnace Rebates	Massachusetts Renewable Heating and Cooling	Equipment Upgrade Rebate	Residential Rebates–Green Heat	Residential Bulk-Fed Wood-Pellet Central Boilers and Furnace Rebates
<p>Rebates are for new, high-efficiency, qualifying wood pellet boilers and furnaces that are installed as primary central heating systems.</p> <ul style="list-style-type: none"> Fuel storage capacity such that the system may continuously operate for a period of at least 14 days under peak load conditions. Automated fuel feed from a bulk storage container/area to the burn chamber in an integrated path Automated on/off fuel feed control based on a demand for heat. Bulk fuel storage container systems must be able to receive automated bulk delivery of pellets Customers are eligible for a \$500 Pellet Storage Upgrade Adder for pellet storage systems that have at least 20 days of storage under peak load conditions 	<p>Rebates are for new, high-efficiency, qualifying wood pellet boilers and furnaces that are installed as primary central heating systems.</p> <ul style="list-style-type: none"> For residential buildings <5,000 SF Replacement of natural gas-fired heating systems are not eligible Systems must be classified as indoor systems and be installed inside Systems must have at least one week’s fuel-storage and automated on/off and fuel feed Commercial: Custom rebates for new qualifying pellet and woodchip boilers replacing fossil fuel: <ul style="list-style-type: none"> Buildings >5,000 SF Requires EVT design review Further review/approval needed for projects over 40,000 SF 	<p>Biomass Boilers. The monitored biomass boiler is designed to use a variety of biomass feedstock, including irregular wood chips/shavings and fabricated wood pellets</p> <p>Rebates for qualifying indoor boilers under 300,000 Btu/hour capacity:</p> <ul style="list-style-type: none"> Thermal storage is required All bulk fuel storage must be outside Tier incentives based on system size: <ul style="list-style-type: none"> <25kW (86,000 Btu/hour) = \$10k 35kW (120,000 Btu/hour) = \$16k 50kW (171,000 Btu/hour) = \$23k 88kW (300,000 Btu/hour) = \$36k \$5k adder for recycling old indoor or outdoor boiler \$2.5k adder for recycling whole house wood furnace Other requirements. <p>Rebates on wood pellet systems only:</p> <ul style="list-style-type: none"> 45% Rebate on tandem boiler systems--\$270k Max Indoor boilers only, more than 300k BTU/hr. output Thermal storage tank is required Bulk pellet fuel must be stored outdoors 	<p>December 2009 through 2011, whole-house efficiency program, targeted toward existing homes heated during the winter.</p>	<p>Offered rebates to residential customers for installing biomass boilers or furnace systems. Rebate for 1/3 of project costs, up to \$3,000.</p>	<p>Renewable heating and cooling (RH&C) technologies (solar thermal, biomass thermal, advanced biodiesel, high-efficiency heat pumps). Rebates up to \$12,000 are available.</p>	<p>Offers residential customers rebates for installing ENERGY STAR-certified heating and water-heating equipment (heat pumps, water-saving devices, biomass heating devices, other energy-saving products). Rebates are available for qualifying pellet boilers for new or existing single-family homes and apartment/ condominium units:</p> <ul style="list-style-type: none"> Must be in electrical service territory of National Grid, Eversource, Unitil, or participating muni. Thermal storage adder up to \$2,000 Maximum system output 120,000 Btu/hour Additional incentives for low income households – up to \$16,500 Funds available through 2020 <p>Rebates are available for qualifying pellet and dry chip fueled systems:</p> <ul style="list-style-type: none"> Project sites must receive electrical service from National Grid, Eversource, Unitil, or participating municipal lighting plant communities Projects over 3.0 MMBtu/hr. must have a feasibility study performed and can get further funding support for feasibility assessments. 5% thermal storage adder--\$25k max 2.5% cascading systems adder--\$12.5k max 2.5% distribution efficiency adder--\$12.5k max 5% non-profit/public/affordable housing adder--\$25k max <p>Rebates on qualifying pellet boilers for:</p> <ul style="list-style-type: none"> Single to 4-unit residential buildings serving as principal residence for occupants, new or retrofit. Systems including bulk fuel storage able to continuously heat for 2 weeks or has a minimum 500-pound capacity fill bin and a permanently installed back-up heating system (propane, oil, natural gas) <p>There are however, C&I funds through Efficiency Maine for thermal energy efficiency projects that lower the total thermal energy consumption for a facility saving a minimum of 400 MMBtu per year</p>	<p>Offers residential customers rebates for installing energy-efficient space-heating equipment.</p> <ul style="list-style-type: none"> Wood/Pellet Stove or Fireplace Insert--\$500. Wood/Pellet Boiler or Centrally Ducted Forced Air Furnace--\$1,000. 	<p>Offers rebates to residential customers who install high-efficiency, bulk-fuel-fed, wood-pellet central heating boilers and furnaces. A rebate payment of 40% of system and installation costs, up to a maximum of \$10,000.</p>

Update of Program Recommendations – 2015 Evaluation

Cadmus reviewed recommendations that were presented in CEDF's 2015 program evaluation to document decisions made by CEDF in implementing these recommendations. Cadmus categorized each recommendation as completed, partially completed, in process, ongoing, or declined.

Overall, CEDF implemented recommendations prioritizing incentives and market-based initiatives over grants or loan guarantees, where it could more effectively drive the market for advanced wood heat. CEDF also took steps, as recommended, to assure that new market actors (contractors, vendors, etc.) are identified and provided with opportunities to participate in the development of CEDF initiatives. CEDF reported providing more time for market actors to respond to solicitations and made efforts to reach beyond the regular market participants to inform them about program opportunities. But as staff noted, CEDF believes more could be done to promote CEDF's programs/funding opportunities.

CEDF also implemented many program management recommendations that are ongoing. These efforts include simplifying the incentive application process, monitoring quality control actions by VEIC, maintaining informal contact with program vendors, and surveying participants annually (through their contract with VEIC).

Recommendations partially completed by CEDF focused on quality assurance and evaluation, measurement, and verification (EM&V) processes. Staff determined that CEDF's existing quality assurance practices and those provided by EVT were sufficient or, in the case of EM&V, program metrics were selected but data collection was incomplete. CEDF commissioned an AWH baseline report in 2015 and plans a follow-up report in 2021 to assess market barriers and advancement. However, this is not a direct replacement of an EM&V plan.

Finally, CEDF declined recommendations if staff determined the benefit to be gained did not exceed the impact of redirecting limited human and funding resources away from the primary goal of advancing the market for advanced wood heat or when factors were beyond their control, such as program funding running out without any new sources identified or state guidelines restricting CEDF's ability to improve navigation through CEDF program pages located on the state's website.

A more detailed summary of the 2015 recommendations and CEDF responses can be found in Appendix B.

Conclusions and Recommendations

Impact Evaluation

Fuel and Greenhouse Gas (GHG) Savings

Conclusion 1. Cord wood stoves are the most popular measure among residential customers and exhibit the shortest payback period of seven years, given current fuel prices. Though not responsible for the greatest CO₂e savings (in total or per incentive dollar like the pellet boilers), they do produce sizable GHG emissions reductions and the highest non-GHG reductions for the most cost-effective option for residential measures.

Recommendation: To increase participation in this measure, a simple increase in marketing may be sufficient, with no needed increase to the incentive amount.

Conclusion 2. If the priority is to offset the greatest amount of fossil fuels, then pellet boilers (both residential and nonresidential) are the primary measure to achieve that goal. In addition, the pellet manufacturing and distribution market experiences the greatest benefit.

Recommendation: To meaningfully drive down the payback period of residential pellet boiler systems, the program may want to consider increasing the incentive.

Conclusion 3. The AWH program sufficiently tracked program spending, system costs, incentive costs, and leveraged funds, but can better track savings impacts.

Recommendation: Record replaced equipment (type and size) and average quantity of offset fuel, as well as new system size, and type and amount of new fuel used.

Process Evaluation

Customer Participation and Satisfaction

Conclusion 4. CEDF staff have influenced advanced wood heating equipment installation, satisfied customers and vendors, and supported the market for advanced wood heat while working within the constraints of limited staff hours and fluctuating funding sources.

Conclusion 5. AWH participants are highly satisfied with the program, their new equipment, and the incentive. Vermonters are driven to program participation for efficiency and environmental reasons, and market actors are committed to furthering the market in Vermont.

Conclusion 6. The advanced wood heat market continues to see large benefits from the program activities. Program equipment and service providers are satisfied with the program and some reported that sales would not maintain without the program.

Program Implementation and Delivery

Conclusion 7. CEDF staff's prioritization of program delivery over data collection hindered their ability to evaluate and report on program performance. Although evaluation and reporting should benefit significantly from the new Access database being developed, the data collected for each project should be as consistent and complete as possible.

Recommendation: Implement standardized data collection practices and consistently require grantees to submit complete data to receive funding.

Conclusion 8. Program data tracking and evaluability may be significantly improved if project data for each customer is tied to a unique anonymous identifier such as a number. This identifier allows customers to be tracked across multiple sources of data and reduces duplication of projects or projects being left out.

Recommendation: Consider applying unique identifiers to each customer.

Conclusion 9. Reevaluation of program data collection and tracking is warranted in one year. Should the AWH program receive additional funding, CEDF may want to reevaluate data collection in one year to document improvements and identify any lingering data issues to be addressed.

Conclusion 10: The program will benefit from documentation and tracking of key performance indicators (KPIs). In 2016, CEDF commissioned a baseline study that tracked program lagging and leading indicators as suggested in its 2015 program evaluation. CEDF is not consistently tracking either, although it plans to contract a new study in 2021 (if funding is available) to better understand progress in the market. In the interim, if CEDF and the CED Board identify a few key indicators and if CEDF regularly track these, it can more easily identify and report year-over-year program accomplishments, adjust the program focus to target specific equipment, or redirect its funding to areas of the market requiring additional support.

Recommendation: Should the program continue in 2020, consider formalizing KPIs. KPIs to consider include goals for customer participation, vendor engagement, equipment installations, emissions reductions, and fossil fuel offsets or other targets established by CEDF and the CED Board.

Appendix A. Impact Assumptions

Table A-1. Cost, Energy Capacity, and Carbon Equivalents Conversions

Fuel	Unit	Cost	MMBtu/unit ^a	Metric tons CO ₂ e/MMBtu ^b
Cord Wood	cord	\$250	22.000	.0139 ^c
Pellets	ton	\$265	16.400	.0182
Fuel Oil #2	gallon	\$2.82	0.138	.0896
Propane	gallon	\$3.35	0.092	.0760

^ahttps://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Fuel_Price_Report/2016/January%202016%20Fuel%20Price%20Report.pdf

^bInternational Wood Fuels. February 22, 2010. *Carbon Footprint White Paper*. <http://woodfuels.com/wp-content/uploads/2015/06/WoodFuels-Carbon-Footprint-Rail-Based-Distribution-White-Paper1.pdf>

^cCord wood is assumed to have 1/3 of the Processing & Refinery stage as Pellets, but the Extraction & Recovery, Transportation, and End Use Combustion values are retained.

Table A-2. Particulate Matter and Emissions Factors by Fuel

Fuel	Units	PM _{2.5}	CO	NO _x	SO ₂	VOC
Fuel Oil #2 ^a	lb/gal	0.00083	Not available	0.0180	0.0426	Not available
Propane ^a	lb/gal	0.00017	Not available	0.0130	0.0001	Not available
“Old” Cord Stove ^b	lb/MMBtu	2.18571	16.48571	0.2	0.02857	3.78571
“New” Cord Stove ^b	lb/MMBtu	0.05	1.443	0.1701	0.02857	0.06075
Pellet Stove ^b	lb/MMBtu	0.27097	2.54194	0.89032	0.02581	0.00265
Pellet Boiler ^b	lb/MMBtu	0.37	1.39	0.17	0.02581	0.065
Cordwood Boiler ^b	lb/MMBtu	2.18571 ^c	16.48571 ^c	0.13152	0.145	1.791
School Pellet Boiler ^b	lb/MMBtu	0.0503	0.25159	0.30191	0.025	0.017

^a <https://www3.epa.gov/ttnchie1/conference/ei12/area/haneke.pdf>

^b NYSERDA. New York State Wood Heat Report: An Energy, Environmental, and Market Assessment. Appendix D. April 2016. <http://www.nescaum.org/documents/new-york-state-wood-heat-report/>

^c PM 2.5 and CO values were omitted for the cordwood boiler, therefore values from the “old” cord wood stove were used in favor of an absent value.

Appendix B. Status of Past Program Recommendations

Table B-1. Summary and Status of 2015 Program Evaluation Recommendations

Recommendation Vermont CEDF Evaluation 2015	CEDF Response Through 9/2019	Status (completed, partially completed, in progress, ongoing, declined)
Identify a stable source of CEDF funding	CEDF has secured federal and nongovernmental grants over the last 4 years however the Vermont Legislature and Governor/Administration have not identified a long-term funding source and currently no new sources are expected.	Partially completed
Prioritize incentives and market-based initiatives over grants and loan guarantees to stimulate the development of emerging renewable energy markets. This approach could include the following:	CEDF focused its programs on market-based incentives and the SSREIP	Completed
a. High initial incentives to kick-start the market and quickly gain participants, scaling incentives back as market demand develops.	Lack of funds led CEDF to choose lower incentive levels which were not high enough achieve the desired effect of kick-starting the market. CEDF choose to have several years of low and steady incentives instead of one year of high incentives.	Declined
b. Balance participation requirements with simplicity of process to sustain participation.	CEDF simplified the SSREIP process reducing the effort required of CEDF staff and program participants. The market actors remain satisfied by the program and progress being made.	Ongoing
c. Implement a quality assurance process to ensure that systems are installed to perform as intended.	CEDF deemed the quality of installations sufficient through the few site inspections being completed. Additionally, Efficiency Vermont’s inclusion of pellet boiler installers in their Energy Excellence Network reduced the need for CEDF to take on a more robust QC role. CEDF coordinated with Efficiency Vermont and others training heating and plumbing contractors on the specific design and installation details important to pellet and wood chip heating systems, specifically with regard with thermal storage (heat buffer tanks).	Partially completed
d. Maintain regular two-way communications with vendors to address any emerging program issues.	CEDF maintains informal contact with vendors and vendors reach out to CEDF or VEIC with questions.	Ongoing
e. Regularly survey participants and market actors to identify program strengths, weaknesses, opportunities, and barriers.	SSREIP participants are surveyed annually by VEIC.	Ongoing
f. Consider offering targeted selective grants and loan guarantees to build the advanced wood heating supply chain and market.	CEDF offered targeted competitive grants for the bulk pellet supply market to address needs in that sector.	Completed

Recommendation Vermont CEDF Evaluation 2015	CEDF Response Through 9/2019	Status (completed, partially completed, in progress, ongoing, declined)
<p>Further develop evaluation, measurement, and verification (EM&V) planning. To allow for near real-time assessment of program effectiveness, quick operational adjustments and timely reporting the team recommends CEDF identify lagging indicators (e.g., incentives paid per month), installed capacity (total and per dollar of awards), annual energy generated (total and per dollar of awards), emissions avoided (total and per dollar of awards), and dollars leveraged per dollar of awards. Also identify leading indicators such as the number of participating qualified installers, the number of qualifying units shipped to Vermont, the number of leads generated by contractors, the inquiries coming into the RERC or other call centers, the number of systems installed outside of CEDF programs. While CEDF program may not be able to significantly influence these leading indicators given limited funding, tracking them can still provide valuable information on the development of the market.</p>	<p>CEDF did not develop an EM&V plan in the format recommended. CEDF implemented metrics to be tracked, but data collection that allowed for analysis of all the metrics was lacking.</p> <p>CEDF did have a baseline study completed that tracked the lagging and leading indicators as suggested, but CEDF is not tracking the leading indicators regularly. The Baseline was completed in 2016. If funds are available CEDF plans to commission a report in 2021 to see what progress was made over the five years, the current status of the sector and what is holding the sector back.</p>	Partially completed and in progress
<p>Improve program tracking and reporting tools. Advance CEDF tracking and reporting systems to ensure that key metrics data are reliably tracked and available for regular analysis and monthly reporting.</p>	<p>CEDF was not able to ensure that key metric data was regularly kept in a way that made it available for reporting. CEDF did realize that it was not able to develop a database and tracking system on its own and has now contracted to have that done.</p>	In progress
<p>Develop a clear vision for the best and highest use of the CED Board. Identify a clearly defined role with actionable objectives.</p>	<p>CEDF, PSD, and the CED Board have discussed this recommendation; however, statutes that control the Board’s role have hindered progress on this recommendation.</p>	Declined
<p>Take steps to assure that new market actors are identified and provided with opportunities to participate in the development of CEDF initiatives.</p>	<p>CEDF has taken this recommendation seriously and given more time to respond to solicitations and made efforts to reach beyond the regular market participants to inform them about program opportunities. But CEDF believes more could be done to promote CEDF’s programs/funding opportunities.</p>	In progress
<p>Conduct greater public outreach. Steps could include the following:</p>		
<p>a. Make the current CEDF Strategic Plan publicly accessible through a website. Make the annual report available to the general public.</p>	<p>Strategic Plans and annual reports are available on VT Dept of Public Service website and are sent to the Legislature in general, and legislators specifically on the energy committees and are also sent out to CEDF email list.</p>	On-going/in progress (The State of Vermont constraints on the website make modifications difficult)
<p>b. Develop a CEDF “brand.”</p>	<p>CEDF has focused on its incentives and programs instead of promoting CEDF or developing a CEDF Brand.</p>	

Recommendation Vermont CEDF Evaluation 2015	CEDF Response Through 9/2019	Status (completed, partially completed, in progress, ongoing, declined)
<p>c. Make CEDF website more customer-focused and publicly transparent through a public dashboard (fed through the project database) that publicly displays key results and impacts as well as descriptions and outcomes of the feasibility studies funded by CEDF.</p>	<p>CEDF’s website is kept up-to date and publicly transparent, but improvements to make it more customer-focused and user friendly have not been made. The recommendation of a public dashboard was not accepted by CEDF as something it should invest in. Feasibility studies were posted to the website, but accessibility of that list requires multiple clicks through the site by the user. Improved functionality is not feasible on the State website.</p>	
<p>Review estimated energy production data for SSREIP solar thermal projects. Analysis of the tracking data indicates there are likely errors in the estimated annual energy production.</p>	<p>The solar thermal incentive program was ending when this recommendation was written. The new Access database will improve any future input issues.</p>	Declined
<p>Conduct a follow-up impact evaluation. Including: a billing analysis and/or site visits with equipment inspection and metering to update estimates of energy production for the renewable technologies supported by CEDF funding.</p>	<p>VEIC, under contract to CEDF, conducts site visits on approximately 10% of the SSREIP incentivized projects.</p>	Partially completed
<p>Record displaced fuels. For all projects associated with energy impacts, consider tracking the fuel types that will be displaced by the given project (e.g., gallons of heating fuel oil per year) to facilitate more precise avoided emission estimates.</p>	<p>CEDF has underinvested in this area resulting in inconsistent data collection and data management. This will be corrected with the new Access database</p>	In progress
<p>Request fuel use data release authorization. In support of the previous recommendation, include on all funding applications a fuel use data release authorization for CEDF to obtain past and future energy consumption data. In addition, clarify in program terms and conditions who retains any applicable tradable credits or allowance, such as renewable energy credits (RECs).</p>	<p>CEDF did not follow this recommendation. CEDF lacked staffing and felt the cost benefit was not sufficient.</p>	Declined
<p>Collect and track demographic data of program participants. Doing so would allow CEDF to examine program impacts by demographic groups, such as income, and design and implement programs for demographic groups that have been underserved by CEDF programs.</p>	<p>CEDF did not agree with the need or benefit of collecting this data.</p>	Declined
<p>Track feasibility study outcomes so they can be more easily linked to program outcomes and metrics.</p>	<p>Feasibility studies were largely ended except where federal funds helped pay for them so there were few feasibility studies to track.</p>	Declined

Recommendation Vermont CEDF Evaluation 2015	CEDF Response Through 9/2019	Status (completed, partially completed, in progress, ongoing, declined)
Consistently track energy production and installed capacity.	Tracking is inconsistent by the grantees. CEDF staffing and budget constraints did not support the additional follow-up with grantees necessary to collect the data. CEDF will reconsider this once the new database is in place.	Declined
Improve data tracking. Recommended data tracking practices include: <ul style="list-style-type: none"> a. Developing unique identifiers for both awards and projects b. Identifying projects by types of energy impacts c. Preparing and maintaining a data dictionary 	Currently, tracking is inconsistent. However, this will be done through the new Access database being developed.	In progress