Mobile and Manufactured Housing Market Characterization

Efficiency Vermont R&D Project: Justice

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Contents

Executive Summary

Manufactured housing (MH) is an important source of affordable housing. However, while MH typically has lower up-front costs, higher energy use intensities (EUI) than site-built single-family homes presents an ongoing affordability challenge for residents of existing manufactured homes. Programs designed to improve energy efficiency of homes, including Efficiency Vermont offerings and weatherization assistance, often face barriers in doing so in MH units (e.g., structural and repair challenges, lack of experienced contractors).

Manufactured housing came under federal regulation with introduction of the 1976 HUD Code. Factory-built homes constructed prior to the HUD Code are commonly referred to as mobile homes. Today, mobile and manufactured homes represent approximately six percent of the housing stock in Vermont. Shipments of new MH units to Vermont have increased slightly over last few years but are still far below peak shipments in 1990s. New MH units are increasingly being built to high-performance energy standards that exceed the HUD Code minimum, and efforts are underway at the State Agency of Transportation, the State Housing Authority, and Vermont Housing & Conservation Board to deploy many more new MH in coming years.

Most residents on MH units are low- or moderate-income, with 62 percent of residents income-qualified for the Weatherization Assistance Program and an additional 29 percent of residents income-qualified for Efficiency Vermont's moderate-income offerings. Most MH residents in the state own their homes but many are located on leased land. About 1/3 of MH units in Vermont are located in mobile home parks. These parks tend to be small—63 percent of MH parks have 25 lots or less—and tend to be located along transportation corridors in the state with concentrations around Burlington, Brattleboro, and Montpelier.

Most MH residents live in homes built before the HUD Code was implemented (34%) or during the first iteration of the HUD Code (1976 HUD Code, approximately 43% of MH residents). Bulk fuels – propane and fuel oil / kerosene – are the predominant fuels used for space heating. Across the broader New England region, most MH units are heated by central furnaces with ductwork. Many of these systems are old and likely inefficient, and about half of MH residents rely on a secondary space heating fuel during the winter heating season, typically electric resistance heating. Also regionally, air-conditioning – typically window/wall air conditioners – are common, used by about three quarters of MH residents. Hot water typically is provided by electric resistance water heaters—over 80 percent of MH units. Many are old, and most are small- or medium-sized storage water heaters, often located in small closets or underneath sinks.

In assessing the program landscape available to MH residents in Vermont, the project team found that current offerings from Efficiency Vermont generally are available to MH residents, but uptake is understood to be low. Vermont's Weatherization Assistance Program provides a good example of how to serve the MH housing stock in Vermont, and other national program examples provide additional information on types of measures and approaches taken to serve the market. While Vermont's WAP program is implementing some electrification measures in

MH units, the program is not available to non-low-income residents living in MH units, approximately 38 percent of the market. Additionally, there are barriers to deploying electrification measures at a broader scale through the WAP program, including skepticism that ccASHP can meet the heating needs of residents.

Without funding to address structural and other repair issues in these homes, programs seeking to achieve a meaningful and lasting impact through energy-savings measures will face high deferral rates or limited longevity. Efficiency Vermont's new Home Repair program is one effort that can help address these issues. Available to income-qualified residents pursuing weatherization, the program could serve as a model for home repair funding offered more broadly to the MH market (including non-low-income households). Alternatively, though stakeholders noted that MH residents tend to be debt-averse, the success of on-bill financing programs in this market sector in places like South Carolina could provide a model for how to approach home repair funding among non-low-income MH residents.

Another challenge to serving the MH market resides with the contractor base. Contractors need training and technical resources to work effectively in these homes. A well-trained crew is a key factor to success—they need to be adept at retrofitting and possess in-depth knowledge of best practices for repairing MH units, including proper air sealing and insulation techniques; the various types of manufactured home construction; and combustion appliance safety and worst-case draft scenarios. In addition to training, contractors might need financial incentives to make serving these homes an attractive option compared to other market sectors.

To support electrification in this housing sector, support with electrical upgrades also is needed, including financial support for panel and service upgrades, as well as support finding qualified electricians. Additionally, product demonstration and/or innovation is needed to overcome hesitancy or skepticism toward electrification technologies, among both residents and contractors.

Based on the state of the MH market in Vermont, the research team recommends the following:

- Update Efficiency Vermont data tracking procedures to record housing unit type and track program activity among customers residing in MH units. This is necessary to understand uptake and penetration of current program offerings in this housing market sector.
- Continue to develop partnerships with housing stakeholders, emphasizing need for home repair dollars in existing MH units, including non-low-income residents who do not meet program income limits. Consider expanding Efficiency Vermont's new Home Repair program to be available to all MH residents, regardless of income, or develop a no-cost financing home repair option for non-low-income MH residents.
- Focus on workforce development and capacity building to develop a sufficient contractor pool willing and able to complete energy efficiency and electrification scopes of work in manufactured homes. Provide support for contractor training, including working with existing contractor networks to identify specific needs.

- In the next Efficiency Vermont market assessment, oversample MH units to develop a deeper understanding of the opportunities and barriers in existing MH units in Vermont. Draw upon those results to update program designs and offerings, similar to work completed by Efficiency Maine. This could include using virtual audits and obtaining photos from MH residents to support on-site data collection methods.

Introduction

Manufactured housing (MH) is an important source of affordable housing. Lower up-front costs can make it an attractive option for low- and moderate-income (LMI) households seeking homeownership opportunities. However, energy use intensity (EUI) of existing manufactured housing is typically higher than that of site-built single-family homes, which presents an ongoing affordability challenge in the form of higher energy bills. Programs designed to improve the energy efficiency of housing, including Efficiency Vermont offerings and weatherization assistance, can serve manufactured housing—but often face barriers in doing so (e.g., structural and repair challenges, lack of experienced contractors). In addition, moderate-income and market rate households living in manufactured housing have fewer options available to incentivize and support energy efficiency and decarbonization upgrades in their homes.

This market characterization report can support Efficiency Vermont in designing effective programs to support MH customers at an appropriate level regardless of income. The report includes new and updated market analysis of manufactured housing in Vermont, leveraging previous work by Efficiency Vermont and other stakeholders. It also includes a review of existing program offerings from Efficiency Vermont, other incentives available to MH residents in Vermont, and a review of national program examples. Together, this information will help Efficiency Vermont staff and partners to provide more equitable programming as barriers and blind spots in existing structures are identified.

Background

As noted by Vermont's Mobile Home Task Force, "Today, all mobile homes manufactured in the United States are produced in HUD qualified factories according to HUD standards."[1] However, prior to implementation of the initial HUD Code for manufactured homes in 1976, there were no uniform construction standards, and homes built in factories varied significantly in their construction quality and durability.

Factory-built homes constructed prior to the 1976 HUD Code commonly are referred to as mobile homes, and factory-built homes constructed in accordance with the HUD Code are referred to as manufactured homes. For this report, mobile and manufactured homes are both referred to as "MH units," except when differentiating between the two is important. Manufactured housing features a permanent steel chassis used for transporting and placing the

[1] Vermont Mobile Home Task Force, February 1, 2024.

unit. Modular housing, which is also factory-built, differs from manufactured housing in that it is constructed in accordance with state and local building codes and regulations and does not feature a permanent steel chassis. This report only covers manufactured housing.

The HUD Code for manufactured housing was updated in 1994 to include standards regulating energy efficiency of manufactured housing. In 2000, the Manufactured Housing Improvement Act (MHIA) gave HUD authority to establish home installation standards for manufactured homes, including on-site utility and appliance connections.[2] The HUD Code regulations are available at Title 24 Part 3280 of the Code of Federal Regulations.

Efforts to update the HUD Code with more stringent energy efficiency standards for manufactured housing have faced significant opposition from industry, but a new standard based on the 2021 International Energy Conservation Code (IECC) is expected to go into effect in July 2025 for multi-section homes. The compliance date for single-sections homes is still not known. The energy efficiency requirements can be reviewed at Title 10 Chapter II Subchapter D Part 460 of the Code of Federal Regulations. Already, however, voluntary, high-performance new construction standards have been implemented for manufactured housing, including ENERGY STAR® and U.S. DOE's Zero Energy Ready Homes (ZERH) at the national level, Efficiency Vermont's Advanced Manufactured Housing (AMH) standard, and the Northwest Energy-Efficient Manufactured Housing (NEEM) Program in the Pacific Northwest.

Table 1 provides a comparison of the energy efficiency characteristics of manufactured housing built in compliance with the HUD Code with voluntary above-code programs. Note that while the new HUD Code, as well as above-code programs, require specific assembly insulation and window efficiency values, the current HUD Code only set a maximum overall heat transfer coefficient (Uo) that the thermal envelope must not exceed. Vermont is located in HUD Zone 3 which requires a Uo less than or equal to 0.079. The insulation and window values provided in Table 1 for the current HUD Code are informed by VEIC and industry experience on typical new manufactured homes built to the current HUD Code.

[2] Kaul, K. and D. Pang (2022). *The Role of Manufactured Housing in Increasing the Supply of Affordable Housing*. Urban Institute.

Table 1. Comparison of Energy Efficiency Specifications of HUD Code and Voluntary Above-Code Programs for New Manufactured Housing

Modeling Assumptions with Points (required for program compliance)								
Assembly	HUD (current)	HUD (2025)		ENERGY STAR MH v3		ZERH MH v1		
	Minimum Standard						EVT AMH Tier 1	EVT AMH Tier 2
	All	Single	Double	Single	Double	All		
Walls	R-13	R-19	R-21		R-24	R-21		R-24
Floor	R-22	R-22	R-30	R-33			R-27	R-33
Ceiling	R-30	R-22	R-38		R-44	R-38		R-44
Windows	U-0.52	U-0.35	U-0.30		U-0.25	U-0.30		U-0.25
Doors	R-1.7	R-2.5		R-3.3				
Air leakage	8 ACH50					4 ACH50	3 ACH50	
Heating	Fed Min	Fed Min				ASHP (7.2 HSPF2)	ccASHP (8.8 HSPF2)	
Cooling	Fed Min	Fed Min				ASHP (14.3 SEER2)	ccASHP (16.2 SEER2)	
Ventilation	Local exhaust						HRV 87% SRE	
Hot Water	Fed Min				HPWH (2.2 UEF)	Fed Min	HPWH (3.3 UEF)	
Thermostat	Manual				Programmable			
Duct Leakage	4 CFM25/100sf							
Duct Insulation	Floor cavity: enclosed by insulation. All other spaces: R-8							
Lighting	100% CFL				100% LED	100% CFL	100% LED	
Appliances	Federal Minimum				ENERGY STAR	Federal Minimum	ENERGY STAR	

While progress is being made with new construction, a recent series of topic briefs by the American Council for an Energy-Efficient Economy (ACEEE)[3] highlights opportunities and challenges for retrofitting existing MH units. The authors highlight that many residential programs offered by states and utilities already serve manufactured homes, but that services can be limited in scope and that there is a need to address MH units specifically through careful design considerations. Funding to support structural repairs, workforce development, and replacement of inefficient homes are key aspects to improving the existing stock of manufactured housing. The analysis below further explores these concepts.

Methods

This market characterization is based on the following research and analysis:

- review and synthesis of published reports from Vermont stakeholders and national organizations;
- analysis of public data sets;
- analysis of program data; and

[3] Bell-Pasht, A. (2023). "Upgrading Manufactured Homes: Using Energy Efficiency to Improve Affordability and Health." ACEEE.

- discussions with key stakeholders, including internal stakeholders within Efficiency Vermont and weatherization program staff at the Vermont Office of Economic Opportunity (OEO), the Champlain Valley Office of Economic Opportunity (CVOEO), and NETO, Inc.

Overview of Public and Program Data Sources

This market characterization uses the following public and program data sources.

- American Community Survey (ACS) data from the U.S. Census Bureau. The ACS provides detailed estimates of the U.S. population, including information on occupied and total housing units in each state. We used the 2022 ACS 5-Year data files to examine estimates of the MH population in Vermont.
- Low Income Energy Affordability Data (LEAD) tool from the U.S. Department of Energy (DOE). The DOE LEAD tool provides energy use, burden, and other characteristics, segmented by key household demographics and housing unit characteristics. The DOE LEAD tool was updated in July 2024 to use 2022 ACS 5-Year data as an input. These data are calibrated with utility and fuel consumption data from the U.S. Energy Information Administration (EIA).
- Residential Energy Consumption Survey (RECS) from EIA. The RECS provides detailed energy use characteristics of residential households, including heating, cooling, hot water, and appliance equipment types. The 2020 RECS public use microdata were used in this report. Due to the small sample of manufactured housing units in Vermont, we developed custom estimates of manufactured housing for the New England Census Division. While the New England Census Division shows some differences in characteristics of manufactured housing compared to Vermont-specific estimates from the ACS, the sample generally reflects the existing manufactured housing stock in the region applicable to Vermont.
- ResStock from the National Renewable Energy Laboratory (NREL). ResStock is a data platform developed by NREL that combines a U.S. housing stock characteristics database with building energy modeling. Different from survey-based datasets such as EIA's RECS and the U.S. Census ACS, ResStock provides a probability-based characterization of the residential building stock, using public and private data sources (including RECS and ACS) to inform the likely housing characteristics of the building stock. Energy simulations are run for the entire housing stock, providing annual and sub-hourly energy use outputs. The U.S. housing stock data set was filtered for Vermont mobile/manufactured homes.
- Weatherization Assistance Program (WAP) data from the Vermont Office of Economic Opportunity (OEO). OEO provided VEIC with several historic data sets for MH units weatherized by the WAP program. These data sets include actual pre-weatherization energy use data, as well as modeled/estimated energy savings and improvement costs. (NOTE: Historic energy use data were provided in 2016; project data capture the 5-year period 2016–2020. More recent data were requested from OEO but were unable to be provided for this market characterization. Given that the data are capturing the existing

building stock, the project team feels comfortable that while not the most recent, the 2016–2020 data, supplemented by interviews with OEO, CVOEO, and NETO, Inc., provide a reliable picture of energy use, potential savings, and costs.)

- **Mobile Home Park Registry data** from the Department of Housing and Community Development (DHCD). The DHCD provides data for all MH parks registered in Vermont, including the number of lots, ownership type, and location. These data were used to gain an understanding of MH units located in and outside of MH parks.

Findings

Existing Manufactured Housing and Resident Characteristics

Mobile and manufactured homes represent approximately six percent of the housing stock in Vermont. Table 2 provides the breakdown of total housing units (including vacant and seasonal homes) and occupied housing units by housing unit type, based on the 2022 5-Year ACS. There are approximately 20,000 total MH units in Vermont, of which about 16,500 are occupied as primary residences. This is consistent with housing counts reported by the Vermont Mobile Home Task Force, which noted that "Vermont's grand list contains 20,485 items categorized as mobile homes."[4] Subsequent tables focus on MH units occupied as primary residences.

Table 2. Total and Occupied Housing Units in Vermont by Housing Unit Type

Housing Unit Type	Total Housing Units*		Occupied Housing Units	
	Count	Share	Count	Share
Single-Family Detached	225,638	67%	177,617	67%
Single-Family Attached	14,514	4%	10,732	4%
Multifamily, 2–4 Units	38,015	11%	31,275	12%
Multifamily, 5+ Units	36,870	11%	29,586	11%
Mobile/Manufactured	20,041	6%	16,588	6%
Other	60	0%	60	0%
All Homes	335,138	100%	265,858	100%

Source: 2022 5-Year ACS Tables B25024 & 25032; *Includes vacant and seasonal units.

Income Levels

Table 3 shows income levels of MH residents in Vermont, expressed as a percentage of area median income (AMI). Over 62 percent of MH residents have incomes below 80 percent of AMI, the income threshold to qualify for the WAP program and low-income offerings from Efficiency Vermont like low-to-no-cost weatherization and appliances, reduced cost loans for home energy improvements, replacement of old mobile homes, and home repair funding to address barriers to weatherization including ductwork, electrical, plumbing, remediation (asbestos, mold, vermiculite), ventilation, and repairs to the foundation, roof, siding, and windows. Approximately 29 percent of MH residents in Vermont have income between 80 percent and

[4] Vermont Mobile Home Task Force, February 1, 2024.

150 percent of AMI, making them eligible for moderate-income incentives from Efficiency Vermont including low-cost weatherization services and reduced cost financing for home energy upgrades.[5] Overall, 91 percent of MH residents in Vermont are qualified for income-based incentives (low-income or moderate-income) from Efficiency Vermont. Given the small percentage of "market rate" MH residents (i.e., nine percent of MH residents whose incomes are greater than 150 percent of AMI, and therefore not income-qualified for low- or moderate-income incentives from Efficiency Vermont), in subsequent tables, these market rate MH residents are combined with moderate-income MH residents as non-low-income households; MH residents with incomes at or below 80 percent of AMI are referred to as low-income households.

Table 3. Income Levels of MH Residents in Vermont

Area Median Income Level	Number of Households	Share of Households
Below 30% AMI	3,218	19%
30-60% AMI	4,634	28%
60-80% AMI	2,452	15%
80-100% AMI	1,781	11%
100-150% AMI	2,964	18%
Greater than 150% AMI	1,540	9%
Total	16,588	100%

Source: DOE LEAD.

Housing Vintage

Housing vintage (year built) is captured by the ACS (and subsequently, the DOE LEAD tool) in decades, while the HUD Code that regulates how manufactured homes are constructed have been implemented in mid-decade years. As a result, the alignment of population data collected by the U.S. Census Bureau and the HUD Code periods is close but not perfect. The first HUD Code came into effect in 1976 and underwent a major update in 1994. Table 4 approximates these vintages by grouping the housing vintage ranges available in the DOE LEAD tool to most closely align with iterations of the HUD Code. Approximately 34 percent of MH residents live in homes that were built before 1980, roughly equivalent to the period prior to implementation of the first HUD Code, and 43 percent live in homes that were built 1980–1999, corresponding to the 1976 HUD Code period. Non-low-income MH residents in Vermont are slightly more likely to reside in newer homes than low-income MH residents.

Table 4. Year Home Built of MH Residents in Vermont

Year Built	Low-Income Households		Non-Low-Income Households		All Households	
	Count	Share	Count	Share	Count	Share
1979 and Before	3,835	37%	1,768	28%	5,603	34%

[5] Other programs may have more narrowly defined income limits for moderate-income households, including Vermont Gas, which limits the moderate-income incentive through its Weatherization Services for Income-Qualified Homeowners program to households with incomes between 80 percent and 120 percent of AMI.

Year Built	Low-Income Households		Non-Low-Income Households		All Households	
	Count	Share	Count	Share	Count	Share
1980-1999	4,479	43%	2,720	43%	7,199	43%
2000 to Present	1,989	19%	1,797	29%	3,786	23%
All Homes	10,303	100%	6,285	100%	16,588	100%

Source: DOE LEAD.

Tenure/Ownership Status

Table 5 shows that over 80 percent of MH residents in Vermont own their homes. However, it is important to note that many MH homeowners live in MH parks or communities where they lease their lots. The Vermont Mobile Home Task Force noted that just over one-half of all MH units in the state are located on land owned by a mobile homeowner, and just under one-half are located on land leased by a mobile homeowner.[6]

Table 5. Homeownership Status of MH Residents in Vermont

Tenure	Low-Income Households		Non-Low-Income Households		All Households	
	Count	Share	Count	Share	Count	Share
Own	8,027	78%	5,346	85%	13,373	81%
Rent	2,276	22%	939	15%	3,215	19%
All Homes	10,303	100%	6,285	100%	16,588	100%

Source: DOE LEAD; *Tenure refers to ownership of housing unit only; MH residents may own their housing unit but lease the land on which it is placed

Space Heating

Table 6 shows the primary heating fuel reported by MH residents in Vermont. Over 62 percent report using fuel oil or kerosene, and 22 percent propane, as the primary heating fuels for their homes. Table 7 shows the share of MH residents using different heating fuels by vintage of their home; an increasing share of newer MH units (those built since 2000) rely upon propane as their main heating fuel, while nearly three-quarters of MH residents living in homes built before 1980 use fuel oil / kerosene to heat their homes.

Fuel oil / kerosene and propane tend to be expensive, and many homes are expected to have old, inefficient heating systems. This represents a significant opportunity to convert homes to high efficiency, cold climate air source heat pumps (in combination with weatherization), to both reduce costs and decarbonize heating in these homes. Currently, less than one percent of Vermont households living in MH units report using electricity as their primary heating fuel, which is likely electric resistance heating or older heat pump technologies.

[6] Vermont Mobile Home Task Force, February 1, 2024.

Table 6. Primary Heating Fuel used by MH Residents in Vermont

Primary Heating Fuel	Low-Income Households		Non-Low-Income Households		All Households	
	Count	Share	Count	Share	Count	Share
Fuel Oil	6,839	66%	3,531	56%	10,370	63%
Propane	1,899	18%	1,770	28%	3,669	22%
Natural Gas	449	4%	183	3%	632	4%
Electricity	91	1%	42	1%	133	1%
Other	1,025	10%	758	12%	1,783	11%
All Homes	10,303	100%	6,284	100%	16,587	100%

Source: DOE LEAD.

Table 7. Primary Heating Fuel by Year Home Built for MH Residents in Vermont

Primary Heating Fuel	1979 and Before (Pre-HUD Code)	1980-1999 ("1976 HUD Code")	2000 to present ("1994 HUD Code")
Fuel Oil	73%	61%	50%
Propane	15%	21%	36%
Natural Gas	2%	6%	5%
Electricity	1%	1%	1%
Other	9%	11%	9%
All Homes	100%	100%	100%

Source: 2022 5-Year ACS PUMS.

While the DOE LEAD tool provides information on the primary heating fuel used by households, as reported by respondents to the ACS, it does not provide information on the type or age of the heating equipment, or use of secondary heating sources. This information is available in the 2020 RECS; as noted above, however, the sample size of the 2020 RECS is limited and insufficient for Vermont-specific analysis of manufactured housing. As a result, estimates below from the 2020 RECS are based on manufactured housing in the New England Census Division. Results are shown for all MH residents and are not broken down by low-income status.

Table 8 shows the type of primary heating equipment used in MH units in New England. The vast majority—over 86 percent—use a central furnace. Table 9 shows that approximately 44 percent of MH residents in New England have primary heating equipment that is 10 or more years old, and 19 percent have primary heating equipment that is 20 or more years old.

Table 8. Type of Primary Heating Equipment Used by MH Residents in New England

Type of Primary Heating Equipment	Share of Households
Central furnace	87%
Wood or pellet stove	2%
Ductless heat pump (mini-split)	8%
Built-in room heater burning gas or oil	3%
Total	100%

Source: 2020 RECS.

Table 9. Age of Primary Heating Equipment Used by MH Residents in New England

Age of Primary Heating Equipment	Share of Households
Less than 2 years old	15%
2-4 years old	21%
5-9 years old	19%
10-14 years old	16%
15-19 years old	10%
20 or more years old	19%
Total	100%

Source: 2020 RECS.

The RECS survey also asks respondents whether they use secondary space heating equipment, and if so, details that usage. In New England, about half of MH residents use secondary space heating equipment. Of those, Table 10 shows that electricity is the most common secondary space heating fuel used, and Table 11 shows that slightly more than one-quarter use that equipment at least a few times per month during the heating season.

Table 10. Secondary Space Heating Fuel Used by MH Residents in New England

Secondary Space Heating Fuel	Share of Households
Electricity	66%
Wood or Pellets	24%
Fuel Oil	6%
Propane	4%
Total	100%

Source: 2020 RECS; estimates based on households that use secondary space heating equipment; user should view estimates with caution due to small number of sample units (27).

Table 11. Frequency of Use of Secondary Space Heating Equipment by MH Residents in New England

Frequency of Use of Secondary Space Heating	Share of Households
Use all or almost all of the time	16%
Use at least once per week	2%
Use a few times per month	9%
Use only when it is very cold	53%
Use only in rare situations, such as when a guest is visiting	21%
Total	100%

Source: 2020 RECS; estimates based on households that use secondary space heating equipment; user should view estimates with caution due to small number of sample units (27).

MH residents in New England also reported the following thermal comfort issues in the 2020 RECS:

- 23% reported poor insulation of their homes.
- 13% reported their homes being drafty all or most of the time.
- 49% reported their homes being drafty some of the time.

Air-Conditioning

Approximately 75 percent of MH residents in New England use air-conditioning in their homes. Of those households, Table 12 shows that nearly half use a window or wall air conditioner as their main source of cooling, and slightly more than one-third use a central air conditioner. Table 13 shows that about one-third of MH residents in New England use primary air-conditioning equipment that is 10 or more years old.

Table 12. Type of Main Air-Conditioning Equipment Used by MH Residents in New England

Type of main air-conditioning equipment	Share of Households
Window or wall air conditioner	47%
Central air conditioner (including central heat pumps)	35%
Ductless heat pump	13%
Portable air conditioner	6%
Total	100%

Source: 2020 RECS; households that use air-conditioning.

Table 13. Age of Main Air-Conditioning Equipment Used by MH Residents in New England

Age of Main Air Conditioning Equipment	Share of Households
Less than 2 years old	24%
2-4 years old	23%
5-9 years old	21%
10-14 years old	10%
15-19 years old	5%
20 or more years old	17%
Total	100%

Source: 2020 RECS; households that use air-conditioning.

Water Heating

Table 14 shows that electricity is the most common water heating fuel used by MH residents in New England, used in over 83 percent of homes. These typically are electric resistance water heaters, and Table 15 shows that over 40 percent are 10 or more years old. Most are storage water heaters that are small or medium in size, as shown in Table 16, and located in interior spaces. Due to the limited interior space available in most MH units, this has implications for new efficient heat pump water heaters (HPWHs) that might be considered as replacements for inefficient electric resistance and fossil fuel water heaters.

Table 14. Primary Water Heater Fuel Used by MH Residents in New England

Primary Water Heater Fuel	Share of Households
Electricity	83%
Propane	11%
Natural Gas	4%
Fuel Oil	2%

Primary Water Heater Fuel	Share of Households
Total	100%

Source: 2020 RECS.

Table 15. Age of Water Heaters Used by MH Residents in New England

Age of Water Heater	Share of Households
Less than 2 years old	20%
2-4 years old	13%
5-9 years old	27%
10-14 years old	23%
15-19 years old	10%
20 or more years old	8%
Total	100%

Source: 2020 RECS.

Table 16. Size of Water Heaters Used by MH Residents in New England

Water Heater Size	Share of Households
Small (30 gallons or less)	40%
Medium (31-49 gallons)	46%
Large (50 or more gallons)	7%
Tankless	7%
Total	100%

Source: 2020 RECS.

Other Appliances

Table 17 shows the electricity is the most common fuel type used by ranges and cooktops in MH units in New England. Approximately 57 percent of MH residents report using electricity as their range/cooktop fuel, while about 33 percent use propane. While based on a small sample size (n=28), of those MH residents using electricity as their cooking fuel, about 13 percent report using an induction range/cooktop.

Table 17. Cooking Fuel Used by Range/Cooktop by MH Residents in New England

Range/Cooktop Fuel	Share of Households
Electricity	57%
Propane	33%
Natural Gas	10%
Total	100%

Source: 2020 RECS.

MH residents in New England also reported the following information about other appliances in the 2020 RECS:

- Approximately 90 percent of residents have clothes washers and dryers in their homes. Nearly all these clothes dryers are fueled by electricity, and about 40 percent of residents with clothes washers and dryers report that these appliances are 10 or more years old.
- About 25 percent report having no LED light bulbs in their homes, 38 percent report having "some" or "up to half" of their light bulbs are LEDs, and 37 percent report that "most" or "all" of their light bulbs are LEDs.

Housing Affordability

Table 18 provides estimates of the affordability of total housing costs (including energy expenditures) for MH residents in Vermont. Housing affordability typically is defined as housing costs that are less than 30 percent of income. Households with total housing costs above this threshold are considered housing cost-burdened (and those with total housing costs greater than 50 percent of income are considered severely housing cost-burdened). Only 42 percent of low-income households living in MH units have an affordable housing burden, while most non-low-income households (96%) have an affordable housing burden.

Table 18. Housing Affordability of MH Residents in Vermont

Share of Income Spent on Housing Costs	Share of Low-Income Households	Share of Non-Low-Income Households
Less than 30% of income	42%	96%
30-50% of income	34%	3%
Greater than 50% of income	24%	1%
Total	100%	100%

Source: 2022 5-Year ACS Public Use Microdata Sample (PUMS); 80% State Median Income (SMI) used as proxy for low-income status; includes households reporting housing costs but no income.

In addition, Table 19 shows that approximately 13 percent of MH residents live in census tracts classified by the Justice40 Initiative's Climate and Economic Justice Screening Tool (CEJST) as Disadvantaged Communities (DACs).

Table 19. Location of Occupied MH Units in Disadvantaged Communities in Vermont

Located in Disadvantaged Community (DAC)	Low-Income Households		Non-Low-Income Households		All Households	
	Count	Share	Count	Share	Count	Share
Non-DAC	8,935	87%	5,577	89%	14,512	87%
DAC	1,367	13%	709	11%	2,076	13%
All Homes	10,303	100%	6,285	100%	16,588	100%

Source: DOE LEAD.

Geographic Locations

Across Vermont, there are 238 MH parks registered with DHCD. Table 20 provides information on the number and ownership type of MH parks and lots in Vermont. In total, there are 7,104

MH lots in these parks; while some lots are vacant, this represents about one-third of the total MH units in the state. MH parks represent an opportunity to market Efficiency Vermont program offerings at scale. However, the fact that approximately two-thirds of MH units in the state are not located in MH parks limits the ability to reach the MH market at scale through outreach to MH parks alone.

Compared to MH parks in the rest of the nation, MH parks in Vermont are small, ranging in size from 2 lots to over 260 lots, with an average of 30 lots per park and median of 16 lots per park.[7] Roughly 63 percent of MH parks have fewer than 25 lots, and only 17 percent of parks have more than 50 lots. MH park residents tend to have lower incomes than the overall population residing in MH units, meaning that non-low-income households in MH units are more likely to reside outside of parks—where program outreach can be more difficult.

Table 20. Vermont Mobile Home Park Types and Number of Lots

Mobile Home Park Ownership Type	MH Parks		Lots in MH Parks	
	Count	Share	Count	Share
For profit	170	71%	3,624	51%
Non-profit	48	20%	1,775	25%
Cooperative	20	8%	1,705	24%
Total	238	100%	7,104	100%

Source: DHCD Mobile Home Park Risk Analysis Tables, updated September 5, 2024.

Figure 1, from a 2021 report by Mead & Hunt for VTrans, provides a geographic representation of MH parcels and MH parks throughout the state.[8] Concentrations are evident along the transportation corridors and around Burlington, Brattleboro, and Montpelier. Analysis by the VHFA of ACS data and Vermont MH park registry data shows that MH units range from 4 percent of the total housing stock in Chittenden County to 12 percent in Grand Isle County. Conversely, most of the MH units located in Chittenden are located in MH parks (64 percent) while very few in Grand Isle County are placed in MH parks (4 percent).[9]

[7] Vermont Mobile Home Task Force, February 1, 2024.
[8] Figure 1 and Figure 7, Mead & Hunt (2021). *Vermont Mobile Homes and Parks Multiple Property Documentation Form Reconnaissance Study*. Prepared for the Vermont Agency of Transportation.
[9] Figure 3-20, VHFA (2024). *Vermont Housing Needs Assessment: 2025-2029*. Prepared for the Vermont Department of Housing and Community Development.

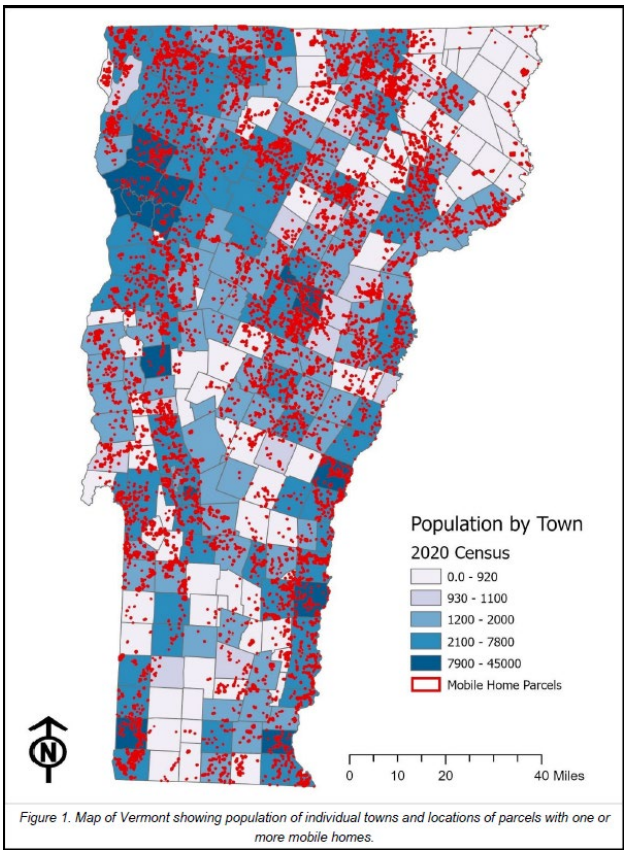

Figure 1. Map of Vermont showing population of individual towns and locations of parcels with one or more mobile homes.

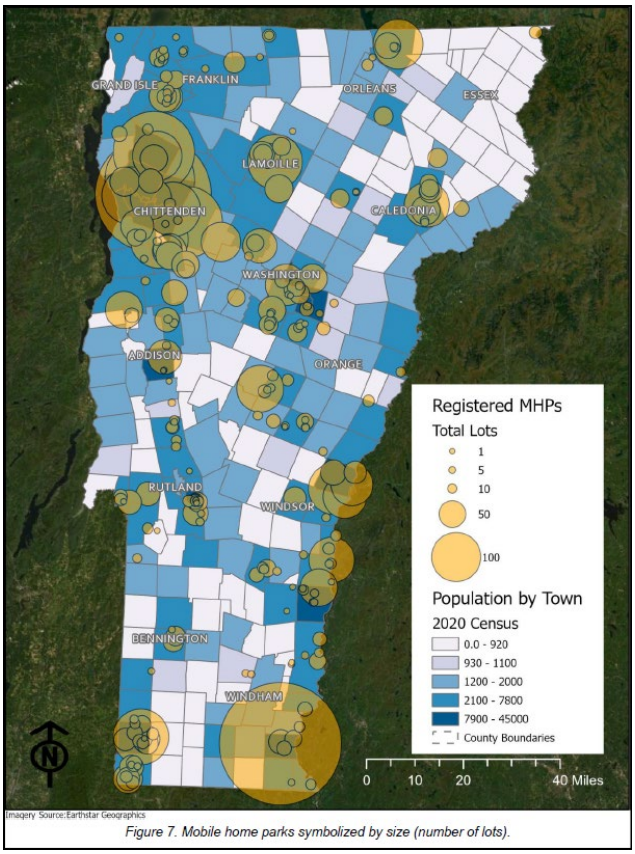

Figure 7. Mobile home parks symbolized by size (number of lots).

Figure 1. MH parcels (left) and MH parks (right).

Source: Figure 1 and Figure 7, Mead & Hunt (2021). *Vermont Mobile Homes and Parks Multiple Property Documentation Form Reconnaissance Study*. Prepared for the Vermont Agency of Transportation.

Table 21 provides estimates of the number of MH residents and low-income status by county. For example, Chittenden County has the most households residing in MH units: over 2,700, of which 43 percent are estimated to be non-low-income households. Just under half (49 percent) of MH residents in Lamoille County are estimated to be non-low-income and therefore not income-qualified for programs like WAP or low-income offerings through Efficiency Vermont (but may be qualified for moderate-income offerings).

Table 21. Households Residing in MH Units by County and Low-Income Status

County	Low-Income Households		Non-Low-Income Households		All Households
	Count	Share	Count	Share	
Chittenden County	1,553	57%	1,186	43%	2,739
Windsor County	1,209	74%	420	26%	1,629
Rutland County	954	63%	550	37%	1,504
Washington County	741	55%	610	45%	1,351
Franklin County	864	69%	383	31%	1,247
Orange County	750	60%	495	40%	1,245
Addison County	717	59%	500	41%	1,217

County	Low-Income Households		Non-Low-Income Households		All Households
	Count	Share	Count	Share	
Caledonia County	763	65%	402	35%	1,165
Lamoille County	557	51%	527	49%	1,084
Windham County	637	62%	383	38%	1,020
Orleans County	628	62%	382	38%	1,010
Bennington County	485	67%	241	33%	726
Essex County	245	71%	99	29%	344
Grand Isle County	201	65%	106	35%	307
Total	10,304	62%	6,284	38%	16,588

Source: DOE LEAD.

Findings from 2024 Maine Residential Baseline Study

Another source of data on baseline characteristics of existing manufactured homes is a recent residential baseline study conducted by NMR Group for the Efficiency Maine Trust, which consisted of a survey and virtual audits. The study oversampled manufactured homes for the specific purpose of ensuring actionable information for this building sector. Surveys were completed for 111 manufactured homes, 64 of which also included self-audit data with photos. An additional 11 manufactured homes received a virtual audit conducted by staff from NMR Group. From this data, four vintage-based prototype energy models were developed. Finally, a billing analysis was conducted using 2020 RECS data from the EIA.

Several key takeaways from the Maine residential baseline study can inform Efficiency Vermont's next steps in meeting this market. Manufactured homes had the highest average electricity consumption of all home types, and water heating was significantly higher than other single-family homes. The following highlights from the study could pertain to Vermont.[10]

- Most manufactured homes in Maine are single-wide and have open floor plans. The latter is helpful for installing ductless heat pumps when there is no existing ductwork, since one indoor unit could serve a large space.
- Similar to the 2020 RECS, the Maine study found that most manufactured homes use a furnace as their primary heating system; and like the DOE LEAD tool (based on 2022 ACS 5-Year data) showed for Vermont, most heat with a bulk fuel (in Maine, oil). The high and often unpredictable cost of heating with bulk fuels makes these homes good candidates for heat pumps, and the presence of ductwork makes these homes good candidates for centrally-ducted heat pumps.
- Also similar to the 2020 RECS, most manufactured homes in Maine have conventional storage water heaters, and all water heaters observed were under 40 gallons. In many cases, these water heaters are located in small closets or underneath kitchen sinks. Based on the location of the current water heater, only 11 percent of manufactured homes in Maine have sufficient space and 54 percent have sufficient ceiling height to support a HPWH. Therefore,

[10] NMR Group, Inc. (2024). *Maine Residential Baseline 2024*. Prepared for Efficiency Maine Trust.

HPWH installation could require relocation of the water heater and additional air-circulation vents.

- Among all residential homes (not exclusively manufactured homes) with whole-home heat pump installations in Maine, 79 percent had 100-amp electric service or lower, indicating the potential to install heat pumps without a costly upgrade to 200-amp service.

Trends in New Construction

In the 1990s, Vermont received over 500 new MH units annually. In the early 2000s, this decreased to approximately 350 new MH units per year before falling further during the housing crisis of the late 2000s. Figure 2 shows that shipments of new MH units since 2012 have fluctuated annually but generally increased by about 30 percent on average over the past three years (2021–2023: 170/year) compared to the previous nine years (2012–2020: 131/year).

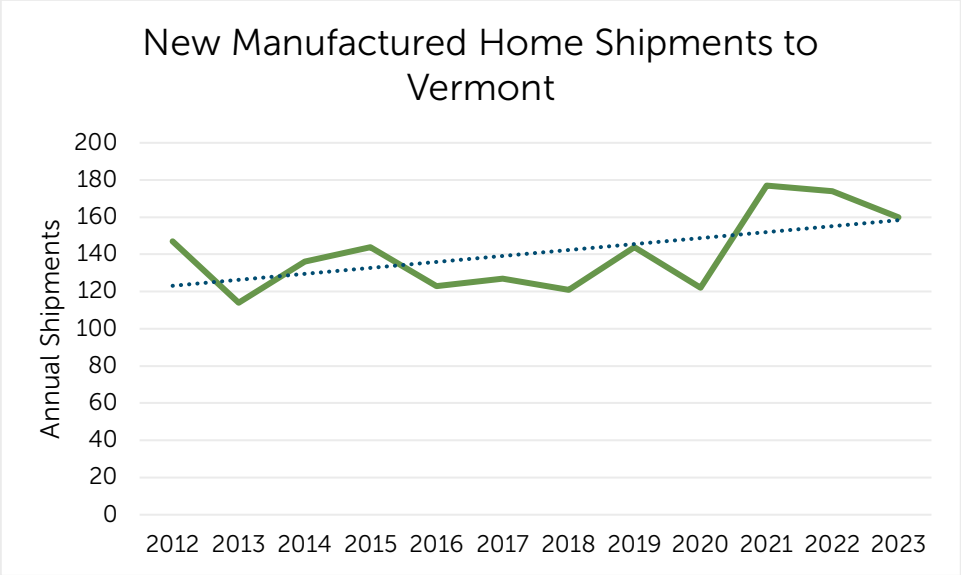

Figure 2. New Manufactured Home Shipments to Vermont, 2012–2023

Source: Manufactured Housing Survey, U.S. Census Bureau.

In recent years, the ENERGY STAR Manufactured Homes Market Share report from the Systems Building Research Alliance (SBRA) shows that the share of new MH units shipped to Vermont that meet the ENERGY STAR standard has held steady in the mid- to high-60s percent (69% in 2020, 64% in 2022)—exceeding both the average for the New England region and nationally (both 26%).[11] A likely contributing factor to the high share of MH units built to this standard was the availability of Vermont Housing Finance Agency (VHFA) loans that required ENERGY STAR ratings.

[11] Systems Building Research Alliance (2020). "ENERGY STAR Certified Manufactured Homes: Better Is Better."

VEIC modeling estimates that ENERGY STAR MH units can save approximately 20 percent over MH built to HUD Code minimum standards, although there is much room for improvement and opportunity, especially for electrification measures.

Zero Energy Ready Homes

The U.S. DOE implemented a Zero Energy Ready Homes pilot for Manufactured Homes (ZERH-MH) at the beginning of 2023. As of March 2024, there were over 7,000 ZERH-MH manufactured homes installed across the country, including seven in Vermont (part of the Shires Housing Project in Bennington). Notably, Clayton Homes, the largest manufactured housing producer in the nation, has committed to building all MH units to meet the ZERH-MH standard. This commitment alone has substantially increased the size of the HPWH market, not only in manufactured homes, but overall.[12]

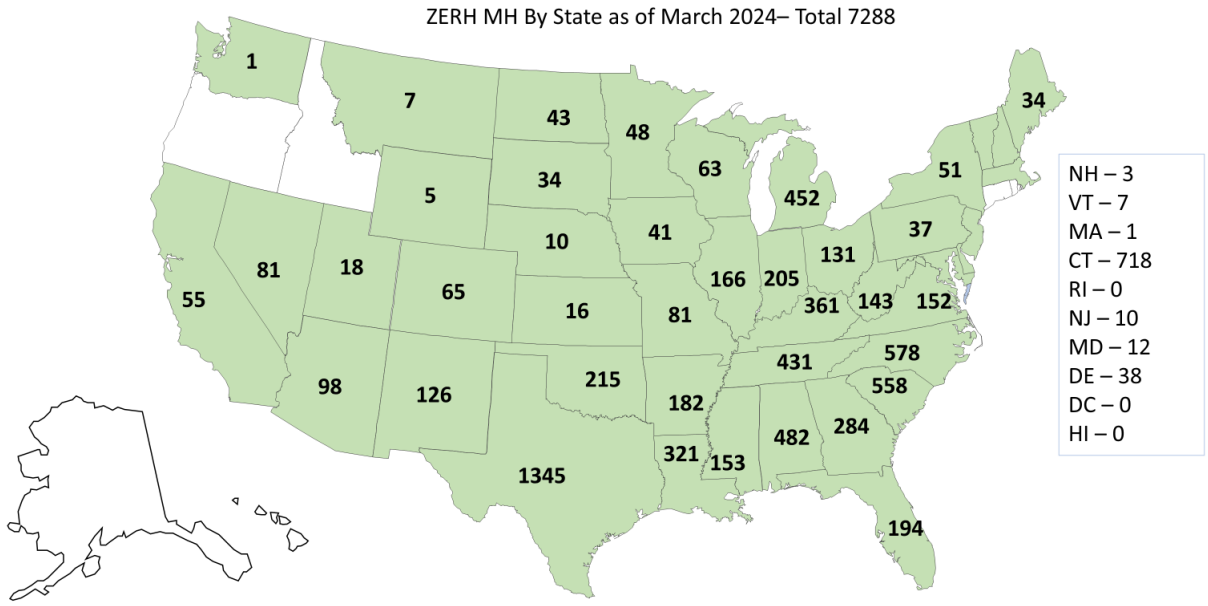

Figure 3. ZERH-MH Installed by State

Source: Joe Nebbia, Newport Partners (May 14, 2024). Email.

Future Demand

The trend line shown in Figure 2 indicates an expectation for new MH units to increase in the future, albeit with annual fluctuations. Efforts by the Vermont Agency of Transportation and State Housing Authority to deploy manufactured homes at scale—30 by the end of 2024 and another 250 by the end of 2025—represent a substantial increase in the volume of new

[12] CleanTechnica notes that Clayton's decision to build to the ZERH-MH standard has increased the market share for HPWHs by 30 percent: https://cleantechnica.com/2024/06/12/one-home-builder-grows-the-entire-heat-pump-water-heater-market-by-30/

shipments seen in recent years. These homes are intended as homeownership opportunities for LMI households. Though no commitment has yet been made to build these units to the Efficiency Vermont Advanced Manufactured Housing (AMH) or ZERH-MH standards, Efficiency Vermont staff are working to secure such commitments to help ensure long-term sustainability of these homes. Additional efforts by VHCB to deploy low-income MH rental opportunities in MH parks will add to this volume, with modest numbers expected in 2024 (fewer than 10 units) but potentially more in 2025.

Though it will become more difficult for new MH units to meet the ENERGY STAR standards when version 3 of the standard goes into effect in January 2026, the commitment by Clayton Homes to build all new MH to the ZERH-MH standard nationally, support from Efficiency Vermont for meeting the AMH standard, and the expected increase in baseline efficiency standards in the HUD code mean that new units are expected to be more efficient than comparable homes built in recent years.

Vermont Stakeholder Mapping

Understanding the key stakeholders impacting the manufactured housing market in Vermont is critical for establishing relationships needed to successfully deploy Efficiency Vermont program offerings to this sector. Efficiency Vermont staff already have established relationships with many of these stakeholders, serving as thought leaders and partners to these organizations. Table 22 provides an overview of the key stakeholders for Efficiency Vermont to engage as it seeks to serve this housing market sector.

Table 22. Key Stakeholders for Manufactured Housing in Vermont

Organization/Group	Key Perspectives
Department of Housing and Community Development (DHCD), Vermont Agency of Commerce and Community Development (ACCD)	• Enforcement of state MH park laws and rules (leases, lot rent increases, sale/closure of parks, habitability standards) • Annual registry of MH parks • Manufactured Home Improvement and Repair (MHIR) program
Office of Economic Opportunity (OEO), Vermont Agency of Human Services (AHS)	• Oversight of WAP program • Insights on weatherization needs, opportunities, and challenges in MH units
Local WAP Agencies (BROC, Capstone, CVOEO, NETO, SEVCA)	• Delivery of WAP program • Insights on weatherization needs, opportunities, and challenges in MH units • Delivery of other programs (e.g., CVOEO Mobile Home Program (MHP), Flood Recovery Assistance Fund (FRAF)) available to/impacting MH residents
Vermont Housing Finance Agency (VHFA)	• Financial and technical assistance support for affordable housing, including MH units • Goal to increase quality of housing stock, including providing financing models and resources for

Organization/Group	Key Perspectives
	infrastructure needs for Vermont's MH park communities
Vermont Housing & Conservation Board (VHCB)	• Financial support for acquisition, rehabilitation, and construction of affordable housing by nonprofit organizations. • Mobile Home Park initiative to acquire and improve MH parks by nonprofit organizations and resident-owned communities. • Purchase subsidy program to assist low-income households upgrade or replace deteriorated homes in VHCB-assisted MH parks • Manufactured Home Replacement & Infill Initiative focused on creation of MH rental units in MH parks with vacant and available lots
Champlain Trust	• Down-payment assistance program for purchase of high-efficiency manufactured homes
Vermont Agency of Transportation (VTrans)	• Market knowledge through existing research efforts • Supporting deployment of new MH units in large volumes
University of Vermont/USDA	• Market knowledge through existing research efforts. • Rural development efforts supporting new MH and improvements to existing MH
Manufactured home producers and retailers	• New manufactured housing—performance features and standards • Knowledge of existing MH market
Park owners and residents	• End customer • Decision-makers • Acceptance of program measures

Programs Impacting Manufactured Homes in Vermont

Efficiency Vermont Program Offerings

Based on review of current residential offerings by Efficiency Vermont and discussion with staff, current residential program offerings by Efficiency Vermont are available to all property types, including MH units. There do not appear to be restrictions specific to MH units but not other housing types. However, there are some programs where MH units may face difficulties meeting project eligibility requirements or securing a contractor that is willing and capable of working in this housing stock. Examples including Home Performance with ENERGY STAR (HPwES), cold climate heat pumps, heat pump water heaters, and electrical system upgrades.

Review of Efficiency Vermont databases and processes indicates that building type details currently are not being systematically captured in the Tracker database, and few projects in historic databases have notes in the comments field indicating that the customer served resides in an MH unit. This limits the ability to assess how current program offerings are impacting the

MH market sector and set goals. Anecdotally, program uptake by MH residents is believed to be lower than by other residential customers.

Available Funding Sources

Several funding sources beyond incentives offered through Efficiency Vermont are available to retrofit and improve MH units in Vermont. Many have income qualifications, limiting which households can receive support. Like Efficiency Vermont programs, many are not specific to MH units, but available to all residential building types. A detailed list of funding sources, measure categories, eligibility requirements, and incentive levels by income level are provided in a companion workbook to this research.

In addition, a recent report by ACEEE provides an overview of federal funding sources available for manufactured housing, including funding from housing, energy, climate, and health programs, including those funded through the 2022 Inflation Reduction Act (IRA) and 2021 Infrastructure Investment and Jobs Act (IIJA).[13]

National Program Examples and Initiatives

The ACEEE report referenced above also highlights several model programs. Table 23 shows key details for programs highlighted in that topic brief as well as others identified by the project team.

Table 23. National Energy Efficiency and Electrification Program Examples for Manufactured Housing

Program	Details
Efficiency Maine Manufactured Home Initiative	• Funding from IRA and competitive grant through DOE Energy Improvements in Rural or Remote Areas (ERA) program • Incentives installation of ducted heat pump systems—provides up to 85% of cost • Available to income-qualified (80% area/county median income, or recipient of HEAP, SNAP, TANF, or MaineCare) • Currently restricted to designated towns—areas with suitable outdoor temperatures (USDA climate zones 6a, 5a, and 5b) and contractor services to support the special needs of the program • Single-wide MH units only, principal residences only, baseline heating fuel must be kerosene or propane • Homeowner contribution ($2,000 upfront or $2,500 if accessing financing) • Estimated bills savings approximately $1,250 per year • Additional resources: ○ Qualified products list

[13] Table 1 of "Federal Funding Opportunities for Retrofits and Replacements" shows details on eligible applicants and activities. Bell-Pasht, A. (2023). Topic Briefs: Upgrading Manufactured Homes. ACEEE.

Program	Details

Oregon Rental Home Heat Pump Program	• Provides incentives to owners of MH units located on leased land (e.g. MH parks)
	• Incentives range from $2,000 to $7,000, or 80% of purchase price and installation costs of the heat pump; amount depends on costs, heat pump efficiency, and resident income levels (LMI vs non-LMI)
	• Incentives of $2,000 to $4,000 available for related upgrades; amount depends on resident income levels (LMI vs non-LMI)
	• Community Heat Pump Deployment Program established to provide grants to eligible entities (including nonprofit MH parks) to then design and implement programs to purchase and install heat pumps and related upgrades by members of the community
	• Additional resources:
	  ○ Program flyer
	  ○ NASEO presentation

Energy Solutions Manufactured Housing Retrofit Program (Louisiana)	• Started as pilot in 2018, adopted as permanent program in 2020 • No-cost energy upgrades for MH residents • Focuses on MH parks in order to aggregate work, reduce travel costs • Provides LED, low-flow fixtures, air/duct sealing, HVAC tune-ups, and cool roof coating for homes located in MH parks • Does not provide HVAC replacement as not cost effective per TRM in use • Average incentive of $1,200, expected savings of 6,500 kWh/year and $780/year • Program unable to keep up with demand (budget is ~$500,000) • Program provides training to existing trade and certification to trade allies • Additional resources: ○ ACEEE topic brief
Help My House Program (On-Bill Financing) (South Carolina)	• On-bill financing program, no up-front cost to customer • Not specific to manufactured homes, but roughly 40 percent of homes served as MH units (compared to 15 percent of homes in South Carolina are MH units) • Can fund home energy audits, weatherization, and high-efficiency equipment • Structured as a loan to customers, financed over 10 years utility bills • Qualification requires home to be "safe" for contractors to work in and home repairs completed by resident • MH units built before 1996 do not qualify due to the high cost of performance energy retrofits in older MH units • Customers qualify if in good standing on utility bills; no other income/credit requirements

Program	Details
	• Similar in structure to VT WRAP pilot • Funding from a low-cost USDA Rural Energy Savings Program (RESP) loan • Additional resources: ○ ACEEE topic brief
Mobile Home Park Utility Conversion Program (MHP-UCP) (California)	• Utility-side investments in MH park infrastructure upgrades • Conversion from master-metering to direct metering of individual lots with additional electrical service and beyond-the-meter upgrades • Required of investor-owned electric and gas utilities by the CPUC; municipal utilities encouraged to partner with IOUs when service territories are shared
Manufactured Housing Opportunity & Revitalization (MORE) Program (California)	• Grant funding to acquire, convert, rehabilitate, and replace old mobile home parks and individual mobile homes to preserve affordable homeownership opportunities • Eligible applications typically are resident organizations, nonprofit housing sponsors, or local public entities, which then award grant funding to residents

Replacement programs (various)	• Numerous programs target the replacement of deficient mobile and manufactured with new, high-efficiency manufactured homes.
	• Many target pre-HUD Code homes (i.e., mobile homes built before 1976). Given limited funding and high demand, this may be viewed as reasonable approach for prioritization. However, some note that a similar percentage of 1976 HUD Code homes are deemed inadequate.[14]
	• Select program examples:
	  ○ Oregon Housing and Community Services (OHCS) Manufactured Housing Replacement Program and Energy Trust of Oregon Manufactured Home Replacement Program targeting homeowners with income below 100% SMI
	  ○ MaineHousing Mobile Home Replacement Initiative targeting homeowners with income below 80% AMI
	  ○ New York Homes and Community Renewal (HCR) Mobile & Manufactured Homes Replacement Program targeting homeowners with income below 80% AMI

In addition to programs offered by states and utilities, NASEO, along with select state energy offices and the U.S. DOE, have formed the Manufactured Housing Energy Efficiency and Affordability Initiative.[15] The goal of the initiative is to share best practices and collaborate to:

[14] Furman, Matthew (2015). Most inadequate condition manufactured homes were built after the introduction of Federal building code. Harvard Joint Center for Housing Studies. https://www.jchs.harvard.edu/blog/most-inadequate-condition-manufactured-homes-were-built-after-the-introduction-of-federal-building-code

[15] 11 participating states are: CA, CO, KY, LA, ME, MN, MO, NY, NC, SC, WV

- address the high cost of heating and cooling manufactured homes;
- create lower-cost, public-private financing options of energy-efficient manufactured home purchases;
- identify opportunities for existing manufactured homeowners to replace their homes with more efficient manufactured homes, or improve their homes' energy efficiency to lower energy costs; and
- improve the availability of affordable, energy-efficient housing options and promote workforce development opportunities in local communities where manufactured homes.

Information shared by the Manufactured Housing Energy Efficiency and Affordability Initiative can serve as a valuable source of program design input for Efficiency Vermont. Recent developments highlighted by the Initiative include the following:

- program design considerations for combining community solar and weatherization in manufactured homes in Michigan[16]
- using community solar to cut energy burdens in manufactured home communities in New Hampshire[17]

Energy Efficiency and Electrification Measures in Manufactured Housing

In discussions with internal and external experts, the following efficiency and electrification measures were identified as impactful for existing manufactured housing in Vermont.

- ducted cold climate air source heat pumps (ccASHP) to replace furnaces, and ductless mini-split or other emerging heat pump options where ducts do not already exist
- 110v heat pump water heater (HPWH) options for homes with constrained electrical panels
- HPWHs with small storage tank options that can fit into existing closets / sink areas while still meeting resident needs
- ventilation, including whole house fans and energy recovery ventilators (ERV), with a focus on the indoor air quality benefits
- attic and floor insulation, when space allows (wall insulation typically is cost-prohibitive with limited space available to add insulation, and it is not recommended in most cases)
- duct repair and sealing
- air sealing
- efficient electric cooking appliances

[16] See: Paulos, B. (2024). A Program Design Combining Community Solar and Weatherization for Manufactured Homes in Michigan. Energy Markets & Policy, Berkeley Lab. https://emp.lbl.gov/publications/program-design-combining-community

[17] See: Oliver, J. (2024). Community Solar Projects in NH's Resident Owned Manufactured Housing Communities (ROCs). Presentation to Clean Energy States Alliance. https://www.cesa.org/wp-content/uploads/CESA-Webinar-9-18-24-slides.pdf

Reports by ACEEE and Slipstream support many of these recommended measures.

- ACEEE highlights that the need for structural repairs often leads to deferrals, and that wall insulation is not likely to qualify under utility cost-effectiveness programs. Recommended low-cost interventions include mechanical system tune-ups, roof measures (leaks/repairs), and direct-install measures (LED lighting, water fixtures, and smart thermostats). Recommended higher-cost interventions recommended include mechanical system replacement (ASHP, HPWH) and electrification support (updates to panels and wiring).
- Slipstream highlights that for manufactured housing in Minnesota, air sealing (penetrations and marriage joints) was cost-effective in nearly all homes, and duct sealing in approximately 75 percent of homes. In addition, they found that MH units have a high share of incandescent lighting, and they recommended plumbing heat tape (limiting the operation to winter only) and limiting the use of portable electric heaters.

In addition to specific measures that are impactful in existing MH units, a recent report by VEIC for the CalNEXT program provides a set of process models for considering electrification retrofits and whole home replacement in manufactured housing.[18] One process model focuses on utility-side considerations, and one focuses on in-unit considerations, with the intent to help programs prioritize segments of the existing housing stock that are most suitable for whole-home electrification retrofits. Considerations include the following:

- sufficient transformer capacity at the MH park or individual location
- sufficient electrical service to the home and panel capacity to support electrification measures
- vintage of the home (many programs prioritize retrofitting MH units built to the 1976 HUD Code or later and replacing MH units built before HUD Code standards)
- structural soundness or the ability to remediate structural issues (e.g., roof repairs, electrical wiring, mold/moisture problems)
- previous weatherization or pairing with weatherization measures

These process models are useful for segmenting existing housing stock at a high level. Individual homes that fall outside of the retrofit pathway might be well-constructed and -maintained, and therefore suitable for weatherization and electrification measures; individual homes built in recent years that fall inside the retrofit pathway might not be suitable. As noted previously, some research indicates that homes built to the 1976 HUD Code standard are similarly inadequate to homes built before 1976.[19]

[18] Figure 32 and Figure 33. McGrath et al (2023). *Mobile and Manufactured Housing Market Characterization Study*. Prepared by VEIC for CalNEXT.
[19] Furman, Matthew (2015). "Most inadequate condition manufactured homes were built after the introduction of Federal building code." Harvard Joint Center for Housing Studies.

Barriers to Energy Efficiency and Electrification of Manufactured Housing

Discussions with internal and external experts also identified the following barriers to deploying energy efficiency and electrification measures for existing manufactured housing in Vermont:

- **Structural deficiencies and other repair needs** including roofs, poorly constructed additions, rotting floors, electrical wiring, and vermiculite insulation. Bulk water management resulting from leaking roofs and plumbing issues are prevalent, with an estimated 1/3 to 1/2 of MH units treated by CVOEO needing roof repairs. Historically, these types of issues have resulted in high deferral rates from programs like WAP.
- **Challenging housing stock.** Limited cavities in walls results in wall insulation being cost-prohibitive. Small crawl spaces and attics make for challenging work insulating bellies and attics in these homes. Infestation by rats and other pests is common in the bellies of MH units, often impeding flexible ductwork run throughout that corridor.
- **Limited funding for non-energy savings measures**. While the availability of housing repair and remediation funding has increased in recent years, helping to keep more MH units in the WAP pipeline, those funds are not available to all segments of the market (e.g., non-low-income households). Based on data from OEO, non-energy savings measures can represent upwards of 40 percent of overall project costs, and these costs have increased substantially from the pre-COVID period.
- **Electrical infrastructure challenges.** CVOEO noted that most MH units treated by their programs have 100-amp electrical service and panels, but very few have 200-amps typically needed for full electrification. Their experience with MH units indicates that homes that are 10 years or older typically have substandard electrical infrastructure.
- **Inefficient heating systems but uncertain functionality of electrification alternatives.** Many MH units have old, poorly functioning heating and hot water systems. Even following weatherization, NETO and CVOEO noted skepticism around the ability of ccASHP alternatives meeting heating requirements during winter peak loads, stipulating that dual fuel options may be needed.
- **Space constraints** for may limit the opportunities for certain measures (e.g., replacing conventional water heaters with HPWHs due to the space requirements of the latter).
- **Lack of qualified contractors**. OEO noted that because the WAP program has crews that are trained and experienced working in MH units, they have found success treating these homes. However, outside of the WAP program, they perceive that there is a lack of experienced contractors willing and capable of working in these homes. CVOEO noted that because MH units often are of poor construction quality, it can be a challenge for contractors to work in these homes, particularly small attics and crawl spaces. Contractors need training on how to effectively treat those spaces—including what techniques that work best and what is most cost-effective. Knowing how to access ductwork and diagnose issues is another area to focus, as is the need to protect water lines from freezing, often requiring a thorough understanding of the construction techniques and house designs to determine where thermal boundaries should exist.

- **Resident behaviors and acceptance.** Stakeholders noted that, anecdotally, MH residents can be hesitant to switch fuels (e.g., switching from propane cooking appliances to electric). Additionally, CVOEO noted that MH residents they have interacted with tend to be debt-averse—the agency has encouraged residents to utilize low/no-cost financing (e.g., USDA loans) when available but these financing options have not been popular, and they are unsure how on-bill financing will be perceived by MH residents in the state.

Energy Use and Electrification Impacts

The summary energy use data for Vermont's exiting stock of mobile and manufactured homes presented in this section is derived from two primary data sources: modeling estimates from ResStock and historic project data provided by the VT OEO.

ResStock – Housing Stock Building Energy Model Data

The tables below reflect occupied mobile/manufactured homes in Vermont. Source data is based on the 2024.1 ResStock dataset. [Note: Approximately 15 percent of manufactured homes in Vermont in the ResStock dataset utilize a primary heating source characterized as 'Other Fuel'. In these cases, the fuel end use is not included in the model outputs. For this reason, we have filtered out these records looking only at summary data for the most common fuels: fuel oil, propane, natural gas and electricity.]

Table 24. Average Annual Energy Use by Primary Heating Fuel

Primary Heating Fuel	Average Annual Electricity (kWh)	Average Annual Fuel (MMBtu)	Average Annual Total (MMBtu)
Fuel Oil	10,250	80	114
Propane	8,460	94	123
Natural Gas	8,067	103	130
Electricity	18,769	-	64
All Homes	9,743	84	117

Looking at all homes, excluding those with 'Other Fuel' at today's fuel costs, total energy costs can exceed $4,000 annually. This estimate is in line with actual fuel consumption data received from VT OEO presented in the following section.

Table 25. Modeled Annual Average Energy Costs

	Average Annual Electricity Cost	Average Annual Fuel Cost	Average Annual Total Cost
All homes	$2,058	$2,468	$4,526

Cost estimates are based on data from the Vermont Fuel Price Report for bulk fuels, and EIA for natural gas and electricity. Both use an average of 2023-YTD2024 cost data.

Table 26. Fuel cost assumptions

	Unit Cost	Unit
Electricity	$0.21	kWh
Natural Gas	$1.92	Ccf
Propane	$2.99	Gal
Fuel Oil	$4.03	Gal

Parsing out the housing stock by vintage shows, as expected, an overall decline in average energy consumption and costs associated with implementation of the HUD Codes. Home vintage is captured in decades by ResStock, while the HUD codes have been implemented in mid-decade years, therefore the alignment to HUD code periods is close but not perfect. The first HUD code came into effect in 1976. The first and only major update to the HUD code occurred in 1994, ResStock vintage bins were created as shown in Table 27. Table 28 and Table 29 show average annual energy use and cost respectively. Cost assumptions are based on current Vermont fuel prices as described in the following section.

Table 27. Alignment of Effective HUD Code with ResStock Vintage Bins

HUD Code	ResStock Vintage
Pre-HUD	<=1979
1976 HUD	1980-1999
1994 HUD	>1999

Table 28. Average Annual Energy Consumption by Vintage

	Average Annual Electricity (kWh)	Average Annual Fuel (MMBtu)	Average Annual Total (MMBtu)
Pre-HUD (<=1979)	9,558	102	135
1976 HUD Code (1980-1999)	9,321	80	112
1994 HUD Code (>1999)	11,098	60	98

Table 29. Average Annual Energy Consumption by Vintage

	Average Annual Electricity Cost	Average Annual Fuel Cost	Average Annual Total Cost
Pre-HUD (<1979)	$2,019	$2,964	$4,983
1976 HUD Code (1980-1999)	$1,969	$2,377	$4,346
1994 HUD Code (>1999)	$2,344	$1,788	$4,132

The spike in electricity consumption of the newer vintage homes is largely driven by an increase in air conditioning.

Relative to single-family detached homes, manufactured housing has on average lower annual energy use, but higher energy intensity, or energy use per home size. Table 30 and Figure 4 below illustrate this by comparing the overall energy use and EUI for the two home types. While single-family homes are on average roughly 75 percent larger than manufactured homes, and

use 50% more energy overall, the EUI of single-family detached homes is 12% less. Single-family detached higher energy use is largely driven by greater heating and hot water loads.

Table 30. Manufactured Homes vs. Single-family Detached Energy Use

	Average Size (sf)	Average Annual Energy Use (MMBtu)	Average EUI (kBtu/sf)
Manufactured homes	1,194	117	106.9
Single-family detached	2,105	178	93.7

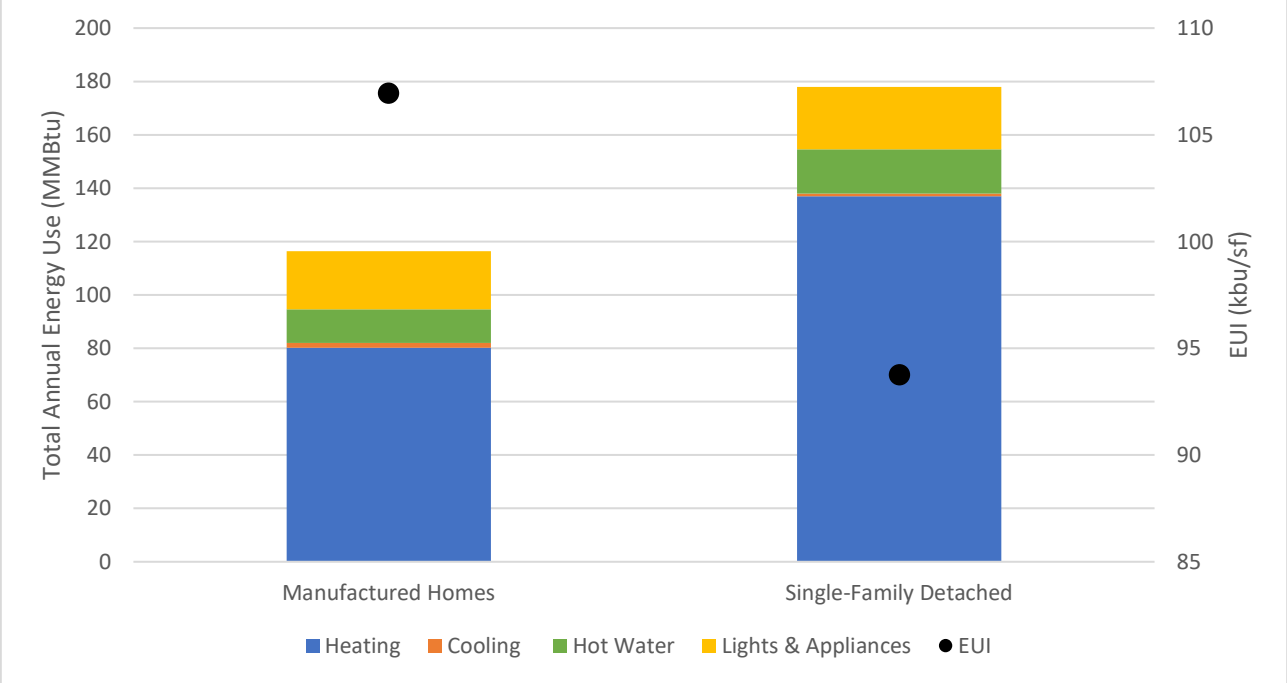

Figure 4. Average Annual Energy Consumption and EUI for Manufactured Homes and Single-Family Detached

In addition to energy intensity of manufactured homes being higher than single-family detached housing, a similar pattern is seen when looking at energy burden, or the percentage of one's income going to home energy use. Figure 5 compares annual energy cost and energy burden, as calculated by the U.S. LEAD Tool. Note that average energy costs for manufactured housing are slightly lower than those presented above due to differences in cost assumptions. The LEAD tool is based on the 2022 U.S. Census ACS survey calibrated to 2022 EIA survey data. While annual energy costs for single-family homes are on average 20 percent higher than manufactured homes, the energy burden is 30 percent lower. Table 31 provides additional details on estimated energy costs and burdens among MH residents in Vermont by area median income level.

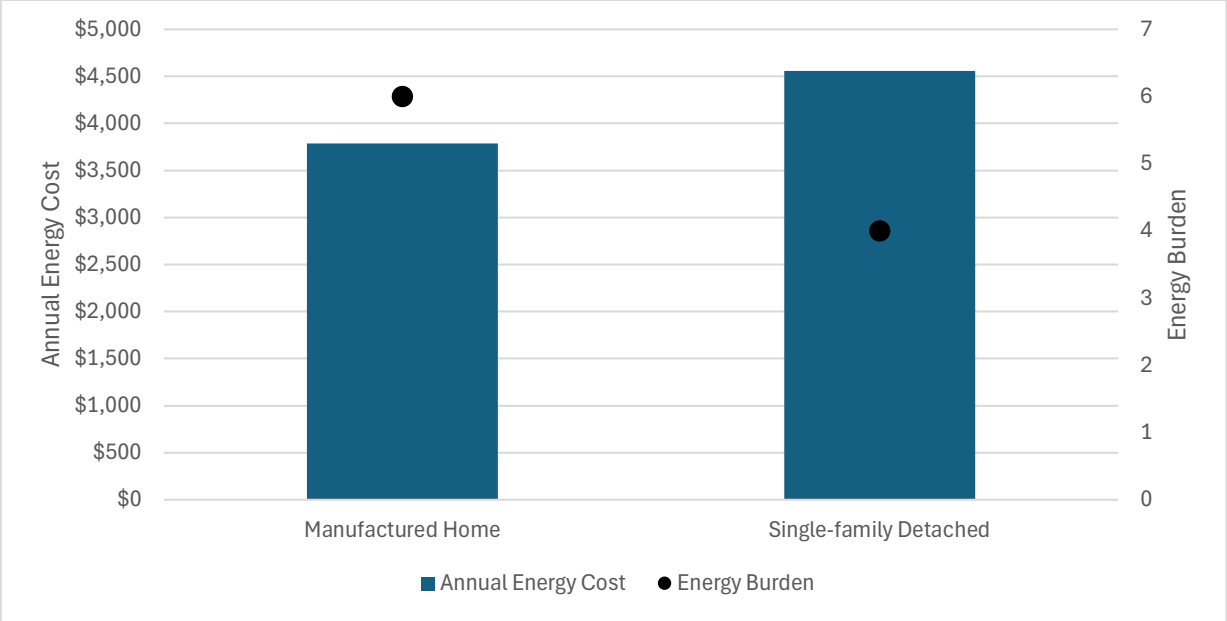

Figure 5. Energy Cost and Burden – Single-Family Detached vs Manufactured Homes

Table 31. Average Energy Costs and Burden in MHs in Vermont by AMI Level

Area Median Income Level	Average Electricity Costs	Average Gas/Other Fuel Costs	Average Total Energy Costs	Average Income	Average Energy Burden
Below 80% AMI	$1,410	$2,212	$3,622	$32,069	11.3%
80-150% AMI	$1,558	$2,581	$4,139	$85,000	4.9%
Greater than 150% AMI	$1,510	$2,279	$3,789	$150,860	2.5%
Total	$1,463	$2,324	$3,787	$58,795	6.4%

Source: DOE LEAD

Vermont Office of Economic Opportunity (OEO) Historic Project Data

Pre-Weatherization Energy Use

Actual historic energy use for Vermont mobile and manufactured homes shared by VT OEO is from 2016. Updated data were requested for this study but were unable to be provided. It may be that homes, on average, have gotten more efficient and use less energy overall. However, because these are homes seeking weatherization, it may also be assumed that this data, while older, is still representative of existing manufactured homes in need of weatherization. The provided data set is composed of fuel records provided to OEO directly from the fuel vendors during the weatherization application process. OEO receives multiple years of consumption history and then derives the annual energy consumption from those data. In the case of biomass fuels, OEO has to rely on the clients' best guess of annual usage. The data summarized below covers approximately two years of fuel records associated with client applications living in mobile homes at four of the five of the local WAP agencies.

Table 32. Average Actual Annual Energy Use for Vermont Manufactured Homes

	Average Annual Electricity (kWh)	Average Annual Fuel (MMBtu)	Average Annual Total (MMBtu)
Including wood	7,189	135.8	**160.3**
Excluding Wood	7,216	72	**96.7**

Source: Vermont Office of Economic Opportunity (email from Josh LaRose Jan 19, 2016)

Looking at only at homes that do not utilize wood heat, the total average annual MMBtu is about 17 percent less than the ResStock modeled average. This is well within the bounds of operational vs asset modeling variance in energy use. Anecdotally, it can be the case that residents do not operate their homes at comfortable temperatures due to inability to afford fuel costs, whereas an energy model simply assumes the home is heated and cooled to the setpoint.

For homes that do not utilize wood heat, total average energy costs are roughly $4,000 annually. Fuel cost assumptions are the same as those presented above in Table 26. Homes in the dataset that did utilize wood used on average 4 cords or 236 bags of pellets. Cord wood can be highly variable in price, and potentially zero cost. Assuming an average $250/cord, and $379/pallet of pellets (Energy Co-op of Vermont average), the cost of wood could add an additional ~$1,500/year to total energy cost.

Table 33. Average annual fuel costs

	Average Annual Electricity Cost	Average Annual Fuel Cost	Average Annual Wood Cost	Average Annual Total Cost
Including wood	$1,519	$1,809	$1,446	**$4,774**
Excluding wood	$1,524	$2,611	$0	**$4,135**

Weatherization Project Statistics

In addition to the historic pre-weatherization energy use data, OEO also shared with VEIC project performance data covering the 5-year operating period 2016-2020. These performance reports provide detailed data about where weatherization projects are performed, projects costs as well as estimated savings. While OEO does have access to measure level savings data, which we may want to pursue, at this time they have only shared project level data.

Based on the 5-year OEO data (2016-2020), overlayed with total population estimates, only about one percent of all existing manufactured homes are treated annually. Of these, 90 percent are owner-occupied. A slight majority (61%) are assumed to be single-section homes (based on square footage data). Most jobs are performed in three counties: Chittenden, Orleans, and Caledonia. Just over 10 percent of all weatherization projects are completed in each of these counties. Table 34 shows the distribution of manufactured homes and average number weatherization jobs completed annually.

Table 34. VT OEO Weatherization Jobs by County

County	Total Occupied MH Units	Average Number of Wx Jobs Annually in MH Units	Percent of MH Units Treated Annually
Addison	1,217	10	1%
Bennington	726	11	2%
Caledonia	1,165	22	2%
Chittenden	2,739	21	1%
Essex	344	4	1%
Franklin	1,247	14	1%
Grand Isle	307	3	1%
Lamoille	1,084	8	1%
Orange	1,245	7	1%
Orleans	1,010	21	2%
Rutland	1,504	12	1%
Washington	1,351	14	1%
Windham	1,020	11	1%
Windsor	1,629	12	1%
TOTAL	16,588	171	1%

Source: DOE LEAD and VT OEO WAP program data (2016-2020)

The majority of weatherization projects (~80%) are estimated to save <50 MMBtu/year. On average, estimated annual savings is 35 MMBtu/job, at an average cost of $264/MMBtu ($11/MMBtu lifetime savings). Of the approximately 300 jobs with a pre-usage variance <50 percent[20] and non-0 reported MMBtu savings, only 12 projects had reported electricity savings.

The one measure level metric reported in the shared performance data was for air leakage. On average, weatherization projects are able to achieve about a 40 percent reduction in air leakage. Average pre-weatherization infiltration rates are reported to be approximately 1,336 CFM50 (~18 ACH50). Post-weatherization infiltration for this dataset averaged 1,327 CFM50 (~10 ACH50).

Average total on-site costs ranged from approximately $6,300 (single-section) to $7,300 (multi-section). Total project costs ranged from about $50 to more than $16,000 per home. Subcontractor costs accounted for 17 percent of total costs on average. Non-energy saving investments, including ancillary, incidental repair. health & safety measures—excluding travel and cleanup—are about 80 percent of energy savings costs. Of all projects, subcontractor costs average 15 percent of total costs.

Table 35. VT OEO Project Costs for Program Years 2016-2020

	Average	Min	Max
Energy	$3,426	$284	$9,386
Non-energy	$2,706	$56	$8,208

[20] Per Josh LaRose, homes with a pre-usage actual to modeled variance greater than 50% should be excluded from analysis.

Travel/clean-up	$599	$0	$2,238
Total project cost	$6,720	$56	$16,325

Table 36 summarizes the average level of effort for weatherization jobs on manufactured homes.

Table 36. VT OEO Project Statistics – Hours and days on job site

Average Number of Days on Job Site	Average Total Job Hours	Average Total Hours for Travel/Cleanup	Average Percent of Working Hours Required for Travel/Cleanup
5	108	17	20

Energy Savings Modeling Scenarios

Energy and fuel costs savings estimates were developed for weatherization, electrification and whole home replacement scenarios. In order to generate these estimates, both prototype energy modeling and historic energy data was utilized. In 2023, a TRM was developed for Advanced Manufactured Homes (AMH). The TRM savings are based on prototype models of the baseline HUD Code home and AMH standard. Final savings are weighted by a mix of baseline efficiencies and fuel types. These savings are applicable to new construction as the baseline is assumed to be a new home built to HUD Code or ENERGY STAR standards. This baseline is not applicable in a retrofit or whole home replacement scenario. A baseline model was developed using the HUD Code prototype as the base model and modified so that modeled energy consumption was more in line with the actual historic pre-weatherization consumption data provided by OEO. Modifications to the baseline prototype include reduction in wall insulation R-value, degraded insulation installation quality for all assemblies, increased infiltration and duct leakage rates. Additionally, the prototype baseline model is limited to a single-section home using propane fuel as this is the most common existing manufactured home type. Upgrade scenarios include basic weatherization, as well as the following electrification measures: induction stove, heat pump ventless dryer, heat pump water heater, ducted mini-split heat pump.

Table 37 provides the detailed inputs for the baseline prototype model and upgrade scenarios.

Table 37. Prototype Energy Model Assumptions

		Existing Manufactured Home Baseline	Basic Weatherization	Electrification Measures
Weather		Burlington, VT		
Size		Single-section (980 sf)		
Envelope	Walls	R-13, G2	-	-
	Floor	R-22, G2	R-22, G1	-
	Ceiling	R-30, G2	R-38, G1	-
	Window	U0.52	-	-

		Existing Manufactured Home Baseline	Basic Weatherization	Electrification Measures
	Doors	R-1.7	-	-
	Air Leakage	10 ACH50	6 ACH50	-
HVAC	Heating	80 AFUE propane furnace	-	Ducted mini-split 16.2 SEER2/8.8 HSPF2 w Integrated Back up
	Cooling	13.4 SEER2	-	
	Duct Leakage	8 cfm25/100sf, uninsulated	4 cfm25/100sf, R-8	-
	Hot Water	0.57 EF propane tank		HPWH UEF 3.3
	Ventilation	EOV: 2.26 cfm/w, auto cfm		-
Lights & Appliances	Lighting[1]	100% LED (sdent, EISA)	-	-
	Refrigerator	Top freezer, 480 kWh/yr	-	-
	Dishwasher	Fed Min: 307 kWh	-	-
	Range/oven	Propane	-	Induction
	Clothes washer	IMEF 1.57	-	-
	Clothes dryer	Propane, CEF 3.30	-	Heat Pump CEF 5.2
	Plug loads[2]	2x	1.5x	-

Table notes:

1. The authors recognize this baseline is not realistic, however this baseline was required for the AMH TRM due to EISA. Since lighting is not a focus of this project the baseline was not modified.
2. Adjusting plug loads was used as a proxy for assumed space heat in the existing home. OEO average pre-weatherization electricity use was much higher than the prototype model estimates without any assumed space heater use.

Energy savings estimates for each of the prototype model scenarios, as well as reference to average savings achieved by OEO Weatherization projects are provided in the tables below. Historic OEO project data does include actual pre-weatherization historic consumption. However, savings data are all estimated based on energy modeling conducted in Hancock software. When OEO provided the historic project data, they cautioned that in some cases actual pre-weatherization data varied considerable from the baseline model energy estimates. When OEO provides energy savings estimates, they filter out any records where the actual to estimated energy use is greater than 50 percent. The same practice was followed here. Savings are based on a filtered subset of projects where the 'pre-usage variance' is less than 50 percent.

Table 38. Estimated Fuel Savings for Weatherization and Electrification Scenarios

Scenario	Fuel Savings			
	Total Savings (MMBtu)	Electricity Savings (kWh)	Fuel Savings (gal)[2]	Fuel Savings (MMBtu)
Full Weatherization (Historic OEO Project data)				
Average[1]	34.7	135	-	34.2
Minimum	2.7	-	-	-
Maximum	282.0	15,064	-	282.0
Prototype Modeling Scenarios (Wx + Electrification)				
Basic Wx	16.8	750.3	155.1	14.2
Basic Wx+ASHP	49.6	(4,803.6)	720.0	65.9
Basic Wx+HPWH	22.0	32.3	238.9	21.9

Scenario	Fuel Savings			
	Total Savings (MMBtu)	Electricity Savings (kWh)	Fuel Savings (gal)[2]	Fuel Savings (MMBtu)
Basic Wx+Induction Stove	17.7	419.1	177.3	16.2
Basic Wx+HP Dryer	19.3	445.5	193.7	17.7
Basic Wx+Full Electrification	66.5	(5,946.7)	947.1	86.7
Prototype Modeling Scenarios (Electrification only, post-Wx)				
Basic ASHP (post-Wx)	32.8	(5,553.9)	564.9	51.7
Basic HPWH (post-Wx)	5.2	(718.1)	83.7	7.7
Basic Induction Stove (post-Wx)	0.9	(331.2)	22.2	2.0
Basic HP Dryer (post-Wx)	2.5	(304.8)	38.5	3.5
Basic Full Electrification (post-Wx)	49.7	(6,697.0)	791.9	72.5
Whole Home Replacement				
Whole home replacement	74.1	(3,716.3)	947.1	86.7

Table notes:

1. Includes projects with 0 savings (i.e. not all homes have electricity or fuel savings)
2. Fuel savings is propane for the prototype home scenarios. These rows are blank for the OEO projects because they represent a mix of fuels.

Energy costs savings were calculated using the fuel costs shown in Table 26. For the prototype model scenarios, all costs are based on propane and electricity savings only. The OEO historic project data contains savings for all fuel types. Cost savings were calculated for each fuel saved in the home using the costs in Table 26. Average costs for all fuels are presented below. When looking at the estimated savings for the whole home replacement scenario, it is important to remember that these estimates are based on an average baseline home. Many existing manufactured homes will consume much more energy than average and realized much higher savings, as indicated by the max savings row for historic OEO project data.

These savings are a 'first pass' based on whole home energy modeling that has traditionally been utilized to support ZEM and the AMH initiatives. For individual measures (non-whole home scenarios), Efficiency Vermont may prefer to develop TRM based savings estimates or additional baseline scenarios.

Table 39. Estimated Fuel Cost Savings for Weatherization and Electrification Scenarios

Scenario	Cost Savings		
	Electricity Cost Savings	Fuel Cost Savings	Total Cost Savings
Full Weatherization (Historic OEO Project data)			
Average[1]	$28	$1,124	$1,149
Minimum	$0	$85	$85
Maximum[2]	$3,182	$7,561	$7,561
Prototype Modeling Scenarios (Wx + Electrification)			
Basic Wx	$158	$464	$623
Basic Wx+ASHP	-$1,015	$2,155	$1,140
Basic Wx+HPWH	$7	$715	$722
Basic Wx+Induction Stove	$89	$531	$619

Scenario	Cost Savings		
	Electricity Cost Savings	Fuel Cost Savings	Total Cost Savings
Basic Wx+HP Dryer	$94	$580	$674
Basic Wx+Full Electrification	-$1,256	$2,835	$1,579
Prototype Modeling Scenarios (Electrification only, post-Wx)			
Basic ASHP (post-Wx)	-$1,173	$1,691	$518
Basic HPWH (post-Wx)	-$152	$251	$99
Basic Induction Stove (post-Wx)	-$70	$66	-$4
Basic HP Dryer (post-Wx)	-$64	$115	$51
Basic Full Electrification (post-Wx)	-$1,415	$2,370	$956
Whole Home Replacement			
Whole home replacement	-$785	$2,835	$2,050

Table notes:

1. As in Table 38, average electric cost savings include projects with 0 electric savings
2. To put this cost savings value into perspective, the maximum total fuel costs based on actual pre-weatherization data, in today's fuels costs, is $11,028. This home was heated with kerosene, a very expensive heating fuel. Excluding this outlier, the maximum total cost was $7,988

Discussion

Manufactured housing is a small segment of the residential market in Vermont, representing only six percent of housing units in the state. However, it is an important source of affordable housing in the state, particularly for low-income and moderate-income residents. Key information about the MH market in Vermont is summarized below.

- Most MH residents are LMI – 62 percent have incomes at or below the income-eligibility threshold for WAP and Efficiency Vermont's low-income offerings, and 29 percent are income-qualified for Efficiency Vermont's moderate-income offerings. Only about nine percent of MH residents have incomes above Efficiency Vermont's moderate-income threshold, and therefore only qualified for market rate offerings.
- Most MH residents live in homes built before the HUD Code was implemented (34%) or during the first iteration of the HUD Code (1976 HUD Code, approximately 43% of MH residents).
- The state has a very high homeownership rate among MH residents, but nearly half of MH units are located on leased land.
- Bulk fuels – propane and fuel oil / kerosene – are the predominant fuels used for space heating. Regionally, most MH units are heated by central furnaces with ductwork. Many of these systems are old and likely inefficient. About half of MH residents rely on a secondary space heating fuel during the winter heating season, typically is electric resistance heating.
- Regionally, air-conditioning (typically window/wall units) is common in MH units—used by about 3/4 of MH residents.

- Hot water typically is provided by electric resistance water heaters—over 80 percent of MH units. Many are old, and most are small- or medium-sized storage water heaters, often located in small closets or underneath sinks.
- Housing costs (including utilities bills) among MH residents typically are considered unaffordable (greater than 30 percent of income) for low-income households, despite lower upfront costs associated with MH homeownership. Housing costs typically are affordable for non-low-income households (96 percent).
- About 1/3 of MH units in Vermont are located in MH parks. These parks tend to be small—63 percent of MH parks have 25 lots or less. MH units and MH parks tend to be located along transportation corridors in the state with concentrations around Burlington, Brattleboro, and Montpelier.
- Shipments of new MH units have increased slightly over last few years but are still far below peak shipments in 1990s. New MH units are increasingly being built to high-performance energy standards (ENERGY STAR, ZERH-MH, AMH). Efforts are underway at the Vermont Agency of Transportation (AOT) and the State Housing Authority, along with VHCB, to deploy many more new MH in coming years.

The MH market sector is challenging serve with energy efficiency and electrification measures due to common construction techniques found in these homes, structural and other repair issues, electrical infrastructure, and other challenges.

- Current offerings from Efficiency Vermont generally are available to MH residents, but uptake is understood to be low.
- The WAP program provides a good example of how to serve the MH housing stock in Vermont, and other national program examples provide additional information on types of measures and approaches taken to serve the market. The WAP program in Vermont is implementing some electrification measures in MH units, but the program is not available to non-low-income residents living in MH units. Additionally, there are barriers to deploying electrification measures at a broader scale through the WAP program, including skepticism that ccASHP can meet the heating needs of residents.
- Without funding to address structural and other repair issues in these homes, programs seeking to achieve a meaningful and lasting impact through energy-savings measures will face high deferral rates or limited longevity.
    - Efficiency Vermont's new Home Repair program is one effort that can help address these issues. The Home Repair program is open to income-qualified residents pursuing weatherization, including low-income residents in MH units, and could serve as a model for home repair funding offered more broadly to the MH market (including non-low-income households).
    - Alternatively, though stakeholders noted that MH residents tend to be debt-averse, the success of on-bill financing programs in this market sector in places like South Carolina could provide a model for how to approach home repair funding among non-low-income MH residents.

    - Modeling of actual housing costs reported by MH residents in the ACS with a hypothetical payment associated with a no-cost loan for housing repairs indicates that total housing costs would remain affordable for most non-low-income households.[21]
- Contractors need training and technical resources to work effectively in these homes. A well-trained crew is a key factor to success—they need to be adept at retrofitting and possess in-depth knowledge of best practices for repairing MH units. Training should cover the following topics:
    - proper air sealing and insulation techniques
    - the various types of manufactured home construction
    - combustion appliance safety and worst-case draft scenarios
- Support with electrical upgrades is needed in this market sector, including financial support for panel and service upgrades, as well as support finding qualified electricians.
- In some cases, product demonstration and/or innovation is needed to overcome hesitancy or skepticism toward electrification technologies, among both residents and contractors.
- In addition to training, contractors might need financial incentives to make serving these homes an attractive option compared to other market sectors.
- Recent work completed by NMR Group in Maine shows value in oversampling MH units to better understand the market, and in completing remote audits to assess specific needs.

Recommendations

Based on the state of the MH market in Vermont, the project team recommends the following:

- Update Efficiency Vermont data tracking procedures to record housing unit type and track program activity among customers residing in MH units. This is necessary to understand uptake and penetration of current program offerings in this housing market sector.
- Continue to develop partnerships with housing stakeholders, emphasizing need for structural repair dollars in existing MH units, including non-low-income residents who do not meet program income limits. Consider expanding Efficiency Vermont's new Home Repair program to be available to all MH residents, regardless of income, or develop a no-cost financing home repair option for non-low-income MH residents.
- Focus on workforce development and capacity building to develop a sufficient contractor pool willing and able to complete energy efficiency and electrification scopes of work in manufactured homes. Provide support for contractor training, including working with existing contractor networks to identify specific needs. For example,

[21] 96 percent of non-low-income MH residents reported having affordable housing costs (less than 30 percent of income), based on the 2022 5-Year ACS PUMS. When adding a hypothetical annual payment associated with a $20,000 zero-interest loan with 15-year repayment period, approximately 93 percent of non-low-income households residing in MH units would maintain affordable housing costs.

Efficiency Vermont could incentivize contractors to obtain the BPI Manufactured Housing certification and use the DOE's weatherization installer job aids interactive tool for manufactured housing.

- In the next Efficiency Vermont market assessment, oversample MH units to develop a deeper understanding of the opportunities and barriers in existing MH units in Vermont. Draw upon those results to update program designs and offerings, similar to work completed by Efficiency Maine. This could include using virtual audits and obtaining photos from MH residents to support on-site data collection methods.