

Healthy Homes Vermont 2021

Efficiency Vermont R&D Project: Healthcare
Partnerships

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Executive Summary

Living conditions have an effect on health.^{1,2} Nationwide, government health departments, health care providers, and social workers are now providing multi-trigger, multi-component interventions to reduce building occupant exposure to indoor asthma triggers, trip and fall hazards, and deteriorating lead paint. Several of these partnerships involve home performance and weatherization contractor networks. They also address chronic emphysema and bronchitis. The list of other illnesses affected positively by comprehensive residential building retrofits covers non-respiratory conditions such as multiple chemical sensitivity, chronic chill, hypertension, allergies, mental health, and arthritis.

Efficiency Vermont collaborated with regional hospitals and the Vermont Weatherization Assistance Program (WAP) to deliver energy-plus-health services to low-income households. The pilot programs targeted customers with asthma, chronic obstructive pulmonary disorder (COPD), and those at risk of falling at home.

RESULTS

In addition to improved comfort at home, participants reported a 71% reduction in falls (N=9) and a 55% improvement in asthma control test or COPD assessment test scores (N=9). The average plus-health cost was \$387 per home for fall reduction (N=16) and \$5,112 per home for respiratory trigger supplies and retrofits (N=9).

The pilots succeeded in establishing Vermont-specific experience and positive outcomes with energy-plus-health program collaborations. Partner relationships are stronger as a result of the pilots, and they are driving new program designs and increased cross-referrals outside the pilot programs. Experiences in air quality testing are leading to expanded energy efficiency program designs.

LOOKING AHEAD

WAP organizations can add cost-effective services to the crews' work scope, leading to holistic home retrofits and increasing health outcomes. However, WAPs are also under pressure to deliver high-volume retrofit rates. Vermont policymakers and program advocates must weigh several priorities such as: (1) comprehensively addressing each home weatherization, solving multiple problems across disciplines and maximizing cost-effectiveness, and (2) scaling up and weatherizing as many homes as possible, knowing those homes will require future services from other support programs. It may be challenging to find the right balance.

¹ Krieger, James., and Donna Higgins, 2002. "Housing and Health: Time Again for Public Health Action," *American Journal of Public Health* 92(5):758-68. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1447157/>.

² Wilson, Jonathan, David Jacobs, Amanda Reddy, Ellen Tohn, Jonathan Cohen, and Ely Jacobsohn, 2016. *Home Rx: The Health Benefits of Home Performance*. U.S. Department of Energy. <https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Home%20Rx%20The%20Health%20Benefits%20of%20Home%20Performance%20-%20A%20Review%20of%20the%20Current%20Evidence.pdf>.

The partners continue to identify areas for deep collaboration and multi-solving. Patient recruitment for the UVM Medical Center Pediatric Pulmonology pilot will continue via ongoing patient tracking for potential home environmental respiratory triggers and doctor referrals to Efficiency Vermont.

A Weatherization Health Initiative pilot led by the Department of Public Service is expected to commence in mid-2022 and continue at least through 2023, further exploring the benefits of energy-plus-health collaboration.

A “Wx-Health” adder is under consideration for inclusion in Vermont’s societal cost-effectiveness screening tool. If approved, the Wx-Health adder will enable Vermont’s energy efficiency utilities to better account for the recognized health and healthcare-associated benefits and avoided costs that result from weatherization-related projects and measures and ensure resource decisions are appropriately directed at least-cost outcomes for customers and society.

Collectively, these efforts will expand Efficiency Vermont and the collaboration partners’ ability to best support Vermonter’s in achieving healthy, energy efficient homes today and for generations to come.

Introduction

THE VERMONT HEALTHY HOMES STORY

Many Vermonters in low-income households are at greater risk of health problems than are high-income households. This is due, in part, to the condition of the buildings in which they live. The nexus between energy efficiency in buildings and improvements in health (especially respiratory health) is now the essential rationale for justifying societal investments in improving housing conditions for vulnerable populations. The healthcare and energy sectors agree that improving housing conditions is a high priority. These sectors also have historical and ongoing support for the rationale from the social services sector.

After demonstrating a successful partnership among those three sectors in 2018, Efficiency Vermont expanded its energy-plus-health collaboration in 2019 and 2020 to involve more locations, more partners, and specific health conditions. Together, the partners are applying their respective funding sources and human resources to pave the way for more positive health outcomes. The path to those outcomes connects energy-plus-health assistance to people at risk of respiratory illness, trips / falls, and other conditions exacerbated by substandard housing conditions.

Collectively, the partners are testing innovative energy-plus-health collaboration pilots and assessing whether these models may be scaled to become a cost-effective component of energy efficiency programs statewide. The pilots' structure and activity also offer a template for other jurisdictions.

This report addresses the progress achieved in the 2018–2021 Healthy Homes pilots and summarizes key findings. [Healthy Homes Vermont 2018](#), [Healthy Homes Vermont 2019](#), and [Healthy Homes Vermont 2020](#) offer historical background on the development of the energy-plus-health program at Efficiency Vermont.

This report also captures additional Healthy Homes program advances made through these healthcare partnership pilots funded by Efficiency Vermont's research and development program.

EFFICIENCY VERMONT HEALTHY HOMES VISION AND GOALS

Efficiency Vermont established the Healthy Homes Vision in 2017:

Through energy efficiency, Vermont homes are safe, affordable, comfortable, durable, and resilient. These attributes result in improved population health and a reduction in greenhouse gases.

The following Healthy Homes program objectives support the vision:

1. Providing cost-effective services that improve indoor environmental quality while reducing energy burden

2. Increasing benefits through strong Healthy Homes collaborations and partnerships
3. Providing credible and valued leadership in the health / energy nexus
4. Creating a clear policy, advocacy, and regulatory strategy for healthful, affordable homes.

To meet program objectives and support this vision, Efficiency Vermont used its partnerships with the Vermont Office of Economic Opportunity Weatherization Assistance Program (OEO WAP), the Vermont Department of Health (VDH), community organizations, and hospitals to establish the Healthy Homes program. The program incorporates the following specific aims:

- Integrate healthy-home principles and resources into all of Efficiency Vermont’s residential program designs and services.
- Build a culture of healthy homes in Vermont by raising awareness with consumers, healthcare providers, and building contractors of the connections among indoor environmental quality, energy efficiency, and health.
- Launch pilots testing how a collaboration among healthcare providers, weatherization programs, community service programs, and Efficiency Vermont can use an energy-plus-health service approach for customers with chronic respiratory illness and / or in-home fall hazards to improve housing quality and indoor air quality (IAQ) and track health outcomes from these services.
- Quantify the health-related non-energy benefits of weatherization retrofits.
- Identify health-specific and indoor environmental quality-specific products with opportunities for energy efficiency improvements.
- Create new tracking procedures for measuring and reporting IAQ before and after energy efficiency services.
- Establish sustainable funding models for energy-plus-health residential interventions.



Efficiency Vermont follows the U.S. Centers for Disease Control and Prevention (CDC) and the National Center for Healthy Housing (NCHH) in defining a *healthy home* as one that is: dry, clean, safe, well ventilated, pest free, contaminant free, maintained, and thermally controlled (Figure 1).

Efficiency Vermont supports utility ratepayers in meeting their energy goals while also ensuring that home energy upgrade projects consider the eight principles of a healthy home.

Principles: U.S. Department of Housing and Urban Development
 Graphic: airmid

Figure 1: Principles of healthy homes

The Healthy Homes Pilots

Efficiency Vermont conducted four pilots from 2018 through 2021, with participant enrollment for three of the pilots ending in summer 2020. Despite COVID-19 delays, all four pilot collaborations continued offering services through 2021.

These pilots quantified the effects of energy-plus-health measures on patients, healthcare providers, and weatherization service providers. The objective was to expand Vermont-specific evidence related to the intersection of energy efficiency and health, so that this evidence can inform future State policy and program decisions.

NORTHEAST KINGDOM

In 2018, Efficiency Vermont, the Northeastern Vermont Regional Hospital (NVRH), Vermont OEO WAP, and NETO (the local WAP affiliate) launched a 10-home pilot for households with occupants experiencing one or both of the prevalent chronic respiratory diseases in Vermont, chronic obstructive pulmonary disease (COPD) and asthma. Participants received energy-plus-health improvements, self-managed care coaching, healthy home education, and green cleaning and healthy living supplies.

The energy-plus-health improvements were specific to each home; examples include whole-home weatherization and electrical efficiency upgrades, active radon mitigation, expanded moisture management, advanced ventilation, smooth-flooring replacements of carpeting, spot HEPA room air cleaners, and appliance replacements.

The self-managed care coaching and healthy home education taught patients how to identify and mitigate respiratory triggers at home, use the new supplies and respiratory-friendly cleaning techniques, and use medication properly. NVRH also provided support in connecting with community services beyond the existing One Touch³ program referrals.

The team administered IAQ testing and health surveys before and after the improvements.

Results

Seventeen patients were referred by NVRH to Efficiency Vermont and NETO. Three patients did not meet program criteria for financial status (2) and health status(1), and one patient declined to join the program. The remaining thirteen participants received in-home self-managed care coaching, environmental assessments, and green cleaning supplies from NVRH staff.

³ One Touch is an electronic survey that WAP Efficiency Coaches complete during the initial visit. Based on customer responses, the survey logs customer referrals to multiple services for each household, triggering automatic notifications that the agency receiving the referral can respond to. <https://onetouchhousing.com/>.

Environmental Assessments

Table 1 summarizes the environmental assessment findings of the 13 homes. Notably, one of the NVRH community health workers conducting the in-home visits has asthma classified as “under-control” and experienced asthma exacerbation event during each home visit.

Table 1: Summary of findings from 13 environmental assessments conducted by NVRH staff

Home characteristics		Number of homes
Receives fuel assistance		7
Dwelling type:	Single-family detached	9
	Mobile home or trailer	4
Occupancy:	1 resident	6
	2 residents	4
	3 residents	2
	4 residents	1
Cooking fuel:	Gas	10
	Electric	3
Functional kitchen exhaust:	Vented outdoors	7
	Recirculating	2
Functional bath fan		5
Living room floor covering:	Carpet or throw rug	8
	Smooth surface	5
Bedroom floor covering:	Carpet or throw rug	7
	Smooth surface	6
Other:	Open trash	9
	Pets	8
	Open pet food	7
	Condensation on windows	6
	Water damage	5
	Mold	5
	Firewood stored in home	5
	Musty odor	5
	Candles	4
	Air fresheners	3
	Pests	3

Energy-Plus-Health Services

Table 2 summarizes the green cleaning and healthy living supplies. The average cost per household for these supplies is \$221. One participant declined all of the supplies despite not having equivalent alternatives on hand.

Table 2: Summary of green supplies provided to patients by NVRH staff

Green cleaning supplies	Number of homes
Air purifier	11
Spray bottle and healthy cleaner recipes	11
Allergen mattress / pillow covers	11
Wedge pillow	10
Spacer / mask for medication administration	9
HEPA vacuum	8

Three participants received weatherization and electrical efficiency services prior to the pilot program, and two of those participants received plus-health services in the pilot. Two participant homes were already energy efficient—well insulated and air-sealed with efficient appliances—and they received plus-health services in the pilot. Two participant homes did not qualify for weatherization and received electrical efficiency measures only.

Eleven participants received a healthy home energy visit (HHEV), five participants received weatherization and electrical efficiency improvements, and nine participants received plus-health improvements and air quality monitoring.

Table 3 summarizes the weatherization, electrical efficiency, plus-health, and IAQ monitoring services provided for the thirteen homes NVRH staff visited.

Table 3: Services provided to Northeast Kingdom pilot participants

Participant #	Pre-pilot Wx and electrical efficiency	Pilot Wx	Pilot electrical efficiency	Pilot HHEV	Pilot-plus-health	IAQ monitoring
1	X					
2		X	X	X	X	X
3				X	X	X
4			X	X		
5				X	X	X
6	X					
7	X			X	X	X
8		X	X	X	X	X
9		X	X	X	X	X
10		X	X	X	X	X
11	X			X	X	X
12		X	X	X	X	X
13			X	X		

Efficiency Vermont partners with WAP to deliver electrical efficiency coaching and measures at the time of weatherization services for all low-income WAP participants. The WAP partners also deliver electrical efficiency measures to low-income customers with high energy burdens who do not qualify for thermal weatherization services. Vermont WAP leverages other funding

resources to provide additional services beyond traditional weatherization improvement measures. Table 4 summarizes the measures completed during the pilot for the five homes receiving weatherization, and Table 5 summarizes the measures completed during the pilot for the seven homes receiving electrical efficiency improvements.

Table 4: Summary of weatherization efficiency measures completed in five homes

Weatherization measure	% of homes
Air sealing and insulation	100%
Bathroom ventilation	100%
Kitchen ventilation	80%
Dryer venting	80%
Smoke alarm	40%
CO alarm	20%
Heating system tune-up	60%
Heating system replacement	20%
Duct sealing and repair	80%
Woodstove install / replacement	40%
Water heater replacement (gas)	20%

Table 5: Summary of electrical efficiency measures completed in seven homes

Electrical efficiency measure	% of homes
Lighting improvements	100%
Refrigerator replacement	57%
Water heater replacement (electric)	29%
Low-flow showerhead	29%
Freezer replacement	14%
Clothes washer replacement	14%
Dehumidifier replacement	14%

Nine participants received plus-health improvements during the pilot, as summarized in Table 6. The average plus-health cost per home was \$4,891. Not all participants accepted all plus-health improvements offered, as explained in the footnotes of Table 6.

Energy results are presented in the Northeast Kingdom and Springfield IAQ & Energy section below.

Table 6: Summary of plus-health measures completed in nine homes

Plus-health measure	% of homes
Smooth-flooring replacement of carpeting	44%
Active radon mitigation	33% ^a
Crawlspace/basement full encapsulation	33%
Ducted balanced heat or energy recovery ventilation	22% ^b
Cooking stove replacement	22% ^c
Trash hauling	11%
Pest abatement	11%
Grab bar in shower	11%
Access ramp into home	11%
Plumbing repairs	11%
Lead abatement	11%

^a Efficiency Vermont offered to install active radon mitigation in a third participant’s home and strongly encouraged the participant to accept the system, however the participant declined owing to decline in overall health.

^b Efficiency Vermont offered a third participant a fully ducted, balanced energy recovery ventilation system, but the participant declined the system owing to aesthetic concerns.

^c Both participants were encouraged to switch from gas to electric; only one agreed to electric.

Seven participants completed the program, meaning they received some combination of energy-plus-health services, self-managed care coaching, green cleaning supplies, and pre-/post-mitigation air quality monitoring, and completed pre-/post-mitigation health surveys. Reasons for incomplete program participation were home ineligibility (three participants), severity of illness (two), unresponsive customer (one), and death (one).⁴

IAQ Monitoring

Pre-retrofit health and energy assessments and IAQ monitoring identified known and suspected moisture, radon, and ventilation issues, and confirmed needs for certain home repairs. Post-retrofit IAQ monitoring uncovered areas for ventilation system adjustments and additional radon mitigation.

In homes without air conditioning, the team sought to monitor the indoor air during winter conditions, when exterior doors and windows were closed. Initially, the project team deployed independent monitors for measuring particulate matter, carbon dioxide, relative humidity, and temperature. After evaluating combination monitors, the team switched to a single unit that offered all four measurements, streamlining monitoring installation and data download. The team experimented with testing nitrogen dioxide using passive samplers, and low-level carbon monoxide using data loggers.

⁴ Initially, the pilot limited co-morbidities to limit confounding health factors; however, due to challenges in identifying a large enough sample size, researchers altered the acceptance criteria to allow patients with co-morbidities into the program. The co-morbidities coupled with advanced age made it challenging to determine the effectiveness of interventions.

The team used short-term activated charcoal test kits for radon testing. Two homes had elevated radon levels at program initiation. Radon levels increased above the U.S. EPA action level in two homes post-weatherization. All homes with elevated radon levels in the living area were offered active radon mitigation systems. Radon mitigation proved challenging in some homes owing to sub-slab soil compaction or high water tables with poor drainage, both of which required larger radon fans or balanced heat recovery radon mitigation systems. Radon systems for these homes cost more than twice as much as traditional radon retrofit systems.

IAQ results are further presented in the Northeast Kingdom and Springfield IAQ & Energy section below.

Health Outcomes

Eight of the nine participants receiving plus-health improvements and IAQ monitoring completed pre- and post-mitigation health surveys and either a COPD Assessment Test (CAT) or an Asthma Control Test (ACT).⁵ The researchers requested the survey and tests at patient intake, three months post-retrofit, and 12 months post-retrofit. The actual timing of tests varied according to patient responsiveness and project implementation schedules. As of the writing of this report, each of the eight participants had completed the pre-survey/test and at least one post-survey/test. Three participants had experienced three- to six-point improvements in their CAT score and one participant experienced a nine-point improvement in their ACT score. Three participants had experienced a five- to seven-point worsening in their CAT score and a two-point worsening in their ACT score.

According to the health surveys, five participants experienced no change and three experienced improvement in visitations to healthcare services, activity levels, cohabitant respiratory issues, or respiratory triggers (uncomfortable temperature, musty odor / mold, chemical use, or pests).⁶ The one participant experiencing a worsening of these metrics reported a cohabitant experiencing sinus issues and rodent activity in the home that was alleviated with traps.

One of the participants that received smooth surface flooring after having carpets removed reported falling due to the smooth flooring. Efficiency Vermont confirmed with the flooring installer that the smooth flooring installed was slip resistant per the program requirements and provided the customer with proper care instructions. Efficiency Vermont also offered to have an alternative flooring installed or make other modifications to prevent future falls. The participant declined these services.

When researchers asked if the program had improved their quality of life, four participants responded yes, two responded no, one responded not sure, and one did not respond.

⁵ CAT scores range from 0 to 40. Adult ACT scores range from 0 to 25. Pediatric ACT scores range from 0 to 27.

⁶ One participant's post-mitigation survey was misplaced, and that participant is not included in this health survey summary.

SPRINGFIELD AREA

In 2019, Efficiency Vermont, Springfield Medical Care Systems (SMCS), Vermont OEO WAP, and SEVCA (the local WAP affiliate) launched a 10-home pilot for asthma patients. Efficiency Vermont designed the pilot to be similar to the Northeast Kingdom pilot but did not include COPD patients. The Springfield area collaboration had received grant funding from VDH to address only asthma. Once the grant funding ended, the collaboration expanded the pilot to include COPD patients, thereby expanding the eligible patient population and fully aligning the pilot with the Northeast Kingdom's.

Results

SMCS referred eight patients to Efficiency Vermont and SEVCA. All patients received self-managed care coaching either in their homes or by phone owing to COVID-19 visitation restrictions. Efficiency Vermont staff provided five participants with home environmental assessments. Participants were not given green cleaning supplies because of limited health partner funding.

Table 7 summarizes the environmental assessment findings of the five homes.⁷

Table 7: Summary of findings from five environmental assessments conducted by Efficiency Vermont staff

Home characteristics		Number of homes
Dwelling type:	Single-family detached	3
	Duplex / triplex, row house	1
	Other: apartment over horse barn	1
Occupancy:	1 resident	3
	2 residents	1
	3 residents	1
Cooking fuel:	Gas	3
	Electric	2
Functional kitchen exhaust:	Vented outdoors	0
	Recirculating	2
Functional bath fan		3
Living room floor covering:	Carpet or throw rug	4
	Smooth surface	1
Bedroom floor covering:	Carpet or throw rug	3
	Smooth surface	2
Other:	Condensation on windows	3
	Pests	3

⁷ The Springfield assessment results differ from those of NVRH because Efficiency Vermont staff tested alternative assessment forms.

Mold	2
Water damage	2
Open pet food	2
Pets	2

Of the eight patients referred, two were unable to participate owing to unresponsive property owners,⁸ one did not meet the health eligibility criteria for the program, and two declined the program—one because of concerns about property tax increases, despite coaching provided that explained the improvements would not affect property taxes, and the other because of unwillingness to remove, or receive support to remove, necessary items from the basement to allow for moisture mitigation and basement encapsulation. Thus, three patients participated in the program.

One participant received weatherization and electrical efficiency services prior to the pilot program and, at the time this report was written, was receiving plus-health services in the pilot based on the findings of the HHEV. The other two participants received a HHEV, weatherization and electrical efficiency improvements, and air quality monitoring; these two homes did not require plus-health improvements beyond the basic health and safety measures included in traditional weatherization.

Table 8 summarizes the measures completed during the pilot for the two homes receiving weatherization and electrical efficiency improvements.

Table 8: Summary of weatherization efficiency measures completed in two homes

Weatherization measure	% of homes
Air sealing and insulation	100%
Bathroom ventilation	100%
Heating system tune-up	100%
Smoke alarm	50%
CO alarm	50%
Dryer venting	50%
Duct sealing and repair	50%
Lighting	50%

The plus-health services planned for the third home: plastic covering the basement floor where accessible, unvented gas space heater removal, two woodstove replacements, cookstove replacement, installation of a range hood vented to exterior, bath fan upgrade with integrated timer, attic hatch repair, and new smoke and carbon monoxide alarms.

Two participants completed the program, meaning they received some combination of energy-plus-health services, self-managed care coaching, green cleaning supplies, and pre-/post-

⁸ Efficiency Vermont gave one of these patients an energy efficient room air conditioner to reduce heat-induced thermal stress.

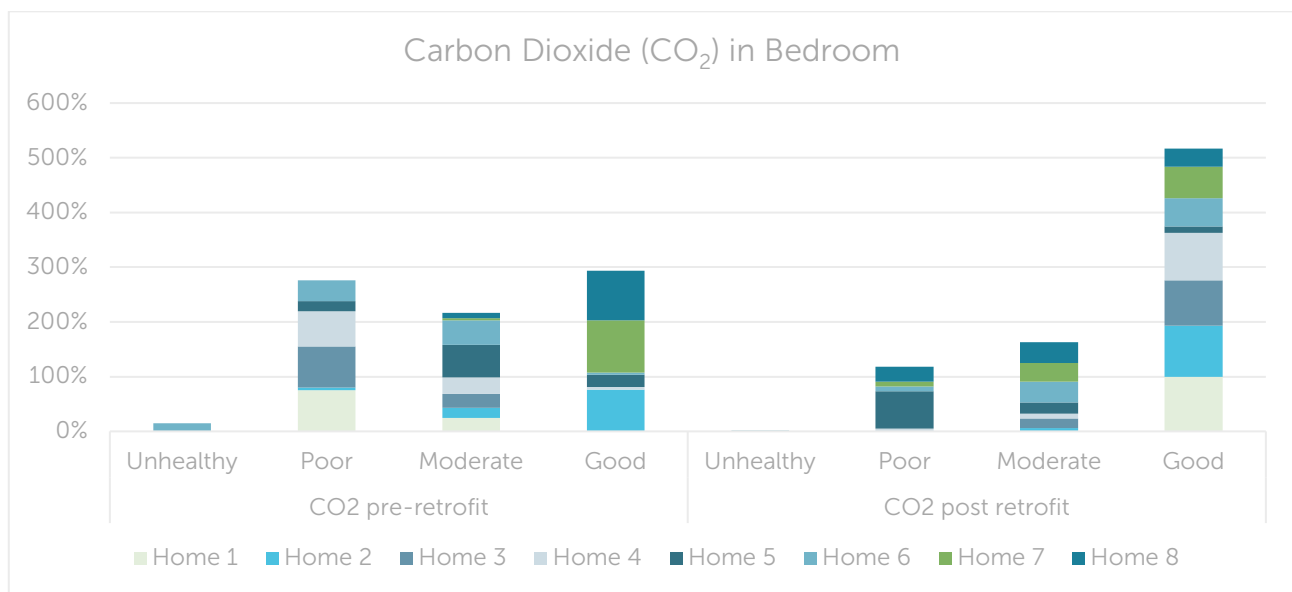
mitigation air quality monitoring, and they completed pre-/post-mitigation health surveys. The pre-/post-mitigation ACT results were available for one participant and showed a two-point improvement in asthma control.

NORTHEAST KINGDOM AND SPRINGFIELD IAQ & ENERGY

Pre- and Post-Retrofit IAQ

Figure 2, Figure 3, Figure 4, and Figure 5 present pre- and post-intervention IAQ monitoring results for six homes in the NEK pilot and two homes in the Springfield pilot. The y-axis represents the percent of time that the eight homes experienced the x-axis condition during the monitoring period. The x-axis conditions are defined below each figure.

Figure 2: Carbon dioxide levels monitored before and after home retrofit in participant bedroom



CO₂ Classifications
 Unhealthy ≥ 2,000 PPM
 Poor 1000 - 2,000 PPM
 Moderate 701 - 999 PPM
 Good ≤ 700 PPM

Figure 3: Particulate matter levels monitored before and after home retrofit in participant bedroom

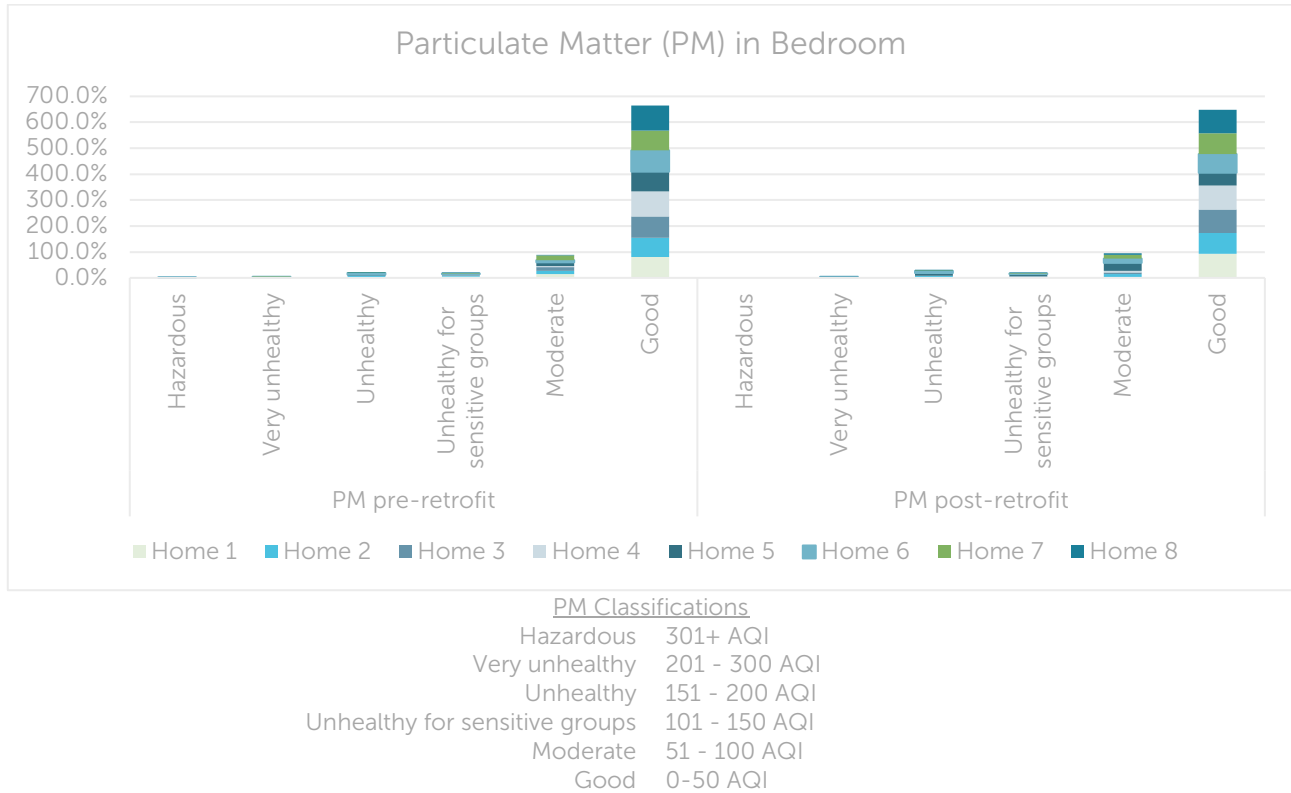


Figure 4: Relative humidity levels monitored before and after home retrofit in participant bedroom

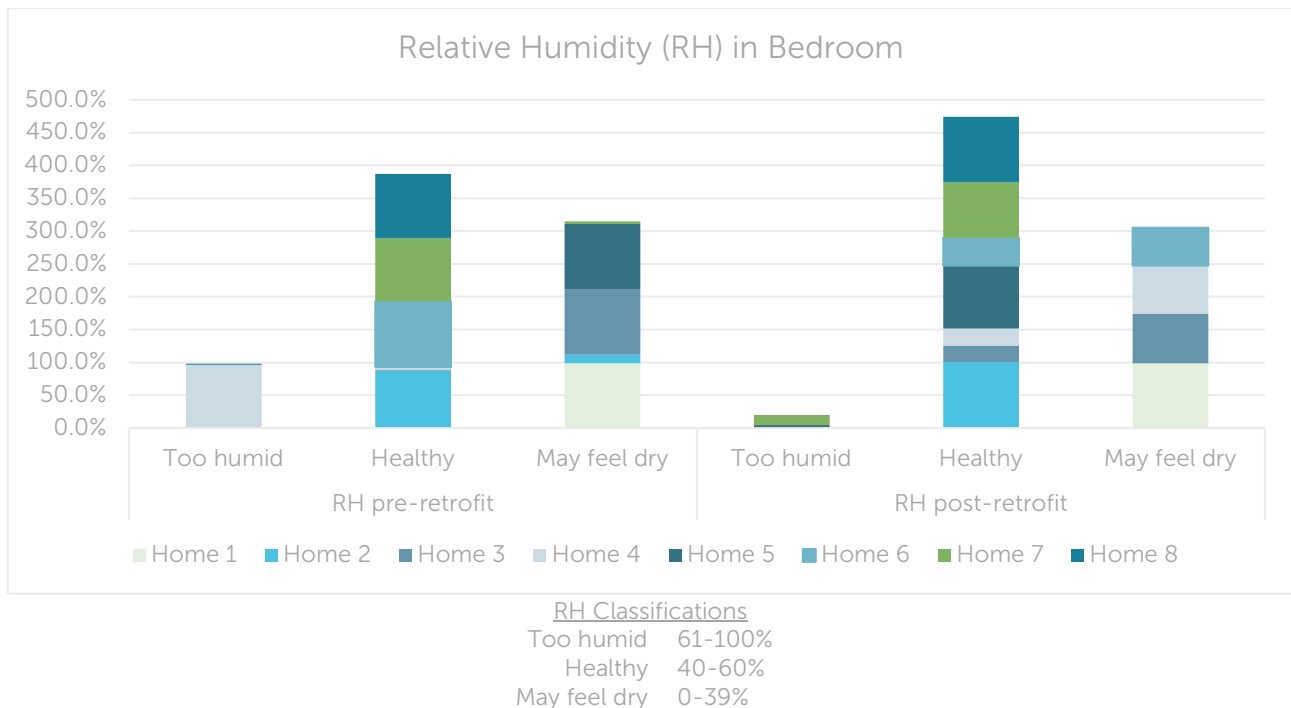
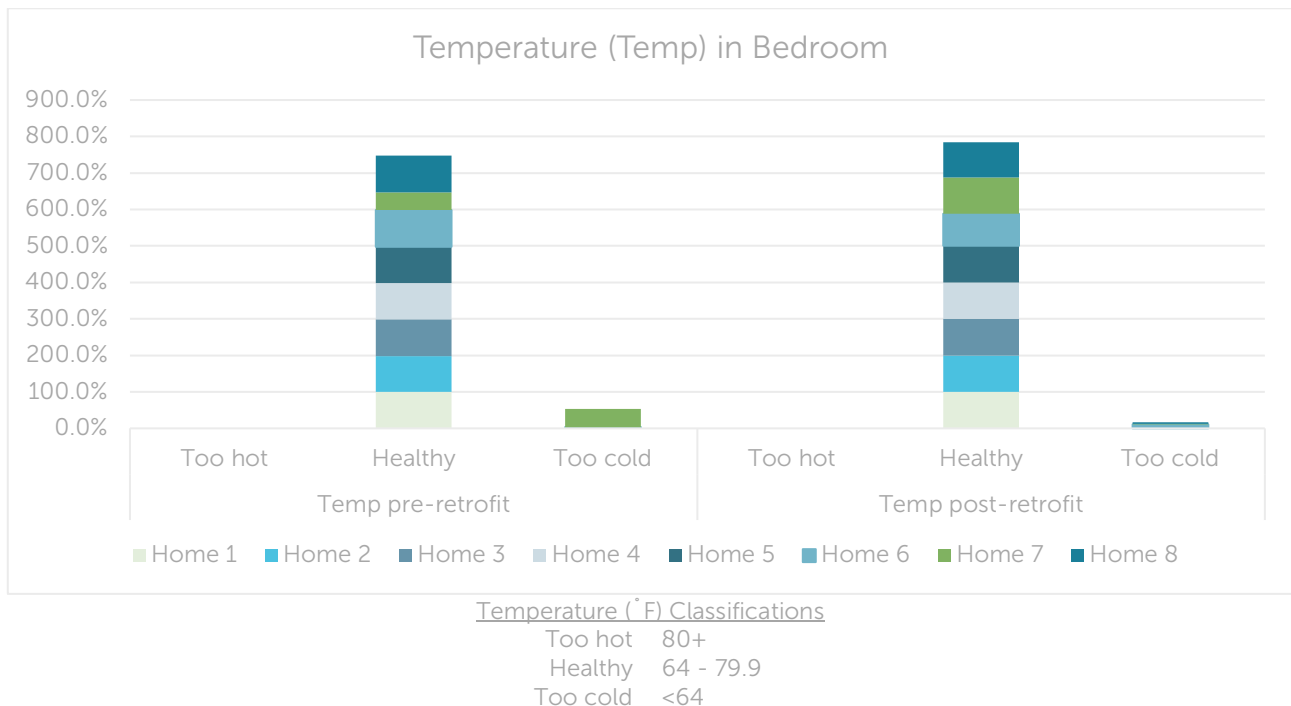


Figure 5: Temperature levels monitored before and after home retrofit in participant bedroom



Bedroom CO₂ levels generally improve across the pilot homes. Homes 5, 7, and 8 experienced an increase CO₂ levels post-retrofit.

Fine PM stayed about the same across the pilot homes. Home 5 experienced an increase in PM levels post retrofit.

RH improved overall across the pilot homes. Home specific decreases in RH are attributed to dryer outdoor conditions during the post-retrofit IAQ monitoring period compared to pre-retrofit and increased ventilation. The RH increase in Home 7 is attributed to occupant activity during the post-retrofit monitoring period, boiling maple sap.

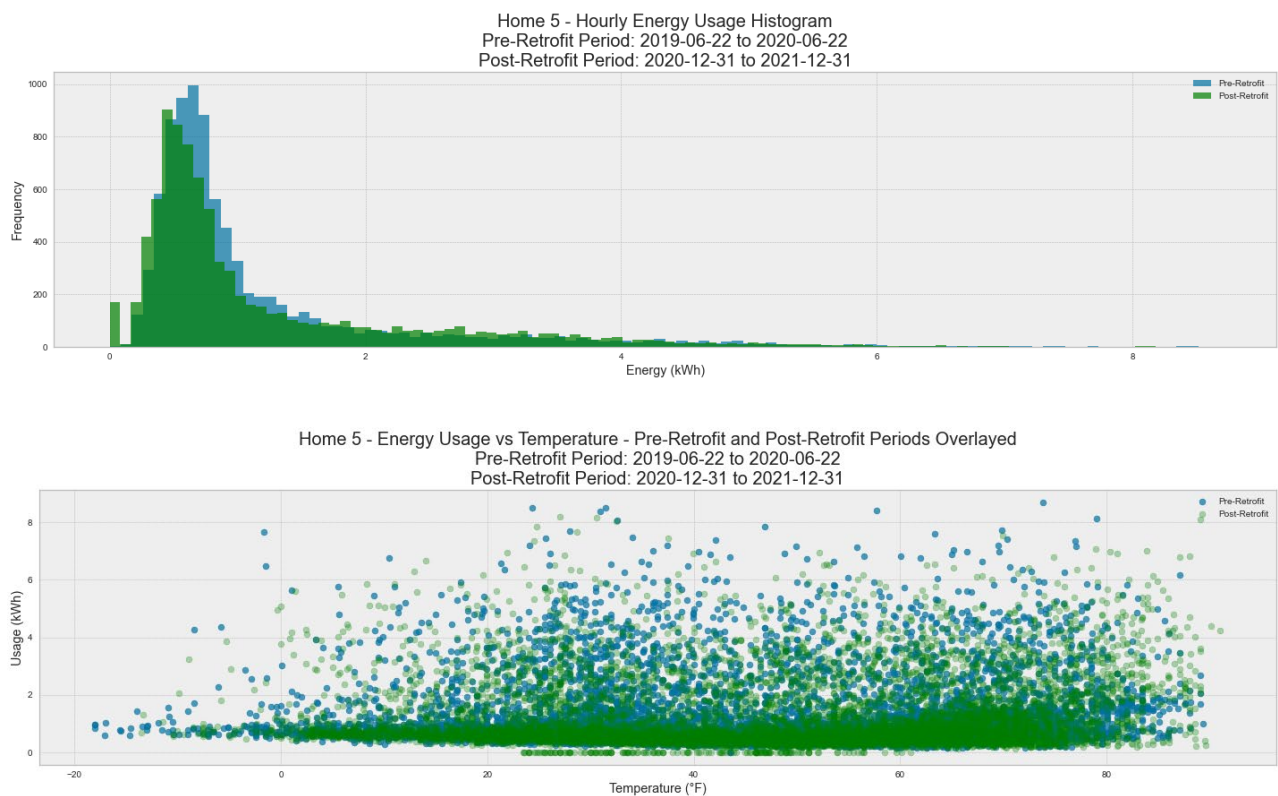
Temperatures stayed within the healthy range most of the time in all homes pre- and post-retrofit. Participants receiving weatherization noted increased comfort post-retrofit.

In response to the post-retrofit IAQ results, the WAP partner increased the ventilation system run time to provide additional fresh air in Home 5, and Homes 7 and 8 were encouraged to increase ventilation system use. Homes 7 and 8 were not selected for re-monitoring the IAQ following the recommendation to increase ventilation, and Home 5 declined additional IAQ monitoring after the ventilation run-time was adjusted.

Pre- and Post-Retrofit Energy

For twelve of the thirteen⁹ participant homes that received energy and/or health retrofit measures during the pilot, the research team analyzed the electrical energy use for twelve months pre- and post-retrofit. The patterns of electrical usage across the participant homes did not show a consistent relationship with outdoor air temperatures, so the team was unable to produce a good quality weather-normalized energy analysis.¹⁰ Figure 6 is an example of a pilot home’s hourly energy use frequency (top) and hourly energy use by temperature (bottom) and is representative of the pilot homes with hourly energy data. The home with the most consistent weather-correlated energy use is shown in Figure 7.

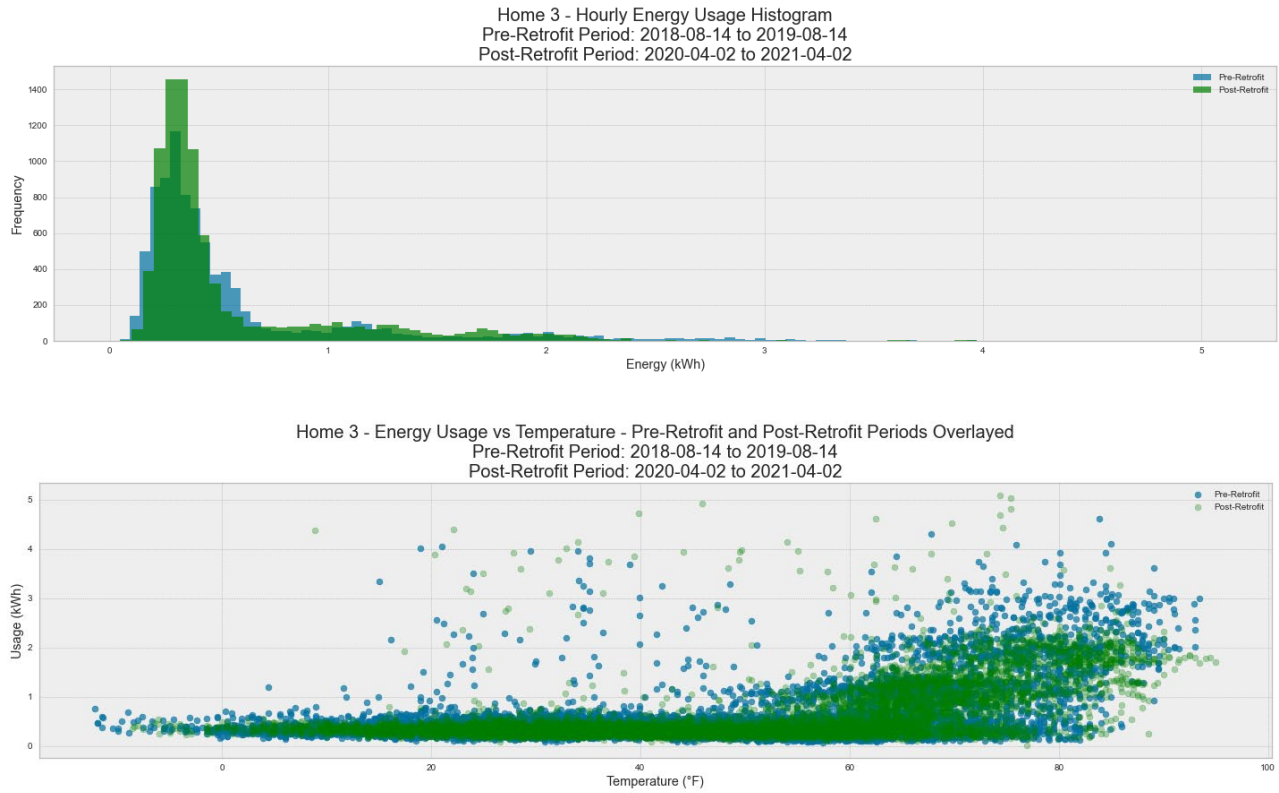
Figure 6: Example 1 of pilot home energy use



⁹ The participant excluded from the electrical energy analysis did not have 12-months pre-retrofit energy data.

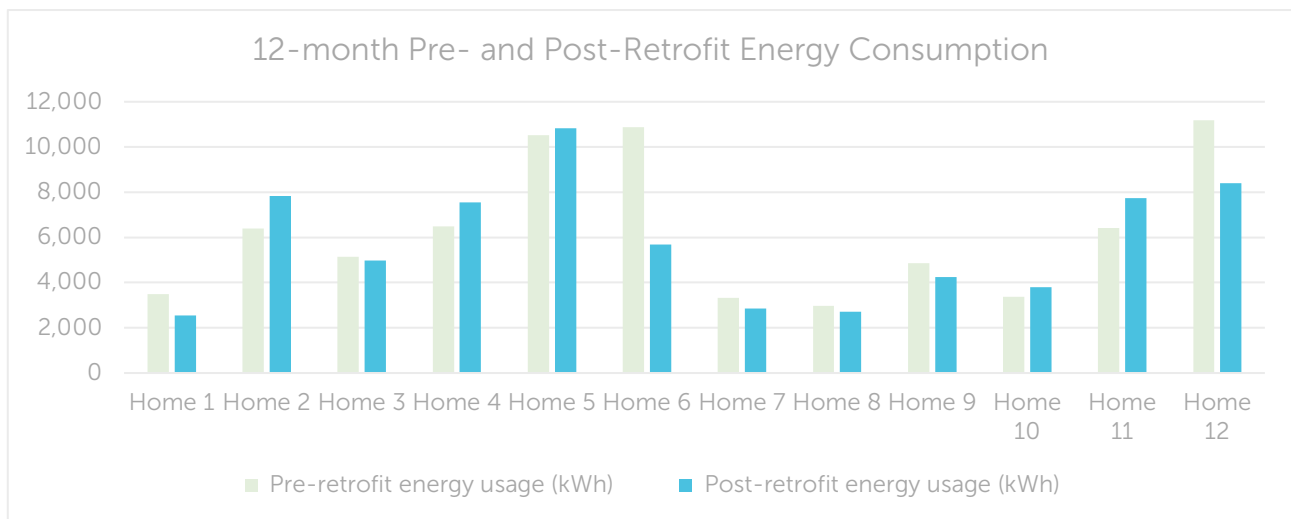
¹⁰ Vermont saw a very slight increase in residential energy use in 2020 compared with 2019 due to COVID. No adjustments were made to the energy savings estimates to account for this slight increase in consumption.

Figure 7: Example 2 of pilot home energy use



Without being about to use weather-normalized energy analysis, the team defaulted to comparing raw electric data for the homes. Figure 8 presents the raw electrical energy usage for 12-months pre- and 12-months post-retrofit for the twelve homes.

Figure 8: 12-months pre- and post-retrofit electrical energy use



Based on the raw electrical energy use data, the homes collectively saved 5,916 kWh.

Bulk fuels represented the primary heating source for all homes in the pilot, however the research team was not successful in collecting bulk fuel data for program participants.

The following testimonials were provided from program participants:

We don't get mold on the windows anymore.

I was able to take a shower in the morning because it's warm. The floors are warm. I hope to move my bed back into the bedroom now that it's warm in there.

With the work done, I'm saving \$150 a month on fuel. I feel a consistent comfortable and my breathing is good.

CHAMPLAIN VALLEY

Results from One Touch identified weatherization recipients who were at risk of falling,¹¹ and prompted the Vermont OEO WAP to collaborate with the University of Vermont (UVM) Medical Center's Falls and Fires Prevention program. The data also presented an opportunity for the Vermont OEO WAP to collaborate with VDH Injury Prevention program, beyond sending referrals through One Touch. In 2019, Efficiency Vermont, CVOEO (the local WAP affiliate), and UVM Community Health Improvement launched a 20-home pilot for patients at risk of falling at home. Participants received stair handrails, grab bars, non-slip bath rugs and slip-resistant strips in tub / shower, improved lighting, and threshold repairs at the time of the weatherization improvements to their homes. CVOEO weatherization crew members trained to provide services by Cover Home Repair, a local nonprofit delivering free home repair and weatherization services, identified and installed the fall prevention measures.

Results

The team capped the pilot at 18 participants in summer 2020, to enable pilot completion by early 2021. One eligible participant declined the program for unrelated health reasons, and one declined the program for unknown reasons. The collaboration completed energy-plus-health services for 16 pilot participants. Two participants left the program after service installation and before completing the final program survey because of unrelated health issues. Two other participants have yet to respond to the final program survey, resulting in a total of 12 pilot participants completing the program.

The 16 participants receiving services ranged in age from 49 to 97, with an average and median age of 73. Two participants declined to provide their age. Eleven participants were female and five male.

Table 9 summarizes the fall prevention measures installed in the 16 participant homes.

¹¹ One Touch data, https://data.surveyygizmo.com/r/541053_5bd5b84b85bb51.74060046.

Table 9: Summary of fall prevention measures completed in 16 homes

Fall prevention measure	% of homes
Grab bar	94%
No-slip bathmat	63%
Doorbell	44%
Grabber stick	44%
Handrail—new	44%
Lightbulb replacement	44%
Stair railing	31%
Tub shower seat	19%
Flooring repair	19%
Dual shower head, handheld	13%
Stair repair	6%
Handrail repair	6%
Slip-resistant strips in tub / shower	6%
Lights—chain extension	6%
Light fixture repair	6%

The average cost for fall prevention measure installation by the WAP was \$387 per home. Table 10 summarizes the program cost for installing fall prevention measures through the WAP.

Table 10: Summary of total cost for fall prevention measures delivered through Vermont WAP

	Crew labor	Subcontractor labor	Crew materials	Subcontractor materials	Total cost
Maximum	\$544	\$394	\$315	\$68	\$939
Minimum	\$20	\$160	\$17	\$68	\$102
Average	\$214	\$277	\$143	\$68	\$387
Median	\$171	\$277	\$130	\$68	\$342

Two critical partners—the UVM Medical Center and the VDH Injury Prevention program—left the pilot in spring 2020, because of funding changes and COVID-19 priorities. Efficiency Vermont and CVOEO stepped in to complete the evaluation role with support from the VDH for data aggregation. However, owing to the change in program management, three participants did not receive a pre-retrofit health survey. Of the 16 participants, two dropped out of the program after retrofits were completed and before the post-retrofit health survey was completed for unrelated health reasons.

Pre-Retrofit Health Survey

Eleven of the remaining 14 participants completed the pre-retrofit health survey conducted by either the UVM Medical Center or the VDH Injury Prevention program. Three of those participants lived alone. Eight participants responded yes to being limited in any way in any activities because of physical, mental, or emotional problems. Ten participants self-reported chronic (lasting three months or longer) medical conditions identified by their healthcare providers, as summarized in Table 11.

Table 11: Chronic medical conditions reported by 10 participants

Medical condition	Number of participants self-reporting
Arthritis or other bone / joint disease	6
High blood pressure / hypertension	5
Breathing / asthma / lung disease	2
Cancer	2
Depression or other behavioral health issue	2
Diabetes	2
Glaucoma / other chronic eye problem	2
Other chronic conditions: multiple sclerosis remission	2
Heart disease or blood circulation problem	1
Other chronic conditions: hypothyroid	1
Other chronic conditions: Lyme disease	1
Other chronic conditions: leg / back / neck	1
Other chronic conditions: degenerative disc disease	1
Osteoporosis	0
Parkinson's disease	0

Four participants completed the pre-retrofit One Touch survey conducted by the CVOEO Efficiency Coach. One Touch electronically manages the referrals among the WAP partners, Efficiency Vermont, and community-based organizations such as UVM Medical Center.

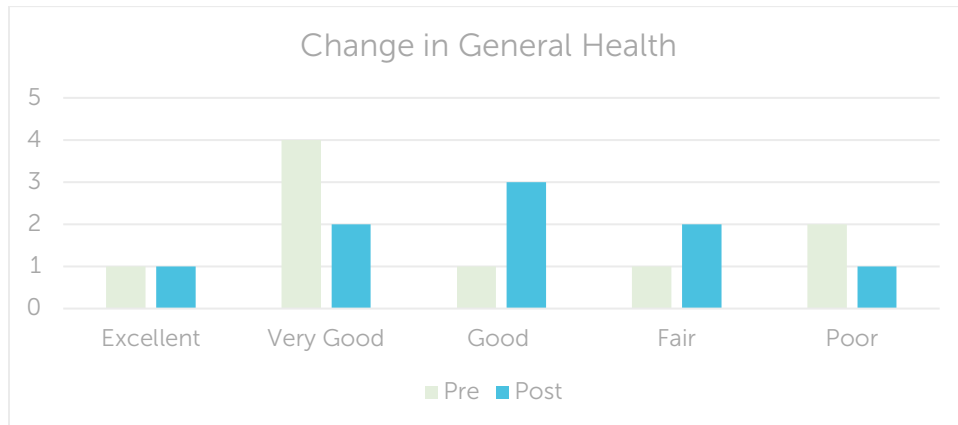
Post-Retrofit Health Survey

Participants completed post-retrofit health surveys an average of 13 months after the fall prevention projects were completed. Post-retrofit health surveys were available for 12 of the 16 participants. Two participants left the program after the work was completed, prior to the post-retrofit survey, and two participants were unresponsive to requests to complete the post-retrofit health survey. Only nine of these 12 participants had also completed the pre-retrofit health survey.

Change in General Health

Among the nine participants completing pre- and post-retrofit health surveys, there was little change in overall self-reported general health, as shown in Figure 9. Five participants in the pre- and three participants in the post-retrofit health survey reported "excellent" or "very good" general health. One participant in the pre- and three participants in the post-retrofit health survey reported "good" general health. Three participants in the pre- and three participants in the post-retrofit health survey reported "fair" or "poor" general health. Given the average age of these nine participants (73), no decline in overall health is a good outcome over the average 20 months between the pre- and post-retrofit health survey.

Figure 9: Self-reported change in general health



Change in Falls

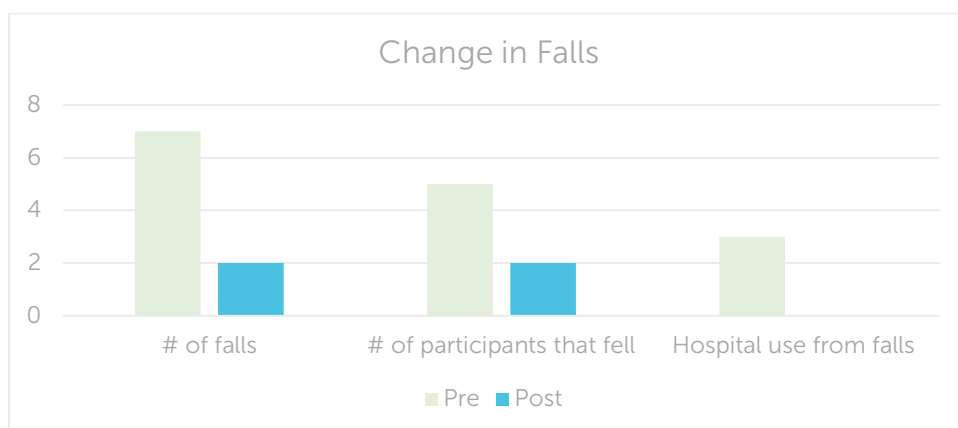
Pre-retrofit, participants reported a total of seven falls. Six of those falls were within three months of the pre-retrofit health survey, and one fall was within the previous year. Post-retrofit, participants reported a total of two falls in the average 13 months since work had been completed. The pilot participation numbers are too small for a robust statistical analysis; however, they are encouraging. Five participants reported falling pre-retrofit, and two participants reported falling post-retrofit, again an improvement.

Hospital Use from Falls

Pre-retrofit, three participants reported having gone to the emergency room and / or being admitted to the hospital to address the injury that the fall caused. Neither of the two participants who fell following the retrofit sought medical care after falling. Participants were not asked whether COVID-19 influenced their decision to not seek medical care after falling.

Figure 10 summarizes participant change in number of falls, number of participants falling, and hospital use from falls pre- and post-retrofit.

Figure 10: Self-reported change in falls

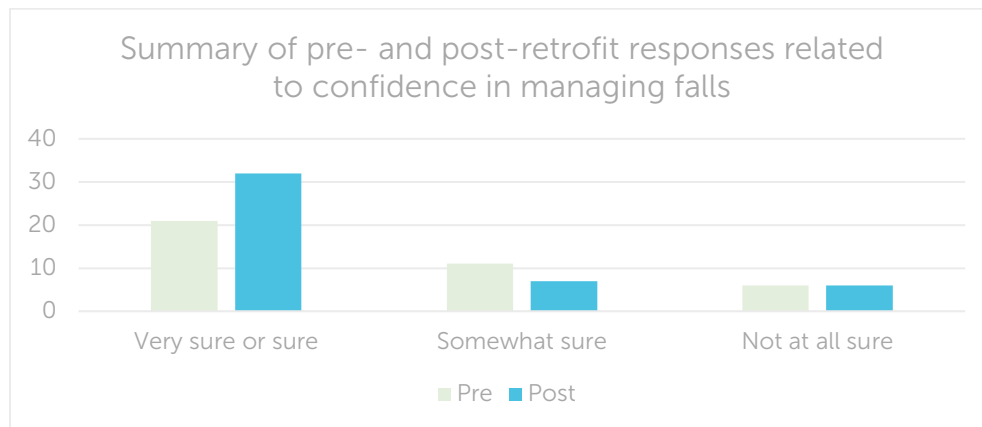


Concerns about Falling

Overall, participants reported little change from pre- to post-retrofit in fear of falling. Seven participants in the pre- and seven participants in the post-retrofit health survey said they were “a lot,” “somewhat,” or “a little” fearful of falling. Two participants in the pre- and two participants in the post-retrofit health survey reported they did “not at all” fear falling.

Participants reported railings, grab bars, and step repairs as the repairs that reduced their fear of falling the most. When asked how sure they were that they could get up if they fell, reduce falls, protect themselves if they fell, increase their physical strength, and become steadier on their feet, participants reported higher confidence post-retrofit than pre-retrofit, as shown in Figure 11.

Figure 11: Participants’ confidence in managing falls pre- and post-retrofit



Change in Engagement with Healthcare Provider

Five participants indicated having spoken with their healthcare provider about falling within the past year pre-retrofit, and three indicated having spoken with their healthcare provider about falling post-retrofit. One of the participants speaking with their healthcare provider post-retrofit about falling had not previously done so. Participants were not asked whether COVID-19 influenced their decision to speak with their health care provider about falling.

Participant Evaluation of Program

The majority of participants found it helpful to have the fall prevention program included as part of their energy work; felt more comfortable talking to their healthcare provider, family, and friends about falling; felt more comfortable increasing activity; felt more satisfied with life; and would recommend the program to a friend or relative, as detailed in Table 12.

Table 12: Summary of participant responses regarding the fall prevention program

Thoughts about the fall prevention program	A lot	Somewhat	A little	Not at all
Helpful to have falls prevention in energy work	8	0	1	0
Feel more comfortable talking to healthcare provider about falling	6	1	2	0
Feel more comfortable talking to family and friends about falling	3	2	3	1
Feel more comfortable increasing activity	4	3	1	1
Feel more satisfied with life	5	2	1	1
Would recommend the program to a friend or relative	9	0	0	0

The following testimonial was provided from a program participant:

I had broken two bones before they came in - it really was huge. I feel safer in my home. They talked to me first and asked what I needed and what was happening, and they accommodated for what I needed and what was happening. I couldn't even come down my hallway without tripping because the people before who tried to help had raised the hallway floor and I would trip over that - they fixed it.

VERMONT AS A WHOLE

UVM Medical Center Collaboration

In 2020, UVM Medical Center Pediatric Pulmonology and Efficiency Vermont created an income-neutral pilot for pediatric patients with asthma and other respiratory conditions such as cystic fibrosis. The program provides a free HHEV and an IAQ monitor loan to patient families and caregivers referred by the UVM Medical Center. These recipients can own or rent their homes and be interested in investigating possible environmental respiratory health triggers related to energy efficiency.

Results

Based on positive early results and a desire to test the program in post-COVID-19 conditions, this program will continue through 2022. Beginning in 2022, UVM Medical Center staff can identify participants through a patient-completed home environmental health survey, and prompt eligible patients to schedule their HHEV with Efficiency Vermont through an online scheduling tool prior to leaving their medical appointment, in order to streamline referrals and

communication. Staff will begin to use an ICD Z code¹² to track patients referred to the program and patients that have suspected environmental triggers but are not eligible for the current program. Using the ICD Z code can help the team see the full population of patients with home environmental triggers.

Weatherization and Health Initiative

Building from the regional Vermont pilots and national evidence in weatherization as a population health strategy, the Vermont Department of Public Service (PSD), VDH, and Vermont OEO WAP have launched the statewide Weatherization + Health Initiative (WHI). The goal of the WHI is to engage with new partners to explore opportunities and identify challenges to integrate home weatherization and health services, and to collaborate on pilot projects that demonstrate efficient processes and effective outcomes.

The desired long-term outcome of the initiative is to establish sustainable systems and funding mechanisms that leverage home weatherization services to deliver improved health outcomes, avoid preventable health system expenditures, address social determinants of health by reducing home energy costs and improving housing quality, and reduce greenhouse gas and other pollutant emissions.

The WHI is tentatively supported by \$500,000 secured via the PSD, and staffing from PSD, OEO WAP, VDH, and Efficiency Vermont. The partners will leverage current or new program funds where possible and appropriate for pilot projects, such as funds associated with the OEO WAP and Efficiency Vermont energy efficiency activities. Tohn Environmental Strategies, LLC, is supporting stakeholder engagement and project scoping. Actual funding will depend on the specific scope and scale of activities proposed and is partially contingent on demonstrated progress.

Following partner engagement in early 2022, partners will develop the specific timeline for activities in collaboration with stakeholders.

Discussion and Conclusion: Beneficial Impact

HEALTH PROVIDERS RECOGNIZE THE BENEFITS OF COLLABORATION

By joining these pilot partnerships, hospitals demonstrated their commitment to improving population health through upstream intervention and testing of innovative healthcare delivery models.

UVM Medical Center Pediatric Pulmonology now sees high value in tracking suspected home environmental triggers across its patient population and in gaining visual and IAQ data insights in patient homes. NVRH community health team staff are now empowered to discuss in-home

¹² ICD (International Classification of Diseases) codes offer data on the social needs of a hospital's patient population. The Z category identifies non-medical factors that can influence a patient's health status.
<https://www.aha.org/system/files/2018-04/value-initiative-icd-10-code-social-determinants-of-health.pdf>.

respiratory triggers and provide healthy living and green cleaning supplies to patients. All hospitals are more comfortable referring patients to Efficiency Vermont and the low-income WAP.

OEO WAP, VDH and Efficiency Vermont have successfully collaborated outside the pilots, further aligning their program offerings to multi-solve meeting each other's program goals for energy efficiency, carbon reduction, and improved health outcomes. The open channels of communication foster deep collaboration and idea sharing.

Ripple Effect

Rutland Regional Medical Center led the way, being the first hospital to support a Healthy Homes pilot in 2016 with a local homeownership and home performance organization, NeighborWorks of Western Vermont. Their leadership had a ripple effect in the state and beyond, encouraging other hospitals to try new collaborations and expand existing partnerships.

After participating in the pilot, NVRH acknowledged the connections between health, climate change, and housing in its 2021 Community Health Needs Assessment (CHNA).

Any discussion on health equity and resilience in 2021 must include the effects of climate change on health... People with chronic health conditions are more likely to suffer harmful health effects due to extreme weather events... The health consequences of poor air quality and extreme weather events include difficulty breathing; worsened cardiovascular and respiratory disease; heat rashes, heat stroke, heat exhaustion; and diminished mental health and well-being... The people with chronic conditions are not the only ones at risk for these health consequences. People with weakened immune systems due to health conditions such as cancer, older adults, children and infants, pregnant women, low-income people of all ages, those who are homeless or living in poor housing conditions, outdoor workers, racial and ethnic minorities, those socially isolated or living alone, and those with no air conditioning are also at risk.¹³

UVM Medical Center now has plans to address the impacts of climate change on the social determinants of health in its upcoming CHNA and is referencing the NVRH CHNA as an example to pull from.

The ripple effect of these pilots is likely to carry forward for other hospitals and health care providers in the region and nationally.

Positive Patient Outcomes

The fall prevention pilot demonstrated cost-effective interventions for reducing falls at home among individuals at risk of falling. Quality of life and home comfort increased for most

¹³ https://nvrh.org/wp-content/uploads/2021/04/CHNA_2021_Final.pdf

participants, and low-income housing stock was improved for generations to come, building local wealth.

More research is needed to identify best measure packages for seniors with complex co-morbidities. Those customers will likely require broader program collaborations to meet their wider spectrum of in-home service and repair needs.

Receiving the Message from Multiple Messengers

Patients receiving consistent messaging from the community health worker and the energy program representatives responded more favorably to behavior recommendations than those receiving messaging from only one partner voice. The reinforcement of recommendations across multiple visits and by multiple actors seemed to create the best chance that the recipient would implement it. Changing behavior is hard. Hearing personal stories from multiple backgrounds can help participants relate to the individuals in those stories and find their own awareness, skills, ability, and motivation to change.

TEAM MORALE PERKS

The WAP crew members and hospital staff expressed appreciation at being able to support customers beyond their typical service swim lanes. Providing holistic services to better address the home and residents as a “system” offered exciting challenges and rewarding outcomes. Staff often join these jobs because they want to help people. Enabling staff to expand their direct impact in customer lives leads to employee satisfaction and encourages employee retention.

ALIGNING PROCESSES FOR SUCCESSFUL IMPLEMENTATION

The WAP crew favored the plus-health measures that aligned with their existing, or newly acquired through training, skill sets, whose installation could easily be learned, or that were easily outsourced. For example, a local flooring center provided full-service flooring replacement, enabling a turnkey referral process that fit neatly within existing WAP referral procedures. On the other hand, no contractors offered turnkey tub-to-shower conversion projects, preventing WAP from recommending those due to the lack of capacity to manage contractor scoping and installation.

Similarly, health care partners were most successful in making referrals when the referral process fit within their existing process flow. Aligning program procedures and services with partner systems improves program outcomes.

CONFIRMED CHALLENGES

The respiratory pilots struggled with patient recruitment, time delays, and co-morbidities.

The partners were challenged in identifying and recruiting patients who met all of these respiratory program eligibility criteria: uncontrolled / severe respiratory disease, low-income household, and homeownership / engaged property owner. Participants would often meet two,

but not all three of those requirements. The collaboration recommends expanding income eligibility criteria and diversifying service offerings to enable a wider net of participants to qualify for future energy-plus-health program services. This will allow health care partners to refer more patients and support a larger sample size for program evaluation. For example, individuals with semi-controlled allergic asthma could still benefit from lower-cost supplies and home retrofits while saving more expensive measures for those individuals classified as uncontrolled.

Time delays due to COVID-19, contractor shortages, and project team turnover led to projects taking much longer than anticipated. Instead of an 18-month maximum timeline per project, the team found that some projects lasted four years. This long delay between pre-assessment and post-assessment is significant when dealing with an elderly population with co-morbidities. It also made comparing pre- and post-IAQ data challenging, as many other factors changed in homes during that time. Future programs are encouraged to design for remote implementation and, if it is feasible within the funding allocation, to use a phased approach to data collection and more frequent customer engagement during unexpected delay periods.

The respiratory pilot results demonstrate the need for more research to identify the best screening practices for patient identification and measure prioritization.

FINDING A BALANCE

The pilots confirmed WAP organizations can add cost-effective services to the WAP crews' work scope, leading to holistic home retrofits and increasing health outcomes. However, WAPs are also under pressure to deliver high-volume retrofit rates. Vermont policymakers and program advocates must weigh several priorities such as: (1) comprehensively addressing each home weatherization, solving multiple problems across disciplines and maximizing cost-effectiveness, and (2) scaling up and weatherizing as many homes as possible, knowing those homes will require future services from other support programs. It may be challenging to find the right balance.

LOOKING AHEAD

The pilots succeeded in establishing Vermont-specific experience and positive outcomes with energy-plus-health program collaborations. Partner relationships are stronger as a result of the pilots, and they are driving new program designs and increased cross-referrals outside the pilot programs. Experiences in air quality testing are leading to expanded energy efficiency program designs.

The partners continue to identify areas for deep collaboration and multi-solving. Patient recruitment for the UVM Medical Center Pediatric Pulmonology pilot will continue via ongoing patient tracking for potential home environmental respiratory triggers and doctor referrals to Efficiency Vermont. The WHI pilot activities are expected to commence in mid-2022 and continue at least through 2023, further exploring the benefits of energy-plus-health collaboration.

At the time of this research, the quantification and attribution of health and healthcare-related non-energy benefits of weatherization-related measures through a “Wx-Health” adder in Vermont’s societal cost-effectiveness screening tool is being discussed as part of the Public Utility Commission Avoided Cost Proceeding (Case No. 21-2436-PET). If approved, the Wx-Health adder will enable Vermont’s energy efficiency utilities to better account for the recognized health and healthcare-associated benefits and avoided costs that result from weatherization-related projects and measures and ensure resource decisions are appropriately directed at least-cost outcomes for customers and society.¹⁴

Collectively, these efforts will expand Efficiency Vermont and the collaboration partners’ ability to best support Vermonter’s in achieving healthy, energy efficient homes today and for generations to come.

¹⁴ For more information about non-energy benefits and energy efficiency utility cost-effectiveness screening, see *The Benefits of Home Performance with ENERGY STAR*: <https://www.encyvermont.com/news-blog/whitepapers/non-energy-benefits-of-encyvermont-s-home-performance-with-energy-star-program>.