COLD CLIMATE HOUSING RESEARCH CENTER
CCHRC

Energy Efficiency Measures Implemented in the Home Energy Rebate Program

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Introduction

Buildings account for a significant amount of the energy consumption, energy costs, and greenhouse gas emissions in the U.S. and Alaska. Approximately 40% of total U.S. energy consumption is used in the residential and commercial sectors, and in Anchorage, for example, buildings account for an estimated 47% of total energy consumption. [1, 2]

Alaska has a significant need to retrofit existing homes. The majority of the homes were built in the 1970s and '80s, and many are drafty and face high energy costs, as they were built using construction techniques that were inadequate for subarctic climates. [3] These inefficient homes, combined with the extreme climates found within Alaska, contribute to homes using approximately twice the energy per year on average as the typical home in other "cold" climate regions in the U.S.[4] It is estimated that even after recent State and Federal energy efficiency programs, approximately 156,000 homes in Alaska are still relatively inefficient and would benefit from a retrofit.[5]

Since 2008, nearly 27,000 homes in Alaska have been retrofit to use less energy through the Alaska Housing Finance Corporation's (AHFC) Home Energy Rebate program, providing a significant reduction in energy use and costs for homeowners as well as creating jobs and boosting local economies.[6] With the end of the program, there are fewer resources available to meet the need represented by the many inefficient homes that burden families with unnecessarily high energy costs. Understanding which energy efficiency measures have been implemented in this program can help to identify building efficiency gaps, understand consumer preferences, and inform future programs. To this end, the Cold Climate Housing Research Center (CCHRC) analyzed data from over 20,300 building retrofits that were conducted in Alaska to determine which energy efficiency measures were implemented. This report outlines the results of which energy efficiency measures were implemented at the statewide level; detailed results split out by regions defined by the Alaska Native Claims Settlement Act (ANCSA) boundaries are located in Appendix A. Two additional supplementary

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[1] U.S. Energy Information Administration Frequently Asked Questions. Available at: https://www.eia.gov/tools/faqs/faq.php?id=86&t=1
[2] Municipality of Anchorage Energy Landscape and Opportunities Analysis. (2017). Available at: https://www.muni.org/Departments/Mayor/AWARE/ResilientAnchorage/Documents/Anchorage%20Energy%20Landscape%20and%20Opportunities%20Analysis.pdf
[3] Madden, D., Wiltse, N. 2018 Alaska Housing Assessment. CCHRC for Alaska Housing Finance Corporation. 2018. Available at: https://www.ahfc.us/efficiency/research-information-center/alaska-housing-assessment/2018-housing-assessment
[4] Ibid.
[5] Ibid.
[6] Home Energy Rebate Program Impacts Report (2019). Cold Climate Housing Research Center. Submitted for publication.

reports related to this one use the details of which energy efficiency measures were implemented to try to determine what the actual energy savings and installed costs were for each measure using multivariate regression analysis; they are titled *Natural Gas Savings from Energy Efficiency Measures in the Home Energy Rebate Program: A Multivariate Regression Analysis* and *Installed Cost of Energy Efficiency Measures in the Home Energy Rebate Program: A Multivariate Regression Analysis*, respectively.

Having information on which energy efficiency measures have already been implemented in the various regions of Alaska can help a variety of stakeholders: contractors doing energy efficiency retrofit work can use this knowledge to tailor services and marketing to customers and policymakers can develop programs, incentives, or regulations to try to meet the identified gaps. This report presents the results of this analysis for the Home Energy Rebate program at the statewide level as well as on a regional basis.

Methodology

While the energy efficiency measures that were implemented through AHFC's Home Energy Rebate program were not explicitly tracked, each home that participated was required to have a detailed energy audit conducted before and after the retrofit. This energy audit was completed using the AkWarm Home Energy Rating software, which models the energy use of the home using the detailed home inputs entered by the energy rater. Each of these models includes measured descriptions of all building components (sizes and insulation levels of walls, windows, ceilings, etc.), the air-tightness of the building, inputs for the heating, ventilation, and hot water systems, as well as the appliances. These AkWarm rating files for the pre- and post-rating are all stored in a centralized database managed by AHFC called the Alaska Retrofit Information System.

For this study, each pre- and post-rating file for every single family or mobile home that participated in the Home Energy Rebate program was extracted and matched based on the unique location key generated when files are uploaded. In all, after cleaning the data, matched pre- and post-rating files for approximately 20,300 homes were used in this analysis.

Detailed data on each building shell component of each home was collected for both the pre- and post-rating. A Python script was developed to compare each of these components for changes in insulation levels and square footage for each home that participated in an energy efficiency retrofit. For insulation retrofits, a minimum threshold of an increase in r-value of at least 0.5 was implemented to filter out accidental changes caused by variation in the way energy raters entered the component versus changes caused by an actual retrofit to increase the insulation levels. Each of these retrofits was then additionally classified by its location within the house; for example, above-grade wall components were split into “garage walls”, “house walls”, “rim joists”, and “crawl space walls.”

Additionally, the heating, ventilation, water heating, air-tightness, and control systems for each home were analyzed to determine if they were retrofit during the program. This was done by comparing the efficiencies, equipment types, fuel types, and characteristics of each system entered in the pre-rating to those modeled in the post-rating.

Statewide Results

The Home Energy Rebate program provided a rebate of up to $10,000 for participating homeowners that improved the energy efficiency of their home. Participants received the results from their energy audit as an ordered list of the most cost-effective energy efficiency measures that they could implement to reduce their home’s energy consumption and cost. They were then given 18 months to implement their choice of energy efficiency measures and get a post energy audit to verify the measures were implemented as well as estimate the home’s improvement using a Star Rating system that ranks a home from 1- to 6-Star based on its efficiency.

For this analysis, we used complete data from 20,347 homes that completed the Home Energy Rebate program, which is 77% of the total number of completions documented by AHFC. Table 1 shows the total number of homes that implemented each category of energy efficiency measure as well as the percentage of homes in the study implementing each measure.

Table 1: Energy Efficiency Measures Implemented in the Home Energy Rebate program - Statewide Results

Energy Efficiency Measures (EEMs)	Number of homes implementing EEM	Percentage of homes implementing EEM
Increased air-tightness	14,840	73%
Installed programmable thermostat	11,193	55%
Replaced heating system	10,040	49%
Replaced water heater	8,583	42%
Insulated ceiling	7,820	38%
Replaced garage door	6,271	31%
Replaced door	4,974	24%
Replaced windows	4,696	23%
Insulated below-grade floor	4,631	23%
Insulated below-grade wall	3,276	16%
Insulated crawlspace	3,035	15%
Insulated rim joist	2,825	14%
Installed ventilation	2,663	13%
Insulated garage ceiling	2,104	10%
Insulated above grade floor	1,639	8%
Insulated walls	1,568	8%
Insulated garage walls	737	4%
Insulated garage floor	548	3%
Installed heat recovery ventilator	543	3%
Insulated cantilevered floor	541	3%
Insulated slab	456	2%
Replaced garage windows	255	1%
Replaced back-up heating system	141	1%

***Note:** Not all energy efficiency measures can be implemented in all homes; for example, a home without a crawlspace cannot insulate the crawlspace. The reported percentages are for all homes.

Increasing the air-tightness of homes was the most commonly implemented energy efficiency measure, with nearly three-quarters of all participating homes becoming less leaky. This high rate of implementation is unsurprising, as typically increasing the air-tightness of homes is inexpensive and can save significant amounts of energy, especially in older, leaky homes. The next three most common efficiency measures were related to mechanical systems. It is extremely common for a programmable thermostat to be installed with a new heating system, so these two measures have a very high level of overlap. The most common insulation retrofit was in ceilings; this is likely due to the relative ease of access to attics and the low cost of blowing in fiberglass or cellulose insulation.

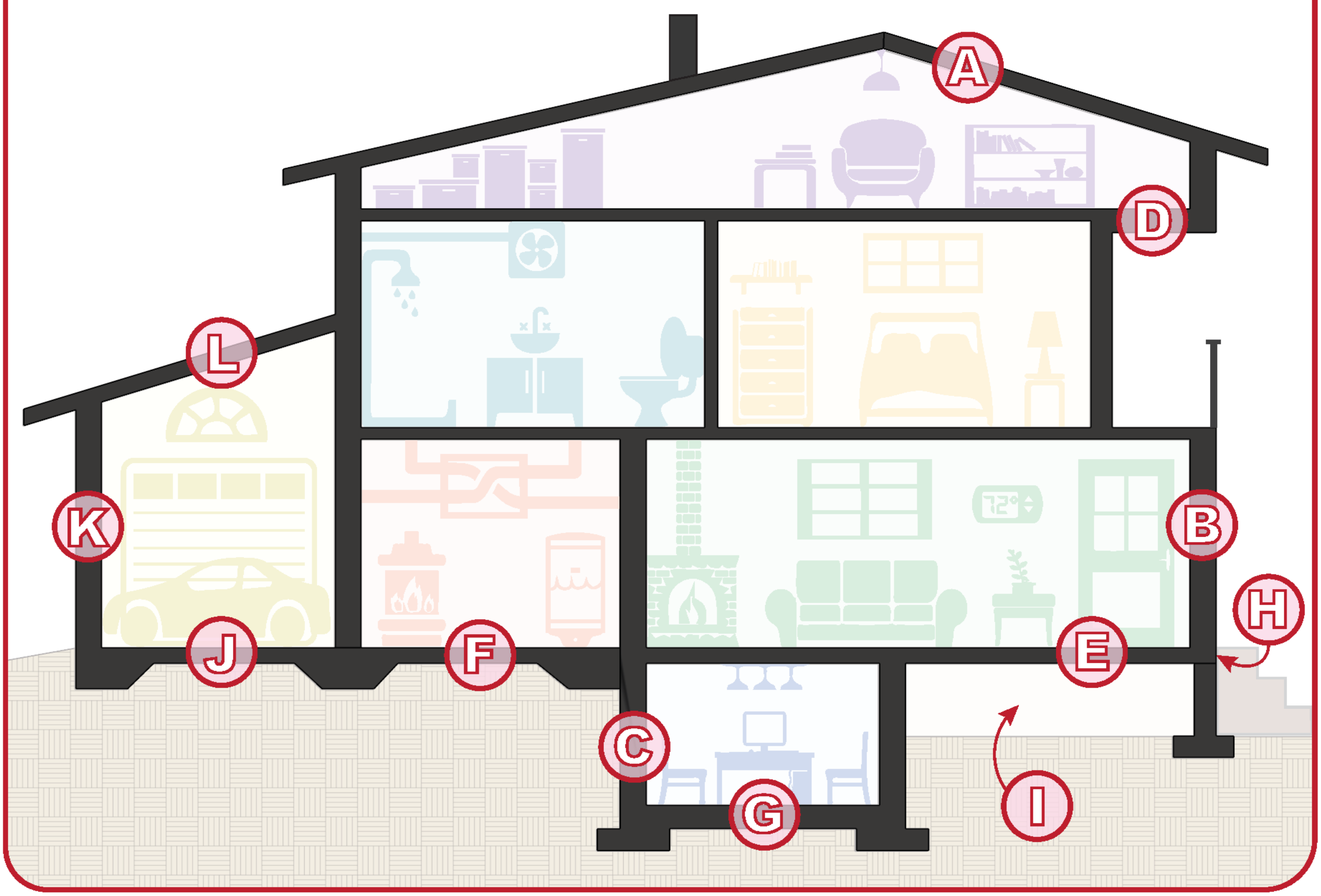
This list also highlights some areas that are opportunities for future energy efficiency retrofits. For example, very few walls added additional insulation (8%), even though many homes in Alaska have minimal wall insulation and thus lose a significant amount of heat through them. Additionally, while nearly three-quarters of homes tightened their home, only approximately 16% of homes installed a mechanical ventilation system or heat recovery ventilator (HRV). While not every home that increases its air tightness will need mechanical ventilation, a significant number of those homes would likely benefit from increased indoor air quality from installing such a system.

The following graphics highlight which energy efficiency measures were implemented in the Home Energy Rebate program and their locations within the home.

HOME ENERGY REBATE PROGRAM
INSULATION RETROFITS
STATEWIDE

PERCENTAGE OF REGIONAL HOMES THAT IMPLEMENTED EEMS

A	38%	Insulated ceilings
B	8%	Insulated above-grade walls
C	16%	Insulated below-grade walls
D	3%	Insulated cantilevered floor
E	8%	Insulated above-grade floor
F	2%	Insulated slab
G	23%	Insulated below-grade floor
H	14%	Insulated rim joist
I	15%	Insulated crawlspace
J	3%	Insulated Garage floor
K	4%	Insulated Garage walls
L	10%	Insulated Garage ceiling



HOME ENERGY REBATE PROGRAM
DOOR / WINDOW RETROFITS
STATEWIDE

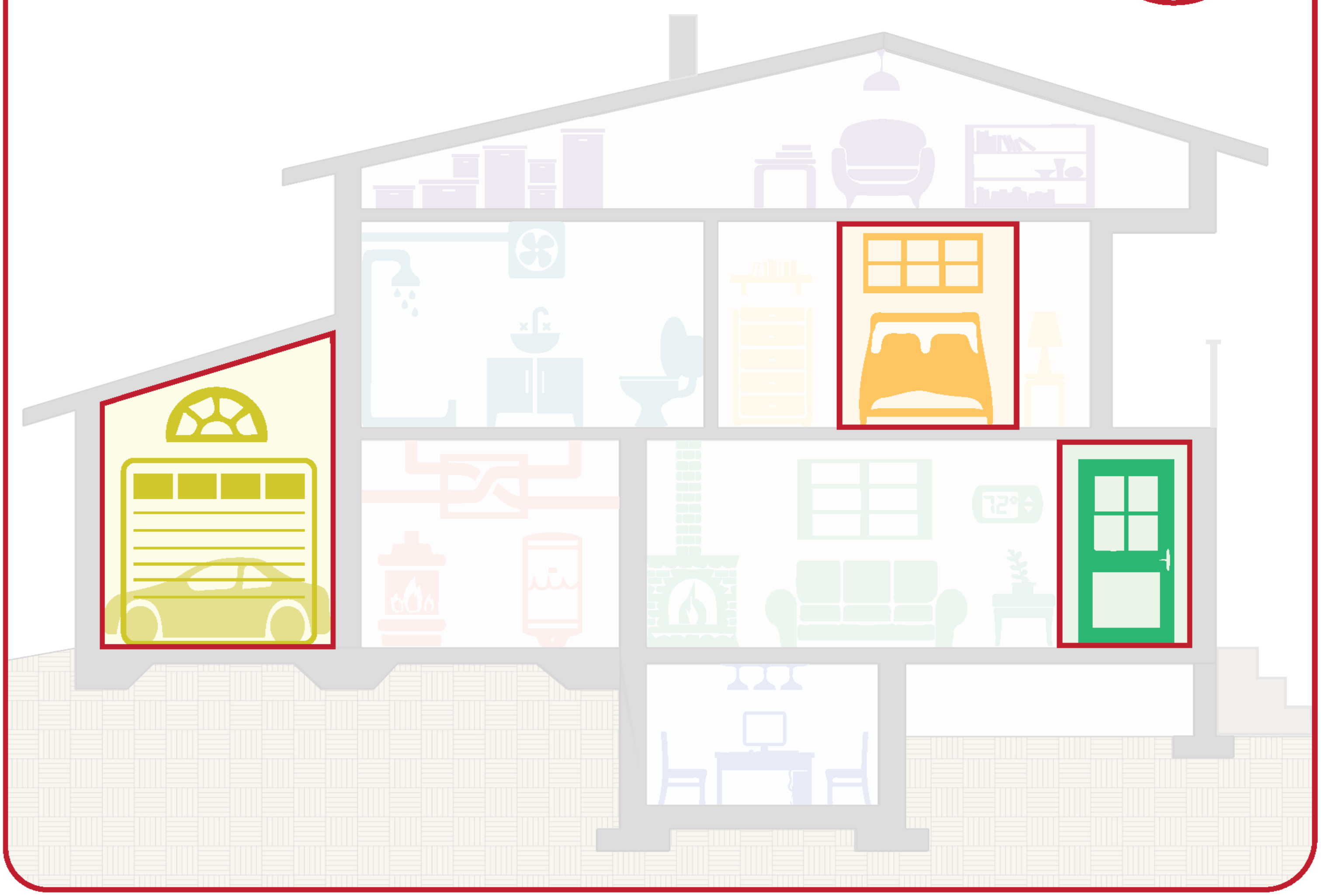
PERCENTAGE OF REGIONAL HOMES THAT IMPLEMENTED EEMS

24% *Replaced exterior doors*

Replaced windows **23%**

31% *Replaced Garage door*

Replaced Garage windows **1%**



HOME ENERGY REBATE PROGRAM

HEATING RETROFITS

STATEWIDE

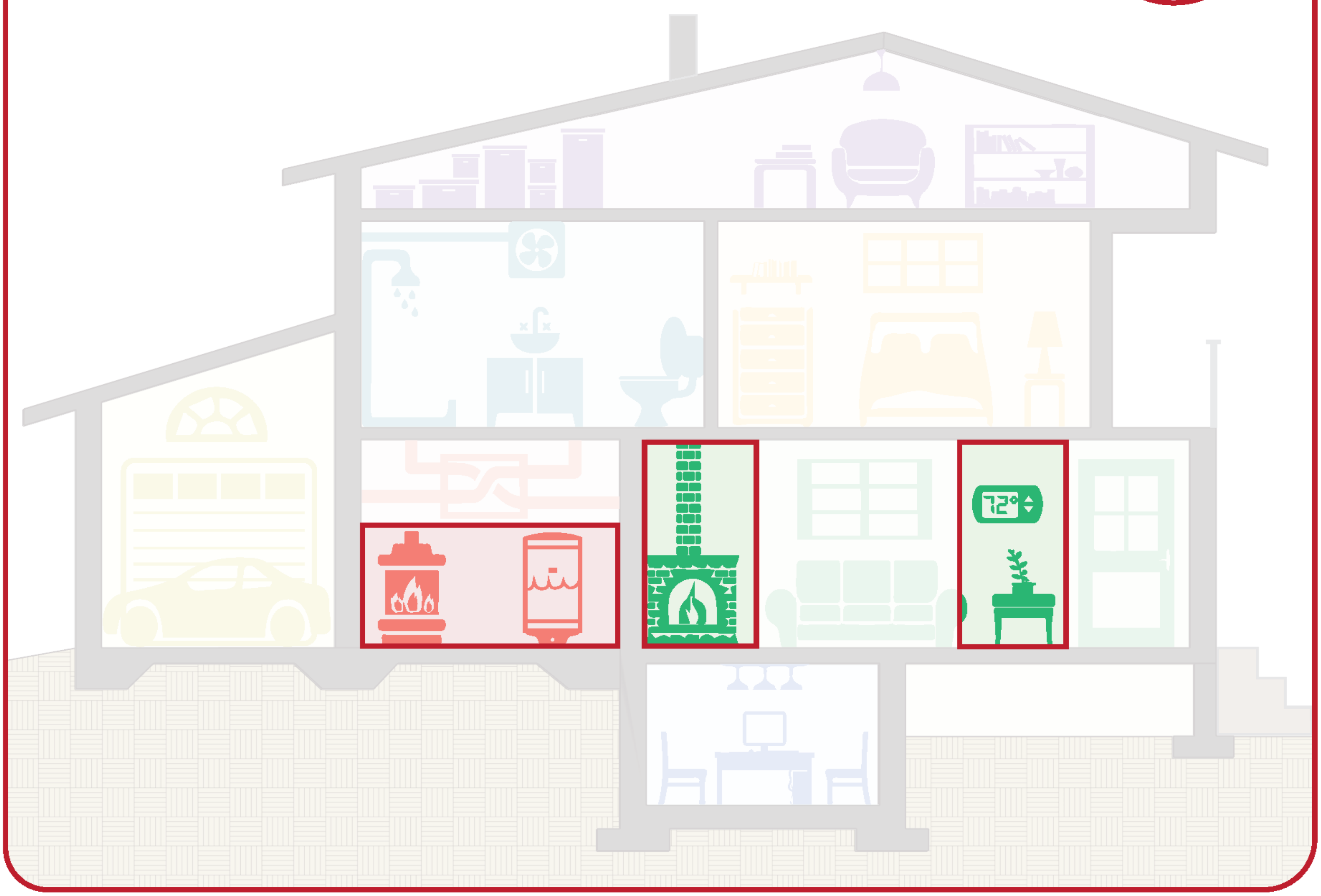
PERCENTAGE OF REGIONAL HOMES THAT IMPLEMENTED EEMS

55% *Installed programmable thermostat*

Replaced heating system **49%**

1% *Replaced back-up heating system*

Replaced water heater **42%**



HOME ENERGY REBATE PROGRAM

VENTILATION RETROFITS

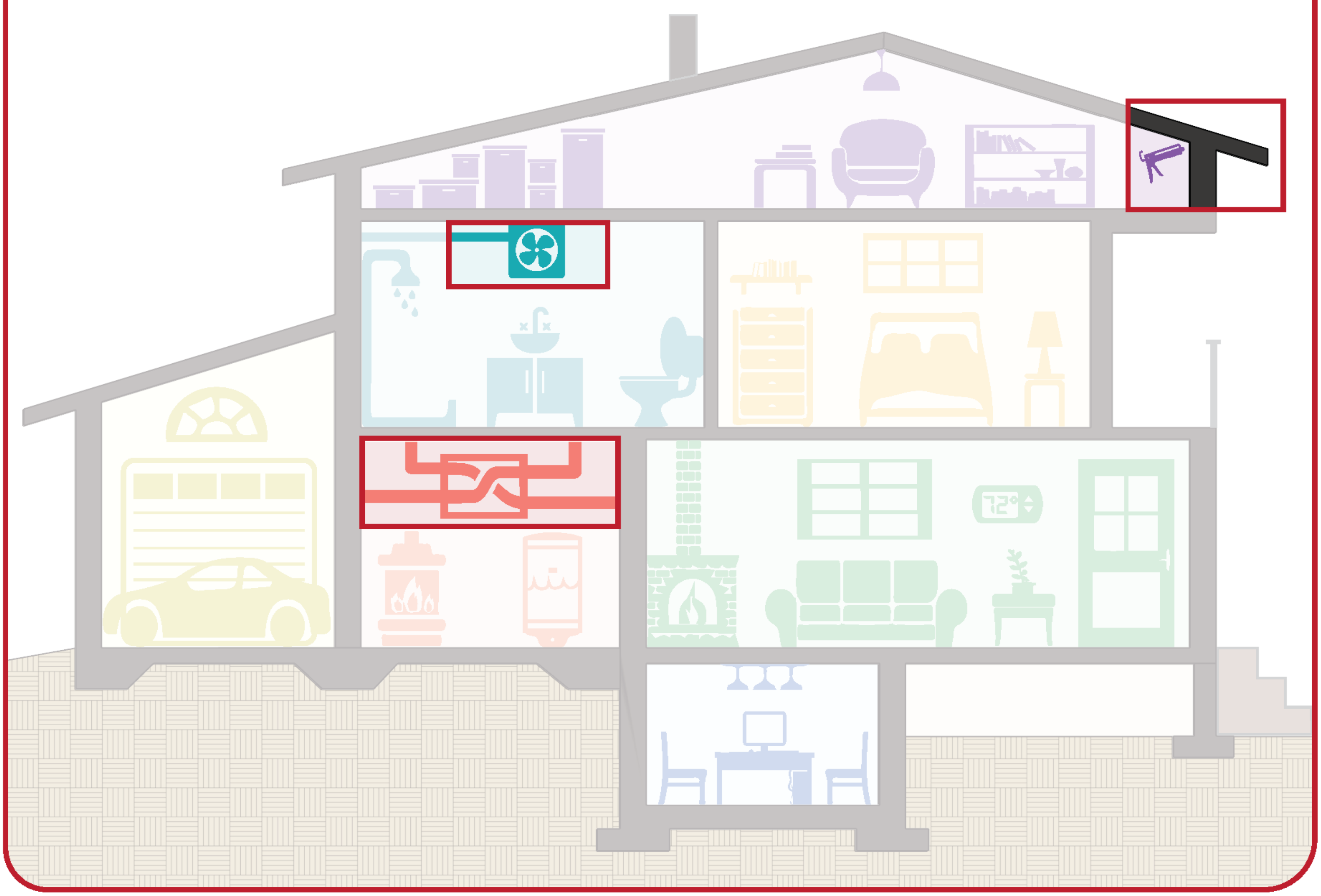
STATEWIDE

PERCENTAGE OF REGIONAL HOMES THAT IMPLEMENTED EEMS

3% *Installed Heat Recovery Ventilator (HRV)*

Increased air-tightness **73%**

13% *Installed continuous ventilation*



Recommendations

There were two fairly large gaps in which energy efficiency measures were implemented in the Home Energy Rebate program: ventilation systems and difficult to install shell components, such as walls and various floor system retrofits.

The lack of installed ventilation systems is a gap that likely will need remedying in many homes in the near term, as the majority of homes also increased their air tightness. While air-tightening a home will decrease its energy consumption, without adequate ventilation systems in place indoor air quality may be compromised. The best situation to provide healthy indoor air is to have a home that is very air tight and have a balanced mechanical ventilation system that provides fresh air from a properly located intake, as this ensures that pollutants are exhausted and clean air is taken from a specified area rather than relying on natural infiltration from an unknown source. Given the potential health and home durability impacts from poor indoor air quality, it would be beneficial to Alaskans to have educational programs on indoor air quality for homeowners. We recommend that health-related organizations partner with groups familiar with building science and construction in order to reach a wider audience and provide a more holistic education.

Facilitating a higher percentage of retrofits to walls, floors, and other shell components is a difficult, but valuable goal. Shell component retrofits have much longer expected lifespans than mechanical systems, which typically require replacement between 10 and 20 years. In contrast, often the insulation that is initially installed in a home is in place throughout the life of the building; thus even though typical life cycle cost analyses limit the benefits to 30 years at most, shell component retrofits have the potential to provide energy cost savings to Alaskans for multiple generations. Key to increasing the amount of shell retrofits is to find innovative ways to decrease the cost of these improvements; new materials such as vacuum insulated panels have the potential to greatly reduce the cost and inconvenience of wall retrofits. We recommend increased funding for retrofit research and development as well as contractor training in modern techniques.

Lastly, if there is ever another program in place that provides rebates to install efficient space and water heating systems, we recommend that the incentive be based on the difference between a specified baseline “typical” replacement system and a highly efficient system. This would encourage purchasing of efficient equipment while not incentivizing replacements of space and water heating systems simply because they are nearing the end of their useful lives.