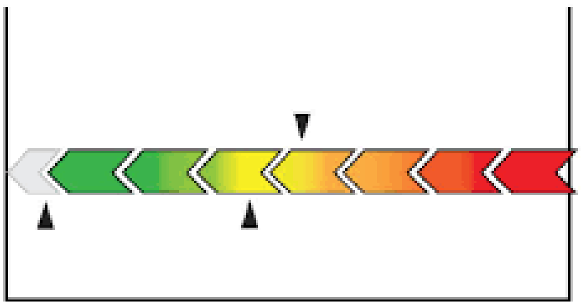
ENERGUIDE



Analysis of NRCan EnerGuide Rating System data for Part 9 homes to inform climate policy

Prepared by: Jannatul Ferdous, UBC Sustainability Scholar 2025

Prepared for: Maggie Baynham, Sustainability Project Manager, Sustainability Division, Corporate Services Department, District of Saanich

August 2025

Disclaimer

This report was produced as part of the UBC Sustainability Scholars Program, a partnership between the University of British Columbia and various local governments and organizations in support of providing graduate students with opportunities to do applied research on projects that advance sustainability across the region.

This project was conducted under the mentorship of District of Saanich staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of the District of Saanich or the University of British Columbia.

Acknowledgements

I would like to thank my project mentor, Maggie Baynham, Sustainability Project Manager at the District of Saanich, for her ongoing support and guidance throughout this project.

Furthermore, I would like to thank Karen Taylor and the Sustainability Scholars Program for their support and work in providing opportunities for students to contribute to real-life sustainability initiatives.

I respectfully acknowledge my position as an uninvited guest living on the land of the traditional, ancestral, and unceded territory of the Syilx/Okanagan people. I also respectfully acknowledge that the District of Saanich lies within the territories of the lək̓ʷəŋən peoples represented by the Songhees and Esquimalt Nations and the W̱SÁNEĆ peoples represented by the W̱JOŁEŁP (Tsartlip), BOḰEĆEN (Pauquachin), SȾÁUTW̱ (Tsawout), W̱SIḴEM (Tseycum) and MÁLEXEŁ (Malahat) Nations.

Executive Summary

This project analyzes Natural Resources Canada's pre- and post-retrofit energy evaluation data for Part 9 homes in the District of Saanich to better understand community retrofit activity and its contribution to achieving local climate targets of a 50% reduction in greenhouse gas (GHG) emissions by 2030 and net zero by 2050. While recent efforts have focused on electrification, energy efficiency upgrades such as insulation, windows, and air sealing are also important for reducing emissions, lowering household energy costs, and improving affordability. The analysis explores retrofit rates, energy and GHG reduction potential, cost-efficiency of different measures, and how upgrades interact with fuel-switching. Findings will inform the 2025 Climate Plan Update and support the design of Saanich and partner-led programs, including the Heat Pump Financing Program, the Home Energy Navigator, and the Heat Pump Direct Install feasibility study.

The study analyzed pre- and post-retrofit EnerGuide evaluations for 5923 Saanich homes (11846 evaluation records total) homes (2007–2024), focusing on 12 upgrade types, fuel-switching trends, and bundles of measures. Energy savings were calculated by comparing pre- and post-retrofit consumption across fuel types, standardized per square metre, and converted to gigajoules. GHG reductions were estimated by applying BC Ministry of Energy and Climate Solutions (2024) emission factors. This enabled assessment of retrofit trends over time, the interaction of efficiency measures with fuel switching, and the relative energy and emissions benefits of different upgrade pathways.

Neighborhood-level analysis examined retrofit trends across Saanich's forward sortation areas (FSAs) and explored correlations with socio-economic factors such as household income, home energy expenditures, and housing characteristics, using data from the ERS dataset and the Energy Poverty and Equity Explorer Tool. Additional analysis estimated operating cost savings for homes switching from natural gas or oil heating to electric heat pumps, based on BC Hydro, FortisBC, and local oil pricing, under current rate structures. The study also evaluated costs, rebates, and cost-efficiency of common upgrades and bundles (e.g., heat pumps, insulation, windows), calculating metrics such as cost per gigajoule saved, cost per tonne of GHG reduced, and payback periods.

The analysis examined the role of heat pumps, both as primary and with supplementary heating systems, and modeled retrofit pathways for achieving the District of Saanich's 2030 and 2050 climate targets. Homes that adopted heat pumps alongside supplementary systems (e.g., natural gas or electric resistance heating) demonstrated measurable energy savings, GHG reductions, and operating cost benefits compared to conventional fossil fuel heating. Building on these findings, scenario modeling assessed retrofit adoption rates—such as full oil-to-heat-pump conversion by 2030, phased natural gas transitions, and widespread envelope upgrades—to meet emissions reduction goals of 56,000 tCO_2e by 2030 and 90,000 tCO_2e by 2050. Key measures include electrification of heating systems and targeted envelope improvements (air sealing, attic insulation, and energy star windows), emphasizing the critical role of combined efficiency and fuel-switching strategies in advancing climate objectives.

Program data show clear patterns in upgrade adoption, homeowner behavior, and the influence of incentive programs. Air sealing (85.4%), heat pumps (80.6%), and natural gas furnace upgrades (36.3%) were the most recommended measures, with high uptake rates for air sealing (92.2%) and NG furnaces (96.6%), while ventilation, domestic hot water, and Energy Star doors had very low adoption (<20%), likely due to lower perceived benefits or higher costs. Most households implemented two or three upgrades, indicating a preference for partial retrofits rather than deep energy renovations. Participation in energy evaluations closely tracked the availability of financial incentives: activity peaked during the LiveSmart BC and ecoENERGY Retrofit-Homes Program (2008–2012), reaching 2,724 homes in 2011, declined sharply after 2013, and surged again in 2022–2023 under new rebate programs. Analysis of fuel-switching patterns reveals that oil-to-heat-pump conversions were typically paired with multiple envelope improvements—such as air sealing (865 homes), attic insulation (217), and window upgrades (215)—while gas-to-heat-pump conversions involved fewer additional measures, likely reflecting greater economic benefits of displacing oil heat. Overall, these findings underscore that strong incentive programs drive participation, while cost-efficiency and perceived impact influence the depth and type of upgrades chosen.

The energy savings analysis reveals that fuel type and the scope of upgrades play critical roles in determining overall energy performance improvements in residential buildings. Homes originally heated with oil and propane achieved the highest average energy savings (81–84 GJ), reflecting the inefficiency of these systems and their high potential for improvement. Natural gas users also realized meaningful reductions (~49 GJ), while homes using electricity saw more modest savings (~24 GJ), due to the higher baseline efficiency of electric systems. Importantly, energy savings increased substantially with the number of upgrades, with homes receiving six or more measures achieving around 100 GJ in total savings—more than double that of single-upgrade homes. The most effective retrofit strategies involved bundled upgrades targeting both the building envelope and mechanical systems, with combinations like air sealing, energy star windows, and wall insulation achieving savings near 55 GJ. These findings emphasize the value of targeting high-consumption fuel types and adopting whole-home upgrade strategies to maximize energy efficiency outcomes.

The analysis of greenhouse gas (GHG) emissions reductions across various home energy upgrades reveals that combining multiple retrofit measures yields significantly greater environmental benefits than implementing single upgrades. Upgrades involving heat pumps—particularly when paired with high-performance building envelope improvements such as energy star windows, attic or wall insulation, and air sealing - achieved the highest average GHG reductions, reaching up to 6 tCO_2e per home. Emissions reductions were positively correlated with the number of upgrades, with homes receiving six or more upgrades seeing total reductions exceeding 7 tCO_2e. Among fuel sources, the most substantial emissions savings were associated with reductions in oil and propane use, followed by natural gas, while electricity showed minimal impact unless coupled with electrification upgrades. These results strongly support a holistic approach to home energy retrofits, emphasizing the integration of efficient heating systems and envelope improvements to maximize climate benefits.

This analysis evaluates the energy savings, cost impacts, and emissions reduction potential of residential retrofits across single-family homes in the District of Saanich. The results demonstrate that energy efficiency upgrades—particularly those targeting heating systems and building envelopes—offer significant opportunities for both environmental and economic benefits. Homes originally using oil or propane heating systems achieved the highest average energy savings post-retrofit—up to 84 GJ, while natural gas-heated homes saved around 49 GJ. The analysis demonstrates that fuel switching, particularly from oil or natural gas to heat pumps, offers the most substantial reductions in household operating costs, energy consumption, and GHG emissions.

Fuel switching from natural gas or oil systems to heat pumps delivers the most significant reductions in household operating costs, energy use, and GHG emissions. While homes retaining natural gas saw only modest benefits (0.3% cost savings and 40% emission reductions), those converting to heat pumps achieved 2–5.5% cost savings, nearly 49% lower energy use, and over 80% emission reductions. Oil-heated homes had the highest baseline costs and emissions, and switching to heat pumps produced the largest gains—cutting operating costs by 22–26%, energy use by up to 16%, and emissions by more than 90%. These results highlight heat pump adoption, especially in oil-heated homes, as the most impactful pathway to meeting community climate goals.

Rebates significantly improved the economic viability of retrofits. With incentives, payback periods dropped as low as 1.15 years for attic insulation and around 8-16.5 years for most heat pump-related bundles. Combined measures generally yielded better cost-per-GJ and cost-per-tonne of GHG reduced than single upgrades, especially when targeting both insulation and heating systems. Despite switching to heat pumps, many homes retained supplementary heating sources, particularly natural gas and wood fireplaces. This trend suggests a need for further policy focus on secondary heating systems to fully decarbonize residential energy use.

The analysis shows that while individual upgrades like air sealing (1,366 tCO_2e) or attic insulation (5,964 tCO_2e) contribute to emissions reductions, they require very large numbers of homes to achieve community-wide targets. In contrast, deep retrofit bundles deliver far greater impact: for example, combining air sealing, energy star windows, and wall insulation can reduce 51,605 tCO_2e, nearly achieving the entire 2030 target with just 27,948 homes. Similarly, fuel switching to heat pumps, particularly from oil and gas systems, provides significant benefits, with 100% conversion of oil-heated homes yielding 16,410 tCO_2e reductions and full conversion of gas-heated homes achieving nearly 29,700 tCO_2e reductions by 2050. These results highlight that the most effective pathway to meeting 2030 and 2050 climate goals lies in prioritizing comprehensive retrofit bundles alongside widespread heat pump adoption.

Table of Contents

Executive Summary ... **iii**

Table of Contents ... **vii**

List of Figures ... **ix**

List of Tables ... **x**

1. Introduction ... **1**

1.1 Background ... 1

1.2 Goals and objectives of the study ... 1

1.3 Research questions ... 2

1.4 Limitations of the study ... 3

2. Literature review ... **4**

2.1 EnerGuide rating system (ERS) evaluation data ... 4

2.2 Use of ERS evaluations in different programs ... 5

2.3 Types of retrofits Considered in the Analysis ... 6

3. Methodology ... **11**

3.1 Literature review and background research ... 11

3.2 Data assemblage ... 11

3.3 Data analysis ... 11

4. Results and discussion ... **25**

4.1 Trends of upgrades in the District of Saanich ... 25

4.2 Status of energy saving ... 30

4.3 Status of GHG emissions reduction ... 34

4.4 Trends of upgrades among the neighborhoods in Saanich ... 37

4.5 Operating cost savings from heating system upgrades 42

4.6 Homes with supplementary heating systems and their status of upgrades 42

4.7 Cost efficiency and pay back period for different upgrades 46

4.8 Status of achieving 2030 and 2050 climate plan targets 53

5. Conclusion 56

References 57

Appendix 59

List of Figures

Figure 1. Number of homes that have done one or more upgrades in the District of Saanich 27

Figure 2. Number of total upgrades in different years in the District of Saanich 28

Figure 3. Average energy saving (GJ) from different fuel sources 31

Figure 4. Average energy saving (GJ) from different fuel sources with number of upgrades 32

Figure 5. Average energy saving from all fuels (GJ) by retrofit bundles 33

Figure 6. Average GHG emissions reduction (tCO_2e) from different fuel sources 34

Figure 7. Average GHG emissions reduction (tCO_2e) from different fuel sources with number of upgrades 36

Figure 8. Average of GHG emissions reduction (tCO_2e) from all fuels by retrofit bundles ...37

Figure A9. Distribution of FSA in Victoria (Topmoving.ca., 2025) 59

Figure A10. Coverage of census tracts in Victoria (Statistics Canada, 2022) 60

Figure A11. Average energy saving (GJ) per sq m from different fuel sources......................63

Figure A12. Average energy saving (GJ) per sq m from different fuel sources with number of upgrades 63

Figure A13. Average GHG emissions reduction per sq m (tCO_2e) from different fuel sources 66

Figure A14. Average GHG emissions reduction per sq m (tCO_2e) from different fuel sources with number of upgrades 66

List of Tables

Table 1. Details of calculating whether any specific type of retrofit was recommended and/or completed or not 13

Table 2. Data fields used to calculate energy savings from different fuel sources 15

Table 3. Emission factors for different fuel sources to calculate GHG emissions reduction in tCO_2e 16

Table 4. Census tracts under each postal code considered for neighborhood analysis 18

Table 5. Items and rates ($) in FortisBC 19

Table 6. Data fields used to identify the homes with supplementary heating systems along with heat pumps 20

Table 7. Cost and rebate amount for some common upgrade types for both ESP and HRR programs 22

Table 8. Number of single-family homes using different fuel sources in the District of Saanich (Introba Inc., 2023) 24

Table 9. Summary of upgrades recommended and done in the District of Saanich 25

Table 10. Number of homes that have done different upgrades along with fuel conversions 30

Table 11. Number of homes according to their construction years in different neighbourhoods in the District of Saanich 38

Table 12. Distribution of homes doing different upgrades in different neighbourhoods in the District of Saanich 41

Table 13. Distribution of social and economic factors in different neighbourhoods in the District of Saanich 41

Table 14. Summary of homes with supplementary heating systems 43

Table 15. Summary of operating cost ($), energy consumption (GJ), and GHG emissions (tCO_2e) in pre- and post-retrofit for the homes having supplementary heating systems along with heat pump....45

Table 16. Cost per GJ of total energy saved ($) with and without rebate for both the ESP and HRR programs for different bundles of upgrades....49

Table 17. Cost per tCO_2e GHG emissions reduced ($) with and without rebate for both the ESP and HRR programs for different bundles of upgrades....50

Table 18. Payback period (years) with and without rebate for both the ESP and HRR programs for different bundles of upgrades....52

Table 19. Total GHG emissions reduction from single-family homes and number of homes required to achieve 2030 and 2050 emissions reduction targets for different bundles of upgrades 54

Table 20. GHG emissions reduction scenarios from building envelope upgrades....55

Table A21. Number of homes that have been doing combination of two types of upgrades..61

Table A22. Number of homes that have been doing different types of upgrades in different years....62

Table A23. Average energy saving (GJ) and average energy saving per sq m (GJ) from different fuel sources for different years of evaluation....64

Table A24. Average energy saving (GJ) and average energy saving per sq m (GJ) from different fuel sources for different bundles of upgrades....65

Table A25. Average GHG emissions reduction (tCO_2e) and GHG emissions reduction per sq m (tCO_2e) from different fuel sources for different years of evaluation....67

Table A26. Average GHG emissions reduction (tCO_2e) and GHG emissions reduction per sq m (tCO_2e) from different fuel sources for different bundles of upgrades....68

Table A27. Distribution of homes doing different upgrades along with the year of construction in different neighbourhoods in the District of Saanich....69

Table A28. Distribution of homes doing different upgrades along with the median household after tax income ($) in different neighbourhoods in the District of Saanich 69

Table A29. Distribution of homes doing different upgrades along with the median home energy expenditure ($) in different neighbourhoods in the District of Saanich 70

Table A30. Cost per GJ of energy saved ($) from different fuel sources with and without rebate for both the ESP and HRR programs for different bundles of upgrades 71

Table A31. Cost per tCO_2e GHG reduced ($) from different fuel sources with and without rebates for both the ESP and HRR programs for different bundles of upgrades 71

Table A32. Payback periods (years) for different bundles of upgrades for both the ESP and HRR programs considering both costs of upgrades with and without rebates 72

1. Introduction

1.1 Background

The District of Saanich has set ambitious climate targets, aiming for a 50% reduction in community greenhouse gas (GHG) emissions by 2030 and net zero emissions by 2050. Achieving these goals requires significant action in the building sector, including upgrading 40% of all building envelopes by 2030 and 80% by 2050. While recent policy and program efforts have primarily focused on electrification—such as supporting the adoption of heat pumps and the transition away from fossil fuel heating—energy efficiency upgrades play a complementary and critical role. Improvements to building envelopes and other efficiency measures not only reduce emissions but also help stabilize energy costs and improve affordability for residents.

Currently, Saanich staff have limited data on the scale and nature of energy efficiency upgrades taking place across the community. This lack of information makes it difficult to assess progress, understand how upgrades interact with electrification and fuel-switching, and identify the most effective strategies for future action. To address this gap, this project leverages Natural Resources Canada's (NRCan) pre- and post-retrofit energy evaluation data for Part 9 residential homes. These data provide a valuable opportunity to examine retrofit rates, efficiency gains from specific measures (such as window replacements, attic insulation, and air sealing), and geographic or temporal patterns of activity.

By analyzing this dataset, the project will generate insights to inform the ongoing Climate Plan Update (scheduled for completion in early 2026) and to shape recommendations for current and emerging Saanich and partner-led programs, including the Heat Pump Financing Program, the Home Energy Navigator, and the Heat Pump Direct Install feasibility study.

1.2 Goals and objectives of the study

This project aims to deepen understanding of the energy efficiency upgrades taking place in the District of Saanich, assess their effectiveness, explore how they interact with electrification and fuel-switching efforts, and determine how these data can more effectively inform climate policy and program design.

The specific research objectives are to:

i. Analyze NRCan's pre- and post-retrofit energy evaluations dataset for Part 9 homes to generate insights into retrofit rates, energy efficiency gains from different upgrades (e.g., window replacements, attic insulation, air sealing), geographic or temporal trends in retrofits, and the most cost-effective measures; and
ii. Inform the Climate Plan Update (to be completed by the end of 2025) and support recommendations for Saanich and partner-led programs, such as the Heat Pump Financing Program, the Home Energy Navigator, and the Heat Pump Direct Install feasibility study.

1.3 Research questions

The EnerGuide Rating System (ERS) dataset was analyzed to address the following questions:

1) What are the energy and GHG reduction potentials from each upgrade type and combinations of upgrades? How have upgrade trends changed over time? To what extent are fuel conversion retrofits being undertaken in combination with envelope/efficiency upgrades?
2) How does the number and type of upgrades vary by neighbourhood in Saanich, and how does this correlate with social and economic factors such as income, age of homes, and homes in need of repair, etc.?
3) What are the estimated operating cost savings for homes that switch from gas to a heat pump?
4) What are the estimated operating cost savings for homes that switch from oil to a heat pump?
5) What can be inferred about the energy use, emissions, or operating costs of dual-fuel systems? For those that install a dual-fuel heat pump, what is the most common pre-retrofit fuel type, what are the resulting energy and GHG reductions?
6) Which upgrades are the most cost-effective, and what kinds of paybacks are they achieving with and without available incentives?
7) What retrofit rates would be required, under different scenarios and upgrade bundles, to enable Saanich to achieve its 2030 and 2050 targets?

1.4 Limitations of the study

This analysis is subject to several limitations:

- **Program Participation Bias:** The dataset is based on NRCan's pre- and post-retrofit energy evaluations, which capture only households that participated in the program. The extent to which these homes represent the broader population of retrofits in Saanich is unknown, as many upgrades may have occurred without an energy evaluation.
- **Energy Price Volatility:** Calculations involving energy costs are a snapshot in time. Prices are subject to fluctuations due to market conditions, regulatory changes, or shifts in fuel availability. For example, Saanich's Make the Switch study (District of Saanich, 2022) found that with BC's carbon tax in place, switching from natural gas to heat pumps typically led to energy cost savings. However, recent changes to the carbon tax framework have shifted the economics of electrification, altering the cost-efficiency of fuel switching in some cases.
- **Scope of Climate Plan Targets:** The Saanich Climate Plan sets community-wide GHG reduction targets but does not specify the relative contributions expected from different building types. This study focuses exclusively on Part 9 residential homes, which means the results should be understood as one piece of the broader building sector picture.
- **Data Quality and Consistency:** Energy evaluations vary depending on the assessor, the accuracy of reported household characteristics, and the level of detail provided. These differences may introduce uncertainty into estimates of retrofit rates, energy savings, and GHG reductions.
- **Variation in Energy Use Data:** The NRCan energy evaluations are completed using a standard set of operating conditions (such as indoor temperature set points) and do not account for some factors that can affect energy used, such as user behaviour or number of occupants in the home. As such, the energy usage and costs from these modelled energy evaluations may vary from actual energy use and costs in the household.
- **Bundled Upgrade Analysis:** When analyzing bundles of upgrades, energy savings and GHG reductions were calculated only for those specific measures. In contrast, operating cost analyses of fuel switching (e.g., gas-to-heat pump conversions) included homes that may have pursued additional upgrades, creating some uncertainty in cost comparisons.

2. Literature review

2.1 EnerGuide rating system (ERS) evaluation data

A home energy audit—also called an EnerGuide Home Evaluation—is a crucial first step toward making any home more energy efficient. This evaluation identifies ways to improve comfort and reduce energy costs. Performed by a certified energy advisor, the audit examines factors such as air leakage, insulation levels, and the condition of the furnace and ductwork. The assessment takes place twice; a pre-retrofit assessment indicates the potential of different upgrades to make the home more energy efficient, and the post-retrofit assessment checks the energy savings realized from the upgrades. After the pre-retrofit assessment, the advisor provides a customized report with recommended upgrades to boost energy efficiency and reduce GHG emissions. The report also includes the home's EnerGuide rating, allowing homeowners to compare their home's efficiency to similar properties in the area and to track improvements over time (BC Hydro, 2024a).

The pre-retrofit evaluation involves the following steps:

i. **Goal setting:** Discussing the homeowner's priorities, including comfort or efficiency concerns.
ii. **Home measurement:** Determining the size and heated volume of the home.
iii. **Insulation inspection:** Recording existing insulation levels throughout the building.
iv. **Heating system documentation:** Identifying the make and model of space and water heating systems.
v. **Blower door test:** Performing a blower door test to detect air leaks and calculate air changes per hour (ACH) and equivalent leakage area.
vi. **Energy modelling:** Creating a digital energy model of the home using HOT2000 software.
vii. **Upgrade recommendations:** Delivering a tailored report with suggestions for energy-saving upgrades and estimated cost savings.
viii. **EnerGuide rating:** Assigning an EnerGuide rating and label to reflect the home's current energy performance.

During the post-retrofit evaluation, the advisor focuses on:

i. **Energy performance review:** Assessing how the home performs after renovations and upgrades.
ii. **Change documentation:** Recording all changes made since the initial evaluation and calculating the new EnerGuide rating.
iii. **Updated rating and label:** Issuing a revised EnerGuide label and a Homeowner Information Sheet based on the updated data.

2.2 Use of ERS evaluations in different programs

In British Columbia, the EnerGuide Rating System (ERS) has been a core measurement and verification tool for residential energy efficiency programs administered by federal, provincial, utility, and municipal bodies. At the federal level, the Canada Greener Homes Grant (May 27, 2021 – 2024 intake closure) required homeowners to complete both pre- and post-retrofit ERS evaluations to qualify for financial incentives. While new applications are no longer accepted, participants with approved files may complete retrofits and submit claims until December 31, 2025. The program offered up to $600 to offset evaluation costs. The companion Canada Greener Homes Loan, which remains active, also requires ERS evaluations as part of its eligibility criteria (Natural Resources Canada, 2025a).

Provincially, the CleanBC Better Homes Program, delivered in partnership with BC Hydro and FortisBC, incorporates ERS evaluations within its Home Energy Improvement Bonus pathway which provides an incentive to homes that complete three or more eligible upgrades. This pathway requires both pre- and post-retrofit ERS assessments to determine performance improvement and corresponding rebate eligibility (CleanBC, 2019b). Although the standalone rebates for conducting evaluations were discontinued as of April 1, 2022, the bonus stream continues to use ERS as a performance measurement standard.

At the municipal level, the City of Vancouver introduced requirements in 2023 for EnerGuide home evaluations as part of its building permit process for medium- and large-scale renovations. The requirements apply above defined project value thresholds and are intended to ensure that renovations contribute to measurable improvements in energy performance (City of Vancouver, 2023). Across these programs, ERS evaluations provide standardized, NRCan-approved assessments of annual energy consumption, enabling consistent performance benchmarking and verification of retrofit effectiveness (Natural Resources Canada, 2025b).

2.3 Types of retrofits Considered in the Analysis

The data acquired from NRCan was for both pre- and post-retrofit EnerGuide evaluations and from that dataset, 12 types of retrofits were identified. The following sections detail the types of retrofits.

2.3.1 Air sealing

Air leakage happens when outside air enters the home and conditioned indoor air escapes through cracks and openings. Relying on this uncontrolled exchange for natural ventilation is not recommended - it can result in too much airflow during cold or windy conditions and too little during warmer weather, potentially compromising indoor air quality. In addition, air leakage can lead to moisture problems that affect both the health of occupants and the structural durability of the home. By sealing these leaks, drafts and cold spots are reduced, leading to improved comfort.

Controlling air leakage is one of the most important retrofit measures and should be a top priority in any home improvement plan. When adding insulation or upgrading the air barrier, it is essential to prevent moisture from entering the insulation or the building envelope. Effective air sealing requires identifying and closing as many air leakage points as possible using materials such as caulking, weather stripping, gaskets, and specialized tapes (Government of Canada, 2024).

2.3.2 Ventilation

Reducing drafts and enhancing ventilation are key elements of any home retrofit. It’s important to distinguish between drafts - unwanted air leaks that lead to heat loss, and ventilation, which is the intentional exchange of indoor and outdoor air to remove stale air and bring in fresh air. Achieving a balance between airtightness and proper ventilation is essential for maintaining good indoor air quality and preventing issues like mould and condensation. There are two primary ventilation methods: natural and mechanical. Natural ventilation involves opening windows and doors to allow airflow, which can be energy-efficient but is often unreliable due to changing weather and the potential for uncontrolled drafts. Mechanical ventilation, in contrast, uses fans and duct systems to provide consistent airflow throughout the year. To ensure healthy indoor environments, the BC Building Code (BCBC 2024) and Part 9 of the National Building Code (NBC) mandate that all new homes in British Columbia be equipped with mechanical ventilation systems.

2.3.3 Attic insulation

Attic insulation plays a vital role in retrofitting homes for improved energy efficiency and comfort. Proper insulation helps maintain indoor temperatures, lowers heating and cooling costs, and reduces the risk of moisture-related issues. Several types of attic insulation are available, including batt insulation, blown-in (loose-fill) insulation, and rigid foam boards. Batt insulation - typically made from fiberglass or mineral wool - comes in pre-cut panels designed to fit between ceiling joists. Loose-fill materials like cellulose or fiberglass are blown into the attic, offering better coverage in irregular or hard-to-reach spaces. Rigid foam boards, on the other hand, are installed on the underside of the roof or around attic edges to boost insulation levels. In colder climates, a higher R-value is essential for effective insulation. For example, homes in Prince George require an attic insulation level of R-60, while homes in milder climates like Greater Victoria typically need only R-40.

2.3.4 Ceiling insulation

As much as 35% of a home's summer heat gain and winter heat loss can occur through the roof, making it the most important area to insulate. Adding ceiling insulation is one of the most effective ways to improve a home's energy performance. In existing homes, it’s relatively easy to install - especially if there is sufficient space in the attic. Attic insulation and ceiling insulation are placed in slightly different locations and serve slightly different purposes. Attic insulation is installed on the floor of the attic (between or above the joists) if the attic is unconditioned (not heated/cooled). Ceiling insulation is installed directly above the ceiling of the top floor, usually inside the floor joists of that level. If the attic is conditioned (part of the heated/cooled space), insulation may instead be placed in the roof slope rather than at the attic floor. The ideal time to add insulation is during renovations, particularly when plaster or drywall is being removed. In addition to boosting energy efficiency, proper ceiling insulation contributes to better weatherproofing and helps prevent moisture-related issues such as condensation.

2.3.5 Foundation insulation

There are several effective methods for insulating foundation or basement areas. One approach involves applying rigid foam boards or spray foam to the exterior of foundation walls. This method works well for both new and existing homes and provides continuous insulation that minimizes thermal bridging. Alternatively, insulation can be added to the interior side of the foundation walls using foam boards or fiberglass batts. This interior method is commonly used in basements and can be more space-efficient, though it often requires the addition of moisture barriers. Crawl space walls can also be insulated using rigid foam or fiberglass batts, which can greatly enhance the home's overall energy efficiency. However, it's essential to ensure that crawl spaces are properly ventilated to prevent moisture buildup and related issues.

2.3.6 Header insulation

Header insulation focuses on insulating the horizontal framing components - known as headers - that support walls, floors, and roofs. These include various types such as exterior wall headers, floor headers, and roof headers. Exterior wall headers are typically located above windows and doors at the top of exterior walls. Floor headers, found within floor systems, are especially important in homes with unconditioned spaces below, as insulating them can reduce drafts and improve comfort. Roof headers are part of the roof framing and contribute to overall thermal performance when properly insulated.

2.3.7 Wall insulation

Walls can account for roughly 20% of a home's total heat loss. In addition to this, cracks and penetrations in wall assemblies often result in uncontrolled air leakage, allowing cold air to enter and heated or cooled air to escape. Insulating walls is most effective during major renovations or repairs. Interior insulation projects often include repairing walls, upgrading electrical wiring, installing insulation and vapour barriers, and finishing with new drywall. Exterior insulation, on the other hand, can be added during re-siding projects, offering an opportunity to significantly improve a home's thermal performance from the outside.

2.3.8 Natural gas furnace

Keeping heating costs under control during the winter requires an efficient heating system. Older gas furnaces often consume more energy than necessary, resulting in higher utility bills compared to modern, high-efficiency models. To improve energy performance, homeowners have two main options: upgrading to a newer furnace or retrofitting the existing unit. Given that British Columbia's electricity grid is largely powered by clean energy, and being a fossil fuel, natural gas is responsible for the majority of GHG emissions from the building sector (District of Saanich, 2023), switching from natural gas furnaces to electric heat pumps is generally the more sustainable and recommended choice. In this study. natural gas furnace as a type of upgrade reflects that improvements are already done but the homes might still use some other types of heating systems (i.e., oil furnaces), which can affect the energy and GHG emissions performances.

2.3.9 Heat pump

Heat pumps provide an energy-efficient alternative to traditional heating systems like natural gas furnaces and electric baseboards. They also offer cooling capabilities, reducing the need for conventional air conditioners and ensuring comfort throughout the year. Unlike systems that generate heat, heat pumps transfer heat, making them highly efficient and low in carbon emissions - especially in British Columbia, where 97% of electricity is generated from clean hydroelectric sources. This clean energy use translates into significant greenhouse gas reductions - about two tons of CO_2 equivalent per year per home - roughly the same as driving a gasoline-powered car 8,000 kilometers. Heat pumps are approximately 300% more efficient than electric baseboards and natural gas furnaces, and about 50% more efficient than standard window air conditioners. Currently, operating an electric heat pump costs roughly 12% less than running a natural gas furnace, with savings expected to increase as carbon pricing rises (BC Hydro, 2024b; Government of Canada, 2022).

2.3.10 Domestic hot water system

Retrofitting a hot water system involves upgrading or modifying existing water heaters to boost efficiency, lower energy consumption, and enhance overall performance - especially important for older, less efficient units. Tankless water heaters deliver hot water on demand, eliminating the standby heat loss common with traditional tanks. Heat pump water heaters use electricity to transfer heat from the air or ground to warm water, offering substantial energy savings. Adding insulation to older water tanks helps reduce heat loss, improving efficiency and cutting energy bills. Using timers on conventional tank heaters allows better control over heating schedules, reducing energy use during off-peak hours. Insulating hot water pipes minimizes heat loss as water travels from the heater to faucets, speeding up hot water delivery and improving efficiency. Finally, installing a hot water recirculation system provides immediate hot water at taps, reducing water waste and enhancing comfort.

2.3.11 Energy star doors

Upgrading to Energy Star-certified doors is an effective retrofit measure that enhances a home's energy efficiency and comfort. These doors meet strict performance criteria for air leakage, insulation, and overall thermal resistance, helping to reduce drafts and minimize heat loss or gain through entryways. Energy Star doors are available in a variety of materials, including fiberglass, steel, and wood, often featuring advanced insulation cores and weatherstripping to improve airtightness. Replacing old or inefficient exterior doors with Energy Star-rated models can significantly lower heating and cooling costs, improve indoor comfort, and reduce strain on HVAC systems. This retrofit is especially beneficial in climates with extreme temperatures, where entryway heat loss can contribute to overall energy waste. Additionally, Energy Star doors often provide improved durability and enhanced security features, making them a practical and sustainable upgrade for homeowners.

2.3.12 Energy star windows

Installing Energy Star-certified windows is an excellent retrofit option to boost a home's energy efficiency and comfort. These windows meet stringent standards for insulation, air tightness, and solar heat control, helping to reduce heat loss during cold months and limit heat gain in warmer seasons. Features like double or triple glazing, low-emissivity (Low-E) glass coatings, and well-insulated frames work together to improve thermal performance and minimize drafts. Replacing old, inefficient windows with Energy Star models can lead to noticeable savings on heating and cooling bills, reduce cold drafts and condensation, and create a quieter indoor environment. This retrofit is especially important in climates with wide temperature swings, where windows often account for significant energy loss. Beyond energy benefits, Energy Star windows also enhance natural lighting, increase property value, and offer greater durability and security.

3. Methodology

3.1 Literature review and background research

Background knowledge about ERS dataset and description of data fields were gathered first to identify the relevant data fields for answering the research questions. District of Saanich's Climate Plan and Building Retrofit Strategy documents were reviewed thoroughly. In addition, each upgrade type was also reviewed to ensure a clear understanding of retrofits taking place in the district.

3.2 Data assemblage

The pre-and post-retrofit EnerGuide assessment data was acquired from the NRCan website (https://open.canada.ca/data/en/dataset/0a7619fd-2ffe-44b5-9027-3dfcec0866fd). District of Saanich provided the list of Evaluation IDs specific to Saanich, which was used to filter the data from main dataset. A complete dataset for 2007-2024 evaluation years was assembled first and only the records with "Final" status were kept by deleting the "Submitted", "Draft" or other records. Moreover, the dataset was thoroughly checked to eliminate the single records (i.e., either only D or only E). Finally, there were 5923 homes (11846 records in total) doing both pre-and post-retrofit evaluations in the district between 2007 and 2024.

3.3 Data analysis

Methods of data analysis for each research question are detailed in the following sections.

3.3.1 Research question 1

Research question 1 was set to identify the energy and GHG reduction potentials from each upgrade and different bundles of upgrades. For this, first the trend of doing different upgrades needs to be identified. Following sections detail the methods for answering research question 1.

Identifying whether any specific type of upgrade was recommended and/or completed for all 12 types of upgrades

In total, 12 types of upgrades were considered. Table 1 contains the details of calculating whether each type of upgrade was recommended and/or completed, or not, for each home with the descriptions of associated data fields. Here, D means pre-retrofit EnerGuide evaluation and E means post-retrofit EnerGuide evaluation. After that, summary tables were prepared to list the number of homes where an upgrade was recommended, the number of homes where upgrades were done, the number of homes which upgraded based on recommendation, and the total number of upgrades and types of upgrades done in those homes. The number of upgraded homes in different years was calculated to see how the upgrade trends changed over time.

In addition to the upgrades below, 3199 homes had an upgrade that included air conditioning; of these homes, 3160 (98.8%) also had a heat pump installed. It is assumed that for this subset of homes, the newly installed air conditioning was a feature of the heat pump. To reduce confusion, or the risk of double counting these upgrades, the installation of air conditioning was removed as an upgrade from the analysis.

Trend of other upgrades along with fuel conversion

To check the extent of fuel conversion retrofits being undertaken in combination with other upgrades, firstly the homes that converted from either natural gas to heat pump or oil to heat pump were identified. FURNACEFUEL field describes the primary heating equipment fuel type (i.e., electricity, natural gas, oil). The homes that had “Natural Gas” in “D” evaluation but “Electricity” in “E” evaluation record, and completed “Heat Pump” upgrade, were marked as “Gas to heat pump” homes. Similarly, the homes that had “Oil” in “D” evaluation but “Electricity” in “E” evaluation record, and completed “Heat Pump” upgrade, were marked as “Oil to heat pump” homes. Finally, the number of other upgrades undertaken in these homes were calculated to see the trend.

Table 1. Details of calculating whether any specific type of retrofit was recommended and/or completed or not

Type of upgrade	Data fields	Descriptions	Upgrade recommended	Upgrade completed
Air sealing	AIR50P (1)	Air leakage at 50 pascals	If 2D < 1D	If 1D < 1E
	UGRAIR50PA (2)	Proposed air leakage at 50 Pa		
Ventilation	ERSVENTILATIONENERGY (3)	Ventilation energy consumption in MJ	If 4D ≠ 3D	If 3D ≠ 3E
	UGRERSVENTILATIONENERGY (4)	Upgrade Ventilation energy consumption in MJ		
Attic insulation	ATTICCEILINGDEF (5)	Description of attic insulation (displays percentage of attic area, followed by the nominal R-value)	If 6D ≠ 5D	If 5D ≠ 5E
	UATTCEILINGDEF (6)	Proposed description of attic insulation (displays percentage of attic area, followed by the nominal R-value)		
Ceiling insulation	CAFLACEILINGDEF (7)	Description of cathedral or flat roof insulation (displays percentage of attic area, followed by the nominal R-value)	If 8D ≠ 7D	If 7D ≠ 7E
	UCAFLCEILINGDEF (8)	Proposed description of cathedral or flat roof insulation (displays percentage of attic area, followed by the nominal R-value)		
Foundation insulation	FNDDEF (9)	Description of foundation insulation (displays percentage of foundation area, followed by the nominal R-value)	If 10D ≠ 9D	If 9D ≠ 9E
	UGRFNDDEF (10)	Proposed description of foundation insulation (displays percentage of foundation area, followed by the nominal R-value)		
Header insulation	FNDHDR (11)	Header insulation value (RSI) – basement	If 12D ≠ 11D	If 11D ≠ 11E
	UGRFNDHDR (12)	Upgrade header insulation value (RSI) – basement		

Type of upgrade	Data fields	Descriptions	Upgrade recommended	Upgrade completed
Wall insulation	WALLDEF (13)	Description of wall insulation (displays percentage of wall area, followed by the nominal R-value)	If 14D ≠ 13D	If 13D ≠ 13E
	UGRWALLDEF (14)	Proposed description of wall insulation (displays percentage of wall area, followed by the nominal R-value)		
Natural gas furnace	FURSSEFF (15)	Primary heating equipment efficiency (Steady State efficiency)	If 16D > 15D	If 15E > 15D
	UGRFURNACEEFF (16)	Proposed primary heating equipment efficiency		
Heat pump	COP (17)	Heat pump co-efficient of performance	If 18D = "Air" OR "Ground" OR "Water"	If 17E > 17D
	UGRHPTYPE (18)	Proposed heat pump type		
Domestic hot water system	PDHWEF (19)	Domestic hot water equipment efficiency	If 20D > 19D	If 19E > 19D
	UGRDHWSYSEF (20)	Proposed domestic hot water equipment efficiency		
Energy star doors	UGRNUMDOORESTAR (21)	Number of ESTAR doors (installed + recommended)	If 21D ≠ 0	If 22E ≠ 0
	NUMDOORESTAR (22)	Number of installed ESTAR doors		
Energy star windows	UGRNUMWINESTAR (23)	Number of ESTAR windows (installed + recommended)	If 23D ≠ 0	If 24E ≠ 0
	NUMWINESTAR (24)	Number of installed ESTAR windows		

**D means pre-retrofit EnerGuide evaluation, and E means post-retrofit EnerGuide evaluation*

Calculating energy saving

The next step was to calculate energy saving for the homes from different fuel sources. Table 2 shows the data fields used to calculate energy savings. Values of these fields for 'D' evaluations are consumption before retrofit, and values for 'E' evaluations are consumption after retrofit. The difference between these two is the energy saving after completing upgrades for each fuel type (calculated based on FURNACEFUEL field). Moreover, energy savings per sq m (divided by the FLOORAREA field) were calculated for all fuel sources along with the total energy savings. All the energy savings values were converted to GJ unit for better comparison. The following are the equations for calculating energy saving per sq m in GJ. Average energy saving of all fuels was calculated from the EGHFCONTOTAL field.

Table 2. Data fields used to calculate energy savings from different fuel sources

Data Fields	Descriptions
EGHFCONELEC	Consumption of electricity (kWh)
EGHFCONNGAS	Consumption of natural gas (cubic meters)
EGHFCONOIL	Consumption of oil (L)
EGHFCONPROP	Consumption of propane (L)
EGHFCONTOTAL	Total energy consumption (MJ)
FURNACEFUEL	Primary heating equipment fuel type
FLOORAREA	Floor area of the house, calculated using the volume divided by 2.5 (square metres)

i. $Energy\ saving\ per\ sq\ m\ from\ electricity\ consumption\ (GJ\ per\ sq\ m) =$

$$\frac{\text{EGHFCONELEC for D evaluation} - \text{EGHFCONELEC for E evaluation}}{\text{FLOORAREA}} * 0.0036$$

ii. $Energy\ saving\ per\ sq\ m\ from\ natural\ gas\ consumption\ (GJ\ per\ sq\ m) =$

$$\frac{\text{EGHFCONNGAS for D evaluation} - \text{EGHFCONNGAS for E evaluation}}{\text{FLOORAREA}} * 0.038$$

iii. $Energy\ saving\ per\ sq\ m\ from\ oil\ consumption\ (GJ\ per\ sq\ m) =$

$$\frac{\text{EGHFCONOIL for D evaluation} - \text{EGHFCONOIL for E evaluation}}{\text{FLOORAREA}} * 0.038$$

iv. $Energy\ saving\ per\ sq\ m\ from\ propane\ consumption\ (GJ\ per\ sq\ m) =$

$$\frac{\text{EGHFCONPROP for D evaluation} - \text{EGHFCONPROP for E evaluation}}{\text{FLOORAREA}} * 0.0253$$

v. $$Total\ energy\ saving\ per\ sq\ m\ (GJ\ per\ sq\ m) = \frac{\text{EGHFCONTOTAL for D evaluation} - \text{EGHFCONTOTAL for E evaluation}}{\text{FLOORAREA}} / 1000$$

Calculating GHG emissions reduction

Emission factors (acquired from B.C. Ministry of Energy and Climate Solutions (2024)) for different energy sources (electricity, gas, oil, propane) were multiplied by energy savings from those sources, respectively to calculate average GHG emissions reduction from the fuel sources (Table 3). Finally, weighted average was calculated to obtain average GHG emissions reduction of all fuels using following equation.

$$Average\ GHG\ reduction\ of\ all\ fuels = \frac{(n\_elec \cdot R\_elec) + (n\_gas \cdot R\_gas) + (n\_oil \cdot R\_oil) + (n\_prop \cdot R\_prop)}{n\_elec + n\_gas + n\_oil + n\_prop}$$

Where,

R_elec, R_gas, R_oil, R_prop = average GHG reduction from electricity, gas, oil, and propane homes

n_elec, n_gas, n_oil, n_prop = number of homes using electricity, gas, oil, and propane as primary fuel

Table 3. Emission factors for different fuel sources to calculate GHG emissions reduction in tCO_2e

Fuel Source	**Units**	**Emission Factors (tCO_2e)**
Electricity	kWh	0.0000099
Natural gas	m3	0.00195705
Propane	L	0.001544292
Oil	L	0.002651823

Energy savings and GHG reductions for each upgrade type and bundles of upgrades

For each home, total number of upgrades completed was computed. The number of homes that did a single upgrade or a specific combination of upgrades was calculated, so that the energy savings and GHG reductions can be linked to them. Average energy savings and GHG reductions from different fuel types were calculated if the number of homes were more than 20 counts for that upgrade and/or bundle of upgrades. These numbers represent homes that undertook only that specific type of upgrade or bundle of upgrades, whereas Table 1 reports the methods used to identify homes undertaking each type of upgrade, regardless of whether they also completed additional upgrades.

3.3.2 Research question 2

Research question 2 was about the upgrade trends among the neighborhoods in Saanich. In terms of neighborhood, the ERS dataset has listed the first 3 digits of the postal code (also known as the forward sortation area, or FSA) in CLIENTPCODE field. This part of analysis also includes some social and economic factors of the neighborhoods and identify the correlation between these factors and trend of upgrades. The following metrics are the social and economic factors that were considered in the analysis.

a. Age of home/year of construction
b. Median household after tax income ($)
c. Median home energy expenditure ($)
d. No. of homes in need of repair
e. Total single detached dwellings
f. No. of homes with high home energy cost burden 6%+

Values for the social and economic factors were collected from the Energy Poverty and Equity Explorer Tool, except for Age of home, which is listed in YEARBUILT field in the ERS dataset. In that website, values are listed for each census tract. The census tracts in each FSA were identified roughly by overlaying two maps (Figure A9, Figure A10). Census tracts in each FSA are listed in Table 4. For household income and home energy expenditure, average values of all census tracts are calculated for each neighborhood. For all other factors, total values are considered. 0133.00 and 0160.05 census tracts are both listed under V8Z and V9E. The statistical values of the social and economic factors are roughly distributed among these two FSAs considering their areas in that FSAs. For example, 0133.00 is divided into 1:3 ratios between V8Z and V9E, and 0160.05 is divided equally between these two FSAs.

Table 4. Census tracts under each postal code considered for neighborhood analysis

Postal Code	Census Tracts
V8N	0120.00, 0121.01, 0121.02, 0121.03, 0121.04
V8P	0104.00, 0123.02, 0122.00, 0124.00
V8R	0103.00, 0102.00
V8X	0131.00, 0130.02, 0130.01, 0132.01
V8Y	0132.04, 0132.03, 0160.07
V8Z	0129.01, 0129.02, 0126.00, 0127.00, 0133.00, 0160.05
V9A	0111.01, 0111.02, 0110.00, 0011.00
V9E	0133.00, 0128.00, 0160.05, 0160.04

3.3.3 Research question 3 and 4

Research question 3 and 4 were set to estimate the operating cost savings for the homes that switch from gas to heat pump and oil to heat pump, respectively. For calculating operating cost, electricity, natural gas, and oil consumptions were considered. BC Hydro’s rate for electricity cost and FortisBC’s rate for natural gas were taken into account. For oil, Peninsula Co-op in Saanichton was contacted via phone call and asked about the per liter price.

Calculation of operating cost for electricity consumption

For first 1,350 kWh per 60-day billing period (i.e., 8,100 kWh/year), rate is $0.1172/kWh (Tier 1). For all usage above 8,100 kWh/year, rate is $0.1408/kWh (Tier 2). There is a basic charge of $0.233 per day and 5% GST is applied to the total bill (energy + basic charge) (BC Hydro, 2025). The following is the equation for calculating operating cost for electricity consumption.

*(IF (EGHFCONELEC <=8100, EGHFCONELEC * 0.1172, 8100*0.1172 + (EGHFCONELEC-8100) *0.1408) + (0.233*365)) * 1.05*

Calculation of operating cost for natural gas consumption

The following are the rates for different items in the gas bill of FortisBC (FortisBC, 2025), and the equation to calculate total bill for natural gas consumption.

*IF (EGHFCONNGAS =0, "", ROUND ((365 * 0.4216) + (EGHFCONNGAS * (7.476 + 1.397 + 2.230)) * 1.004 * 1.05, 2))*

Table 5. Items and rates ($) in FortisBC

Items	Rate ($)
Basic charge per day	0.4216
Delivery charge per GJ	7.476
Storage and transport per GJ	1.397
Cost of gas per GJ	2.230
Additional charge (0.4%)	0.004
GST	5%

Calculation of operating cost for oil consumption

According to Peninsula Co-op in Saanichton, heating oil is $1.812 per liter after tax. This price is simply multiplied with their oil consumption in liter.

After calculating the energy cost for electricity, natural gas, and oil consumption, average operating cost savings from these fuel sources were calculated for the home that switched from either gas to heat pump or oil to heat pump. Similar calculations were carried out for the homes that kept using natural gas or oil-based heating systems to compare among the scenarios analyzed. For average of all fuels, weighted average of operating costs from all fuel sources was computed.

Energy costs are a critical factor in household decision-making around retrofits and fuel switching, but they are also highly dynamic. Prices for natural gas, electricity, and other fuels fluctuate in response to global markets, supply and demand, and local infrastructure costs. Both the natural gas and electricity rates are regulated by BC Utilities Commission (BCUC). Electricity rates are generally less prone to fluctuation because BC generates its own supply and as a crown corporation, BC Hydro is committed to maintaining very low and stable rates.

In addition, policy instruments such as carbon pricing have historically played a major role in shaping the relative affordability of different energy sources. In British Columbia, the provincial carbon tax - introduced in 2008 - made fossil fuels more expensive and improved the business case for switching to clean electricity. For example, Saanich's Make the Switch study (District of Saanich, 2022) demonstrated that with the carbon tax in place, households that transitioned from natural gas furnaces to electric heat pumps often realized net energy cost savings, in addition to lowering their emissions. However, recent changes to the carbon tax framework have shifted this equation. With the reduced cost of natural gas relative to electricity, the financial savings from electrification are now less consistent across households, and in some cases, switching fuels may increase monthly utility bills.

3.3.4 Research question 5

Research question 6 identified the homes with supplementary heating systems along with heat pumps to check the energy saving, GHG reduction, and operating cost saving for those homes. For those homes, analysis was carried out to find out the common types of supplementary heating systems. Table 6 **Error! Reference source not found.**contains the data fields used in the analysis to answer this question.

Table 6. Data fields used to identify the homes with supplementary heating systems along with heat pumps

Data fields	**Description**
SUPPHTGFUEL1	Supplementary heating system #1 Fuel
SUPPHTGFUEL2	Supplementary heating system #2 Fuel
SUPPHTGTYPE1	Supplementary heating system #1 Type
FURNACEFUEL	Primary heating equipment fuel type
FURNACETYPE	Primary heating equipment type
HPSOURCE	Heat pump type (air, water, ground or N/A)

The homes that converted from a natural gas-based heating system to a heat pump and from an oil-based heating system to a heat pump were identified first by comparing the D and E evaluation values in the FURNACEFUEL field. For those homes, the supplementary heating fuel types listed in E evaluations (in SUPPHTGFUEL1 and SUPPHTGFUEL2 fields) were analyzed to find the homes with supplementary heating systems as backup for the heat pumps. Besides, the homes having heat pump in either D and/or E evaluations in HPSOURCE field were identified and analysis was carried out to find out if these homes have any supplementary heating systems or not. For the homes with supplementary heating systems, energy savings from electricity, natural gas, and oil consumption, and GHG reductions from these systems were calculated along with the operating cost savings. Average energy saving of all fuels was calculated from the EGHFCONTOTAL field. Average operating cost saving and GHG emissions reduction from all fuels were calculated by taking weighted average of operating cost saving and GHG reductions from electricity, natural gas, and oil consumptions, respectively.

3.3.5 Research question 6

The costs of different upgrades and information regarding rebates/incentives available were primarily collected from the BC Ministry of Energy and Climate Solutions (MECS). MECS shared the cost and rebate amounts for both CleanBC Income Qualified Program (ESP) and Non-income Qualified Program (HRR). ESP data encompasses from 2022 to present, while HRR data encompasses from 2019 to present.

The CleanBC Energy Savings Program (ESP) and the Home Renovation Rebate (HRR) offer rebates for home energy retrofits. ESP is an income-qualified program providing substantial rebates (up to $19,000) for upgrades like heat pumps, insulation, and windows, along with additional support for electrical and ventilation upgrades. It requires pre-registration and use of a registered contractor, who applies on your behalf and deducts the rebate from your invoice. In contrast, the HRR is available to all homeowners and offers a bonus rebate ($750–$2,000) plus $20 per percentage point of energy efficiency improvement, based on pre- and post-retrofit EnerGuide evaluations. To qualify, one must complete at least three eligible upgrades and submit proof within 6 months.

ESP and HRR differ in several key areas, particularly in eligibility, process, and rebate structure. ESP is an income-qualified program targeting low- to middle-income households. It offers high, upfront rebates - sometimes covering the full cost of upgrades like heat pumps, insulation, and windows. The process is streamlined, requiring homeowners to pre-register and use a registered contractor who applies on their behalf and deducts the rebates directly from the invoice. EnerGuide evaluations are not required, making it simpler for those focused on immediate affordability. In contrast, HRR is open to all income levels and provides a bonus rebate based on the home's measured energy performance improvements. To qualify, homeowners must complete at least three eligible upgrades and undergo both pre- and post-retrofit EnerGuide evaluations, which assess the home's energy efficiency. The homeowner manages the process and applies after completing the evaluations. The standalone HRR rebates (which are no longer available) did not require the energy evaluation, but to incentivize deeper retrofits, the bonus rebate was (and still is) available, requiring the energy evaluation to calculate rebate amount. In short, ESP is ideal for income-qualified households seeking simplified, high-value rebates without the need for energy audits, while HRR suits homeowners interested in broader upgrades and rewarded based on actual energy savings (CleanBC, 2019a, b).

Analysis has been carried out for both the programs. The rebate data reflects rebates funded exclusively through the MECS program. In some cases, rebate amounts that households received may have been higher than recorded here due to other available incentives at the time, including the Canada Greener Homes Grant and Saanich's top-ups to the CleanBC/HRR grants. Some of the cost and rebate data were collected from secondary sources found online (i.e., air sealing and NG furnace). As there are substantial records only for few upgrades and bundle of upgrades, those are considered to analyze and compare the cost-efficiency. The upgrades considered are – air sealing, attic insulation, natural gas furnace, heat pump, and energy star windows, and different combinations of them. The following table contains the cost of these upgrades with rebate amount (if available) with the data sources (Table 7).

Table 7. Cost and rebate amount for some common upgrade types for both ESP and HRR programs

Upgrade type	**Average Upgrade Cost ($)**		**Average rebate ($)**		**Data sources**
	ESP program	HRR program	ESP program	HRR program	
Air sealing	1000	1000	N/A	N/A	(BetterHomes Ontario, 2025) *
Attic insulation	4963.05	2327.20	4127.01	752.63	MECS
Natural gas furnace	6800	6800	3800	3800	(Fortis BC, 2025; The

Upgrade type	Average Upgrade Cost ($)		Average rebate ($)		Data sources
	ESP program	HRR program	ESP program	HRR program	
					Home Depot, 2025) **
Heat pump	17226.90	16112.71	9801.50	5601.10	MECS
Energy star windows	13108.51	3835.32	6819.38	1184.97	MECS

** A range of $200-$1500 for the cost of air sealing was found and $1000 was considered as an average. Same cost was considered for both programs.*

*** Same cost and rebate amounts were considered for both programs.*

Cost efficiency of these upgrades was calculated for both the programs, considering with and without rebate amounts. Cost per GJ of energy savings and cost per tCO_2e of GHG reduced were calculated to compare the cost efficiency of the upgrades and bundle of upgrades. Moreover, the payback period was calculated by dividing the initial cost of upgrades (with and without the rebates) by the annual operating cost savings from electricity, natural gas, and oil consumptions.

3.3.6 Research question 7

Research question 7 is about analyzing the scenarios to achieve the 2030 and 2050 targets set in Climate Plan of the District of Saanich. In the original 2020 Climate Plan, the target was to reduce GHG emissions by 56,000 tCO_2e by 2030 from retrofits, and 90,000 tCO_2e by 2050. This reduction included 100% of oil heating being converted to heat pumps by 2030, 40% of natural gas space and water heaters converting to heat pumps by 2030 and 100% by 2050, and 40% of buildings doing envelope upgrades by 2030 and 80% by 2050. The envelope upgrades alone were estimated to achieve 9,695 tCO_2e reduction in total by 2030 in the Climate Plan (District of Saanich, 2020). The numbers of homes needed to be retrofitted with single or bundle of upgrades to achieve these targets were calculated using following equation.

$$No\ of\ homes\ needed\ to\ be\ retrofitted\ with\ single\ or\ bundle\ of\ upgrades = \frac{2030\ or\ 2050\ climate\ target\ for\ GHG\ reduction}{Average\ GHG\ reduction\ from\ all\ fuel\ sources\ for\ that\ upgrade(s)}$$

For envelope upgrades, three bundles of upgrades were considered as a substantial number of homes have done these bundles. They are air sealing + attic insulation, air sealing + energy star windows, air sealing + attic insulation + energy star windows. Total GHG reduction from single family homes was calculated using following equations. For this analysis, the number of homes under different fuel sources in Saanich were found in the District of Saanich Building Retrofit Strategy Modelling Report (Table 8).

$$Total\ GHG\ reduction\ from\ single\ family\ homes\ for\ single\ or\ bundle\ of\ upgrades = (n_{elec} \cdot \bar{R}_{elec}) + (n\_gas \cdot R\_gas) + (n\_oil \cdot R\_oil) + (n\_prop \cdot R\_prop)$$

Where,

R_elec, R_gas, R_oil, R_prop = average GHG reduction from electricity, gas, oil, and propane homes

n_elec, n_gas, n_oil, n_prop = number of homes using electricity, gas, oil, and propane as primary fuel in the District of Saanich (Table 8)

Table 8. Number of single-family homes using different fuel sources in the District of Saanich (Introba Inc., 2023)

Fuel source	No of single family detached homes	No of single family attached homes	Total no of single-family homes
Electricity	11447	4614	16061
Natural gas	6647	2679	9326
Oil	1805	728	2533
Propane	425	171	596
Wood	934	377	1311
		Total	**29827**

4. Results and discussion

4.1 Trends of upgrades in the District of Saanich

4.1.1 Upgrade recommendations and adoption patterns

The summary of the uptake of various energy efficiency upgrades recommended through assessments compared to actual implementation is provided in Table 9. Air sealing and heat pump installations were the most frequently recommended measures (85.4% and 80.6% of homes, respectively) and also demonstrated relatively high uptake, with 92.2% of recommended air sealing and 69.5% of recommended heat pumps being completed. Natural gas furnace upgrades also had a strong adoption rate (96.6%), suggesting that homeowners prioritize heating system improvements, likely due to direct comfort benefits, utility savings, or the need to replace equipment nearing the end of life.

Table 9. Summary of upgrades recommended and done in the District of Saanich

Type of upgrades	Upgrade recommended	%	Upgrade Completed	%	% uptake	Upgrades done based on recommendation
Air sealing	5059	85.4	4665	78.8	92.2	4032
Heat pump	4774	80.6	3317	56.0	69.5	3241
Energy star windows	4065	68.6	2000	33.8	49.2	1858
Attic insulation	3518	59.4	1481	25.0	42.1	1336
Energy star doors	2689	45.4	450	7.6	16.7	334
Foundation insulation	2187	36.9	946	16.0	43.3	683
NG furnace	2152	36.3	2078	35.1	96.6	1600
Wall insulation	1566	26.4	590	10.0	37.7	450
Domestic hot water	1467	24.8	247	4.2	16.8	155
Header insulation	899	15.2	486	8.2	54.1	224
Ventilation	508	8.6	27	0.5	5.3	9
Ceiling insulation	319	5.4	303	5.1	95.0	45

In contrast, upgrades such as ventilation (5.3% uptake), domestic hot water (16.8%), and Energy Star doors (16.7%) saw very low implementation, despite being recommended for a significant portion of homes in some cases. This trend could reflect higher costs, perceived lower impact, or logistical barriers associated with these upgrades. Insulation measures showed mixed results: attic insulation was commonly recommended (59.4%) but had a moderate uptake rate (42.1%), whereas wall and foundation insulation also lagged behind, possibly due to higher installation complexity (Table 9).

The most prominent pairing was air sealing and heat pump installation, with 2,420 homes completing both upgrades. This was followed by combinations like air sealing with a natural gas furnace (1,667 homes) and attic insulation with heat pumps (575 homes) (Table A21). These trends suggest that homeowners often pursue relatively easy envelope improvements alongside major HVAC system upgrades to maximize energy efficiency.

4.1.2 Number of upgrades implemented per home

Figure 1 shows the distribution of homes based on the number of upgrades implemented. Most homes adopted two upgrades (1,978 homes), followed closely by those that implemented three upgrades (1,668 homes). A significant portion also completed one upgrade (740 homes) or four upgrades (744 homes). Beyond this point, adoption declines sharply: only 356 homes undertook five upgrades, and fewer than 200 homes adopted six or more. Very few homes completed eight or more upgrades, with just three homes achieving ten upgrades. This trend indicates that while many households are willing to undertake multiple improvements, the likelihood of implementing more than three upgrades drops considerably. This pattern likely reflects financial and logistical constraints, with homeowners prioritizing the most cost-effective or impactful measures rather than pursuing comprehensive retrofits.

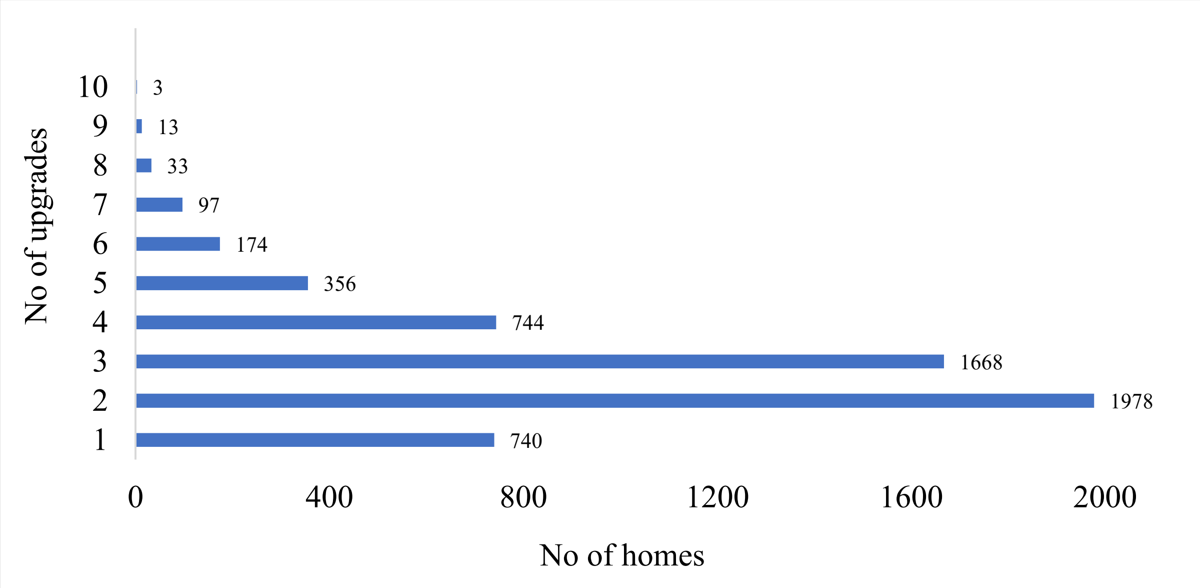


Figure 1. Number of homes that have done one or more upgrades in the District of Saanich

4.1.3 Program participation trends over time

The number of home evaluations conducted each year from 2007 to 2024 is illustrated in Figure 2. Two distinct peaks are observed, corresponding to periods when major incentive programs were active. First peak (2008–2012) was during the LiveSmart BC and Federal ecoENERGY Retrofit-Homes Program, participation surged, with the highest count in 2011 (2,724 homes). Other high-activity years include 2009 (2,447 homes) and 2012 (1,802 homes). This indicates strong program influence on homeowner engagement in energy efficiency upgrades during this time. The decline after 2013 indicates the end of these programs, and evaluations dropped sharply, with fewer than 500 homes annually from 2013 to 2020, and a low of 52 homes in 2020 (which also corresponds to restrictions imposed during the COVID-19 outbreak). This suggests limited activity when no major incentives were available. The second peak (2022–2023) evaluations rose dramatically again, reaching 2,020 homes in 2022 and 2,463 homes in 2023, aligning with the introduction of new federal and provincial rebate programs, such as the Canada Greener Homes Grant and CleanBC. This resurgence reflects the strong role financial incentives play in driving homeowner participation.

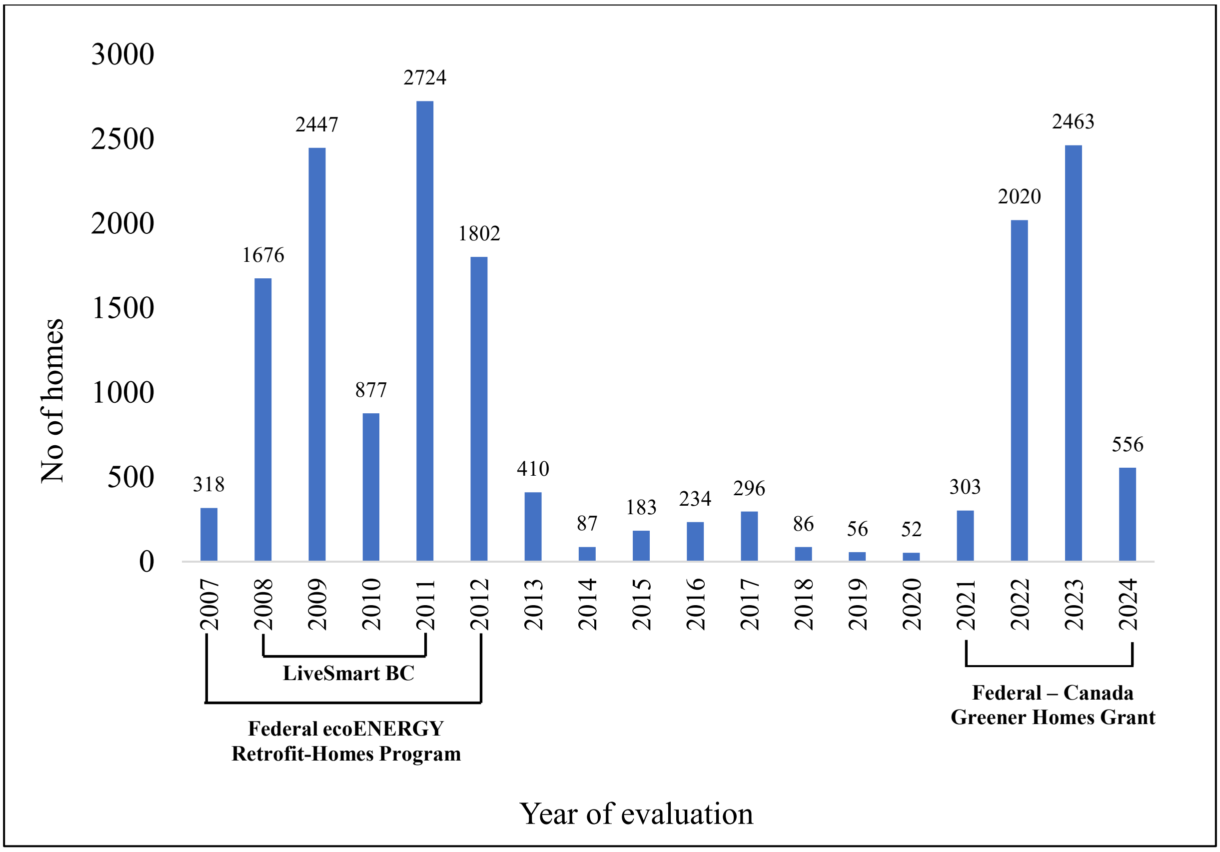


Figure 2. Number of total upgrades in different years in the District of Saanich

Over this period (2007-2024), the most common upgrades included heat pump installations (3,317 homes), air sealing (4,665 homes), and energy star window replacements (2,000 homes), indicating a strong focus on improving thermal performance and energy efficiency. The most prominent upgrade occurred in 2023, when 901 homes installed heat pumps, marking the highest number for any single upgrade in any year. This reflects a significant shift toward electrification and energy-efficient heating systems in recent years. Other notable peaks include 734 air sealing upgrades in 2023 and 610 heat pump installations in 2022, highlighting a shift towards heat pumps in recent years and perhaps households understand the value of doing some complementary efficiency improvements at the same time (Table A22).

4.1.4 Fuel switching and associated upgrades

Table 10 compares the types of building envelope and mechanical upgrades completed alongside fuel-switching to heat pumps, distinguishing between homes converting from natural gas and those converting from oil. In total, 1,074 and 451 homes were documented for converting from oil and natural gas to heat pump, respectively. The 2023 Retrofit Strategy estimated that there were 2,533 of oil heated and 9,326 of gas heated single family homes. So, there was a significantly higher penetration rate for oil heated homes given the smaller numbers in the community. Overall, oil-to-heat-pump conversions were associated with a significantly higher number of complementary upgrades compared to gas conversions across nearly all categories. For example, air sealing was the most common measure for both groups, with 865 oil-converted homes (80.5%) implementing it compared to 326 gas-converted homes (72.3%). Similarly, attic insulation (217 (20.2%) vs. 48 (10.6%)) and foundation insulation (205 (19.1%) vs. 34 (7.5%)) were much more prevalent in oil conversions. Upgrades like energy star windows (215 (20.0%) vs. 42 (9.3%)) and doors (65 (6.1%) vs. 7 (1.6%)) also show a similar pattern. This suggests that oil-to-heat-pump projects are often part of more comprehensive retrofit packages, possibly due to the greater efficiency gains and cost savings achieved when replacing higher-cost heating fuels.

In contrast, gas-to-heat-pump conversions tend to involve fewer additional envelope improvements, likely reflecting lower operating cost differentials and different homeowner investment priorities. It is possible that homes previously heated with oil were, on average, maintained or upgraded less frequently over time compared to homes heated with natural gas. Consequently, when these households transitioned from oil heating to heat pumps, there may have been a greater propensity to undertake additional efficiency measures, such as insulation, air sealing, or window replacements in order to catch up on deferred upgrades. In addition, the generally older average age of oil-heated homes may have contributed both to lower baseline efficiency and to a greater need for upgrades at the time of conversion. Together, these factors could help explain why oil-to-heat-pump households exhibit higher rates of concurrent efficiency improvements relative to gas-to-heat-pump households.

Table 10. Number of homes that have done different upgrades along with fuel conversions

Types of upgrades	Gas to heat pump	Oil to heat pump
Air sealing	326	865
Ventilation	3	13
Attic insulation	48	217
Ceiling insulation	47	73
Foundation insulation	34	205
Header insulation	23	115
Wall insulation	17	97
Domestic hot water	27	55
Energy star doors	7	65
Energy star windows	42	215

4.2 Status of energy saving

4.2.1 Energy saving by fuel type

The average energy saving (in GJ) achieved across different fuel types after implementing energy efficiency upgrades is illustrated in Figure 3 and energy saving per sq m (GJ) is provided in Figure A11. The results indicate that the most substantial savings occur in homes originally using oil and propane heating systems, with average reductions of approximately 81 - 84 GJ, reflecting the high energy intensity and inefficiency of these systems compared to alternatives like heat pumps. Homes using natural gas also experienced notable savings (around 49 GJ), though lower than oil and propane, due to the relatively higher baseline efficiency of gas heating systems. In contrast, homes primarily using electricity showed the lowest savings (approximately 24 GJ), likely because electric heating systems are already more efficient in terms of energy conversion, leaving less potential for reduction. The overall average energy savings across all fuel types was about 40 GJ, highlighting the significant role of fuel type in determining potential energy savings. These findings suggest that retrofits targeting oil- and propane-heated homes, followed by natural gas-heated homes deliver the highest energy savings, making them prime candidates for programs seeking maximum energy and emissions reductions.

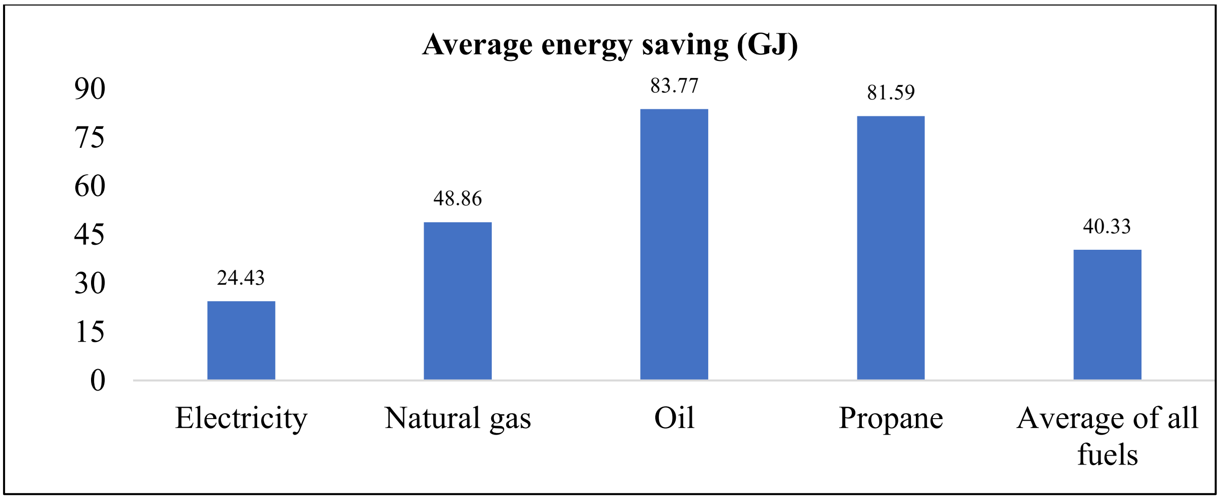


Figure 3. Average energy saving (GJ) from different fuel sources

Table A23 presents average energy savings across fuel types from 2007 to 2024. The highest average energy savings from all fuels occurred in 2015, with 72.26 GJ per home and 0.36 GJ/m², primarily driven by natural gas and electricity reductions. While overall savings showed a declining trend in recent years, oil-based systems consistently yielded the highest per-home savings across all years, with peak values like 150.10 GJ in 2014. This suggests that retrofits in oil-heated homes may deliver greater absolute energy reductions compared to other fuel types.

4.2.2 Cumulative effect of multiple upgrades on energy saving

The average energy savings increase steadily with the number of upgrades across all energy types (Figure 4 and Figure A12). Propane and oil users experience the highest savings, especially at 6+ upgrades, where propane savings exceed 200 GJ. This suggests that buildings using these fuels are less efficient initially and benefit more from upgrades. Electricity and natural gas show moderate but consistent savings growth, reflecting the smaller efficiency gains typical in systems that are already more optimized. Average energy savings of all fuel types rise from under 50 GJ with one upgrade to around 100 GJ with 6 or more, highlighting the cumulative effect of multiple upgrades. In summary, more upgrades lead to significantly greater energy savings, particularly for buildings using oil or propane. This reinforces the value of comprehensive energy efficiency strategies tailored to the building's existing energy profile.

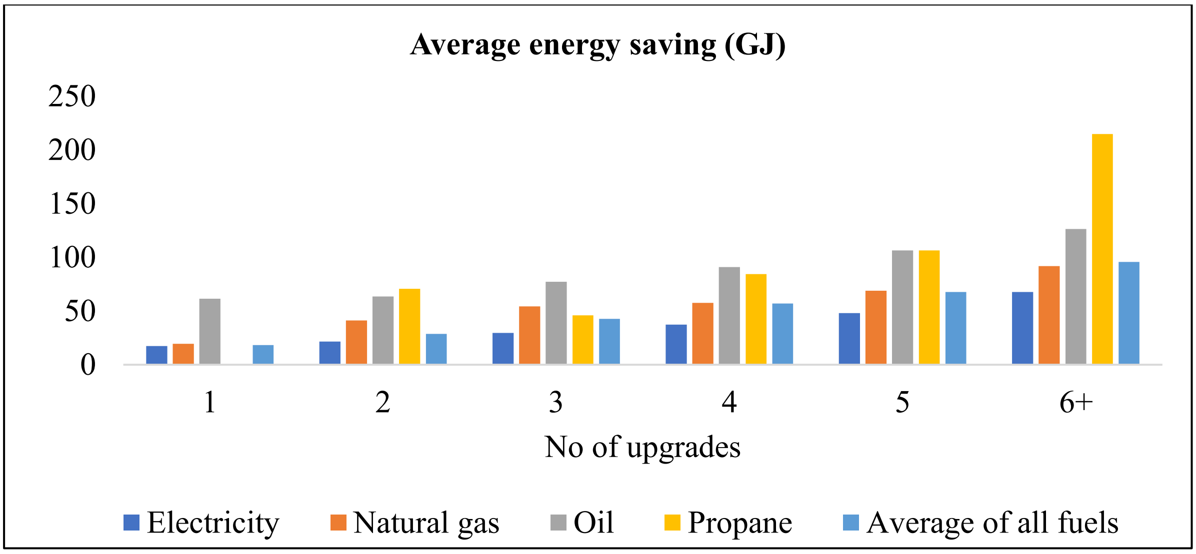


Figure 4. Average energy saving (GJ) from different fuel sources with number of upgrades

4.2.3 Top-performing upgrade bundles for energy saving

The average energy savings (in GJ) from all fuels achieved by different combinations of energy efficiency upgrades is illustrated in Figure 5. Table A24 also shows average energy savings by upgrade bundle for all the fuel types individually. It clearly demonstrates that combining multiple upgrades results in significantly higher energy savings than implementing individual measures alone. The highest savings - nearly 55 GJ - come from combining air sealing, energy star windows, and wall insulation, followed closely by combinations that include natural gas furnaces and heat pumps. These top-performing combinations involve upgrades to both the building envelope and mechanical systems, highlighting the effectiveness of a whole-home approach.

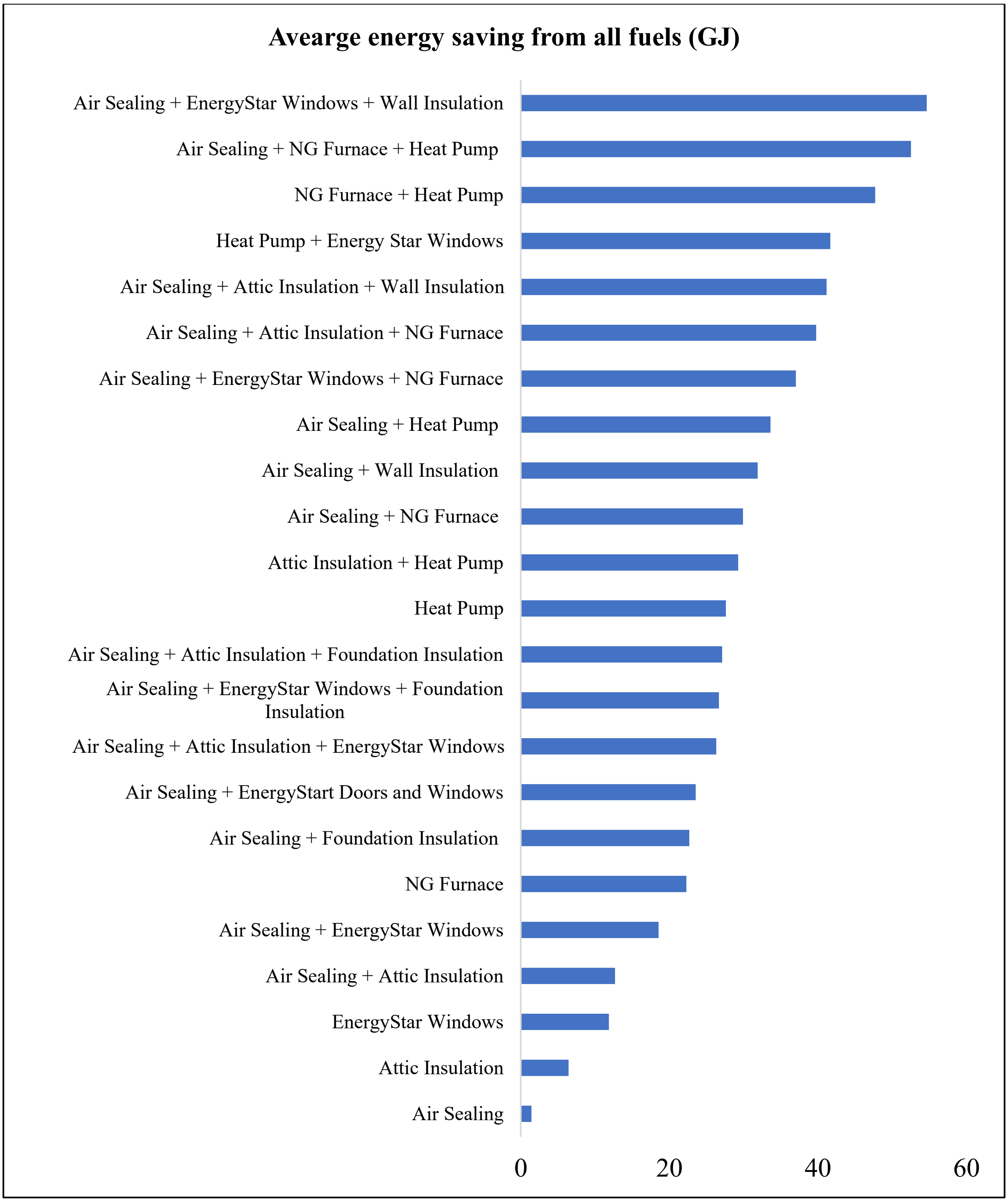


Figure 5. Average energy saving from all fuels (GJ) by retrofit bundles

Single measures such as air sealing, attic insulation, or energy star windows yield relatively low savings when implemented alone. However, when these are combined - especially with heating system upgrades like heat pumps or NG furnaces - savings increase substantially. Notably, air sealing appears in nearly all high-performing combinations, suggesting it is a foundational upgrade that enhances the effectiveness of other measures. The data supports a strategy of bundling complementary upgrades, particularly those that address both insulation and heating systems, to maximize total energy savings.

4.3 Status of GHG emissions reduction

4.3.1 GHG emissions reduction by fuel type

Figure 6 presents the average GHG emissions reduction, measured in tCO_2e, across various energy sources - electricity, natural gas, oil, and propane, as well as the cumulative average reduction. The average GHG emissions reduction per sq m is illustrated in Figure A13. The results indicate that the most significant reductions in emissions were achieved through reductions in oil and propane usage, accounting for approximately 6 and 5 tCO_2e, respectively. Natural gas reductions also contributed meaningfully, with an average reduction of about 3 tCO_2e. In contrast, electricity usage showed a negligible reduction in GHG emissions, due to the low emissions intensity of electricity in the studied context. The average GHG emissions reduction from all fuel sources amounts to approximately 2.66 tCO_2e. These findings highlight the importance of targeting high-emission fuel types for replacement or efficiency improvements in order to maximize environmental benefits.

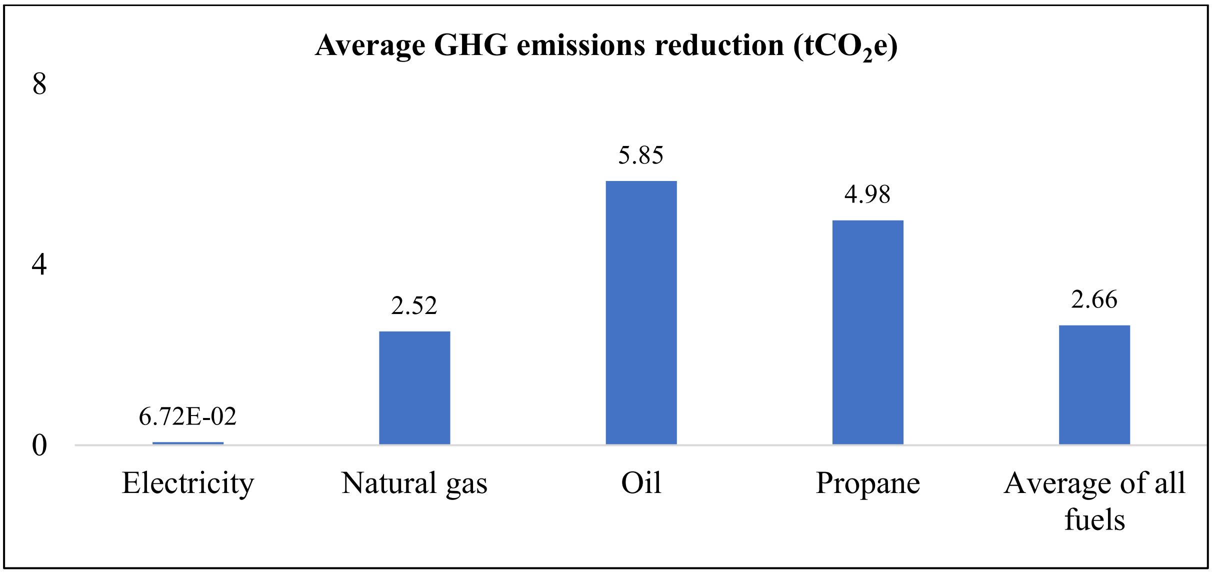


Figure 6. Average GHG emissions reduction (tCO_2e) from different fuel sources

Table A25 details average GHG emissions reductions from 2007 to 2024. The highest average reduction occurred in 2016, with an average of 6.05 tCO_2e per home, largely driven by significant oil-related savings (7.76 tCO_2e) that year. Oil heating consistently contributed the largest per-home GHG reductions across most years, with values like 10.47 tCO_2e in 2014, highlighting the substantial emissions impact of transitioning away from oil-based systems. While total reductions have generally declined in recent years, this trend reflects both fewer deep retrofits and a shift in baseline fuel sources.

4.3.2 Cumulative effect of multiple upgrades on GHG emissions reduction

The relationship between the number of building upgrades and the corresponding average reduction in GHG emissions (tCO_2e) and GHG reductions per sq m are illustrated in Figure 7 and Figure A14, respectively. The analysis revealed a clear positive correlation between the number of upgrades and the total GHG emissions reduction. Buildings with only one upgrade achieve an average reduction of around 0.6 tCO_2e, whereas those with six or more upgrades show a significant reduction exceeding 7 tCO_2e on average. This trend demonstrates the cumulative impact of multiple efficiency improvements.

Across all upgrade levels, oil and propane reductions contribute noticeably to the total savings, especially at higher upgrade counts. GHG reductions from electricity are modest throughout because electricity is already nearly zero emissions.. Natural gas reductions also grow incrementally with additional upgrades but remain modest compared to other fuels. Overall, the finding underscores the effectiveness of implementing multiple upgrades to achieve substantial GHG reductions, supporting the case for comprehensive retrofit strategies rather than isolated improvements.

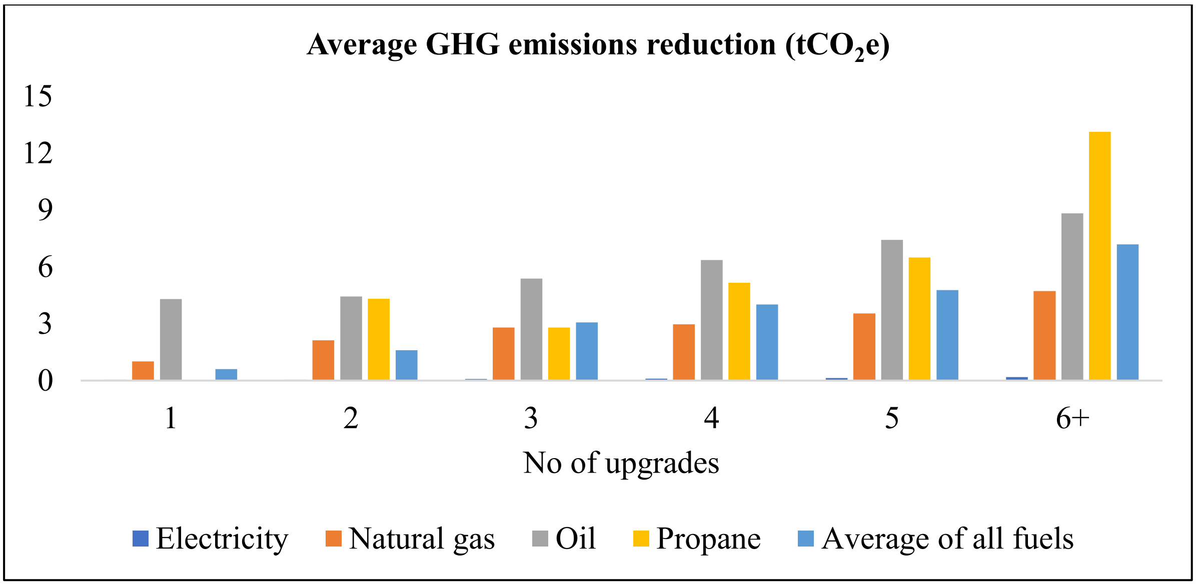


Figure 7. Average GHG emissions reduction (tCO_2e) from different fuel sources with number of upgrades

4.3.3 Top-performing upgrade bundles for GHG emissions reduction

Figure 8 displays the average total GHG emissions reduction (tCO_2e), associated with individual and combined building upgrades, and Table A26 summarizes reductions by fuel types. The results show that combinations of upgrades consistently yield the highest GHG emissions reductions, with the top-performing group being air sealing + attic insulation + NG furnace, achieving nearly 6 tCO_2e in savings. Other high-impact combinations include air sealing + energy star windows + NG furnace, and air sealing + NG furnace, each contributing between 5.2-5.3 tCO_2e in reductions. These outcomes highlight the synergy between envelope upgrades (e.g., insulation and window replacement) and high-efficiency heating systems. In contrast, individual measures on their own result in significantly lower reductions. For example, standalone upgrades such as air sealing, attic insulation, or energy star windows reduce GHG emissions by only 0.02-0.38 tCO_2e on average. This suggests that while single upgrades contribute to emissions reduction, their impact is magnified when implemented as part of a broader retrofit strategy. Notably, heat pumps appear in nearly all top-performing combinations, emphasizing their key role in decarbonizing residential energy use when integrated with building envelope improvements.

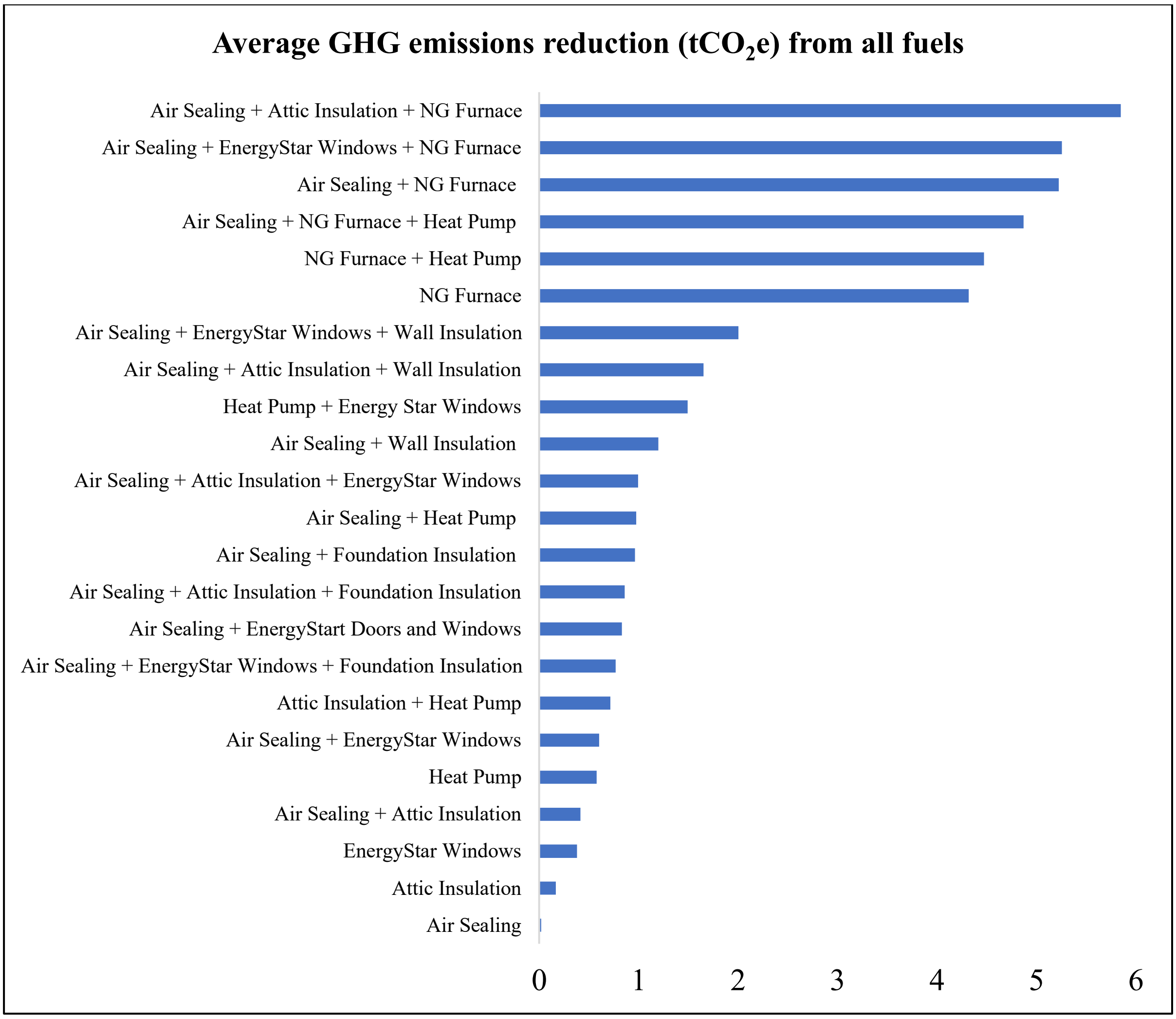


Figure 8. Average of GHG emissions reduction (tCO_2e) from all fuels by retrofit bundles

4.4 Trends of upgrades among the neighborhoods in Saanich

4.4.1 Age of homes and associated upgrades by neighbourhood

Table 11 provides a breakdown of number of homes by construction year across neighbourhoods (FSAs) within the District of Saanich. The data shows that the majority of homes were built between 1950 and 1999, with 2,679 homes constructed between 1950–1974 and 2,070 homes from 1975–1999, together accounting for over 65% of the housing stock. Older homes, built before 1950, are concentrated in specific FSAs such as V8P, V8R, V8Z, and V9A, reflecting historical development patterns. For instance, V8P alone has 245 homes built before 1950. In contrast, newer developments (post-2000) are relatively limited, with only

231 homes built since 2000, representing less than 5% of the total. This age distribution highlights a significant portion of older housing stock in Saanich, indicating considerable opportunities for energy retrofits, particularly in mid-20th-century homes that are less energy-efficient by modern standards.

Table 11. Number of homes according to their construction years in different neighbourhoods in the District of Saanich

FSA	Built in 2000 or later	Built between 1975 and 1999	Built between 1950 and 1974	Built between 1925 and 1949	Built before 1925	Total for FSA
V8N	49	588	717	44	17	**1415**
V8P	22	143	596	212	33	**1006**
V8R	3	7	83	43	5	**141**
V8X	34	426	299	97	28	**884**
V8Y	41	339	216	17	8	**621**
V8Z	50	423	519	104	53	**1149**
V9A	6	16	133	192	51	**398**
V9E	26	128	116	31	8	**309**
Total	**231**	**2070**	**2679**	**740**	**203**	

Table A27 outlines the distribution of upgrades by home construction era within the District of Saanich. Homes built between 1950 and 1974 saw the highest number of upgrades overall, including 2,170 air sealing and 1,525 heat pump installations, reflecting both the age-related need for retrofits and the suitability of these homes for energy efficiency improvements. In contrast, homes built after 2000 had the fewest upgrades, likely due to already meeting more modern energy standards. The data suggest that mid-20th century homes represent the primary target for deep energy retrofits in the district.

4.4.2 Distribution of upgrades by neighbourhood

Table 12 outlines the number and types of energy efficiency upgrades implemented in homes across various FSAs in the District of Saanich. Among neighbourhoods, V8N and V8Z had the highest total upgrade activity, with 3,937 (23.7%) and 3,170 (19.1%) upgrades (it is not number of homes) respectively, suggesting either higher participation rates or a larger number of older, energy-inefficient homes. In contrast, smaller FSAs like V8R and V9E saw significantly fewer upgrades, with totals of 405 (2.4%) and 830 (5.0%), respectively. Upgrades such as ventilation systems and domestic hot water improvements were less frequently implemented across all FSAs, suggesting either lower awareness, cost barriers, or fewer perceived benefits. These findings reflect both the geographic distribution and upgrade preferences within Saanich, offering useful insights for targeting future retrofit programs based on neighbourhood-specific trends and opportunities.

4.4.3 Social and economic factors affecting retrofit uptake by neighbourhood

Table 13 presents a breakdown of key social and economic factors across neighbourhoods (FSAs) in the District of Saanich, revealing important contextual factors that influence home energy retrofit activity. A total of 5,814 homes across all FSAs completed at least one energy upgrade, with 330 of these limited to a single measure. The highest retrofit activity was observed in V8N (1,390 homes, 23.9%) and V8Z (1,136 homes, 19.5%), both of which also have large single-family housing stocks. In contrast, areas like V9A and V8R showed much lower retrofit participation, with 391 (6.7%) and 139 (2.4%) homes respectively, despite having substantial numbers of homes needing attention.

The data also highlights neighbourhoods where need is high: V9A has the largest number of homes requiring major repairs (765, 27.9%), followed by V8Z (621, 22.7%) and V9E (259, 9.5%). These same areas tend to have lower median household incomes - such as V8Z ($56,229) and V9A ($56,581), and higher rates of energy cost burden, with over 1,140 (14.5%) homes in V9A and 1,462 (18.6%) in V8Z spending more than 6% of income on home energy. In contrast, V8R, while having a lower number of upgrades, reports the highest median household income ($95,960) and a relatively low incidence of energy poverty, suggesting that financial capability rather than need may be the limiting factor for retrofit adoption in more affluent areas.

Table A28 presents the distribution of home energy upgrades by neighbourhood income level in the District of Saanich. The majority of upgrades were undertaken in areas with median household after-tax incomes between $80,001 and $90,000, accounting for 1,598 air sealing and 1,140 heat pump installations. Interestingly, neighbourhoods with incomes below $60,000 also showed substantial activity, particularly for air sealing (1,217 homes) and heat pumps (871 homes), suggesting strong engagement with retrofit programs across income levels, including lower-income households. In contrast, higher-income areas (above $90,000) saw relatively few upgrades, likely due to a smaller number of qualifying homes or less retrofit need.

Table A29 shows the distribution of home upgrades based on median household energy expenditures in Saanich. The highest number of upgrades occurred in neighbourhoods where median annual energy costs exceeded $2,000, including 2,395 air sealing, 1,712 heat pump installations, and 1,019 energy star window replacements. This trend suggests that households facing higher energy bills are more likely to pursue retrofits, particularly those targeting building envelope improvements and heating system upgrades. In contrast, areas with energy expenditures below $1,500 showed notably fewer upgrades, indicating a potential correlation between higher energy costs and retrofit activity.

These findings underscore the need for equity-focused retrofit programs. Neighbourhoods with low income, high repair needs, and high energy cost burdens, such as V8Z, V9A, and V9E should be prioritized for targeted support. Tailored financial incentives and outreach efforts in these areas could help overcome economic barriers and deliver the greatest social and environmental impact.

Table 12. Distribution of homes doing different upgrades in different neighbourhoods in the District of Saanich

FSA	Types of upgrades												Total no of upgrades
	Air sealing	Ventilation	Attic insulation	Ceiling insulation	Foundation insulation	Header insulation	Wall insulation	NG furnace	Heat pump	Domestic hot water	Energy star doors	Energy star windows	
V8N	1135	9	352	62	225	106	80	522	761	65	107	513	**3937**
V8P	811	4	277	42	195	95	162	426	526	48	96	349	**3031**
V8R	113	0	42	6	25	17	27	50	55	5	13	52	**405**
V8X	684	4	253	54	135	68	71	266	517	30	62	261	**2405**
V8Y	463	4	130	35	88	50	31	149	379	23	38	193	**1583**
V8Z	886	3	264	66	164	80	116	392	675	45	88	391	**3170**
V9A	331	3	101	21	67	42	77	188	196	22	27	154	**1229**
V9E	242	0	62	17	47	28	26	85	208	9	19	87	**830**

Table 13. Distribution of social and economic factors in different neighbourhoods in the District of Saanich

FSA	Total no of homes in the FSA done single upgrade	No of homes that did any type of upgrade	No of homes need major repairs	No of single-family homes	No. of homes with high home energy cost burden 6%+	Average of median household after tax income ($)	Average of median home energy expenditure ($)
V8N	74	1390	250	4595	1290	85,005	2,214
V8P	63	990	200	3025	895	69,038	1,751
V8R	12	139	190	1885	285	95,960	2,053
V8X	48	869	260	3645	1025	79,703	2,003
V8Y	49	598	195	3535	870	84,042	2,167
V8Z	50	1136	621	4909	1462	56,229	1,422
V9A	11	391	765	2280	1140	56,581	999
V9E	23	301	259	3316	878	66,759	1,719
Total	**330**	**5814**	**2740**	**27190**	**7845**		

4.5 Operating cost savings from heating system upgrades

The average operating cost savings ($) achieved by homes that switched from natural gas or oil heating systems to heat pumps was compared with the homes those kept using gas or oil-based heating systems. Table 15 summarizes the changes in operating cost associated with pre- and post-retrofit heating systems, focusing specifically on cases of fuel switching. It should be noted that while the values are presented in relation to heating system changes, many of these homes also undertook additional retrofits (e.g., insulation, windows, or air sealing), which likely contributed to the observed reductions.

Homes that converted from oil to heat pumps realized substantially higher average operating cost savings. The pre-retrofit average operating cost of all fuels for oil-based homes was $3,059.09, which decreased to $2,486.33 for homes those switch to heat pumps ($572.76 savings). On the other hand, the pre-retrofit average operating cost of all fuels for natural gas-based homes was $1,371.19, which dropped by only $38.45 after switching to heat pumps. In contrast, for homes continuing to use natural gas, average operating cost saving was lower ($14.76 saving) than for those converting to heat pumps (Table 15).

4.6 Homes with supplementary heating systems and their status of upgrades

4.6.1 Use of supplementary heating systems in homes

Table 14 summarizes the prevalence and types of supplementary heating systems installed in homes before and after retrofits, as well as among homes that converted their primary heating from gas or oil to heat pumps. In the pre-retrofit evaluation, 638 homes had heat pumps, with 498 homes using various supplementary systems such as wood fireplaces (177 homes), natural gas fireplaces (191 homes), and wood stoves (58 homes). Following retrofits, the number of homes with heat pumps increased substantially to 3,694, with 2,915 homes continuing to use supplementary heating systems. Wood fireplaces (1,237 homes) and natural gas fireplaces (986 homes) remained common supplementary sources post-retrofit.

Among homes converting from gas to heat pumps (451 homes), 383 still retained supplementary heating, predominantly natural gas fireplaces (252 homes) and wood fireplaces (88 homes). Similarly, of the 1,074 homes converting from oil to heat pumps, 791 maintained supplementary heating, with wood fireplaces (520 homes) and wood stoves (114 homes) being frequent options.

These findings highlight that supplementary heating systems remain widely used even after primary heating system upgrades, reflecting either a need for backup heating or occupant preferences. The persistence of wood and natural gas fireplaces as supplementary sources suggests considerations for both energy efficiency and emissions reduction programs to address these secondary systems alongside primary heating upgrades.

Table 14. Summary of homes with supplementary heating systems

Supplementary heating system	No of homes	Supplementary heating system	No of homes
Has heat pump in pre-retrofit evaluation			**638**
Has supplementary heating systems			**498**
Electric baseboard	14	Propane based system	39
Fan heater units	3	Wood stove	58
Forced air furnace	3	Wood fireplace	177
Electric radiant panels	2	Wood furnace	1
Natural gas fireplace	191	Others	7
Natural gas furnace	3		
Has heat pump in post-retrofit evaluation			**3694**
Has supplementary heating systems			**2915**
Electric baseboard	103	Propane based system	150
Fan heater units	9	Wood stove	343
Forced air furnace	6	Wood fireplace	1237
Electric radiant panels	8	Wood furnace	14
Natural gas fireplace	986	Others	47
Natural gas furnace	12		
Converted from gas to heat pump			**451**
Has supplementary heating systems			**383**
Electric baseboard	19	Propane based system	3
Electric radiant panels	3	Wood stove	12
Others electric	4	Wood fireplace	88
Natural gas fireplace	252	Wood furnace	2
Converted from oil to heat pump			**1074**
Has supplementary heating systems			**791**
Electric baseboard	36	Propane based system	29
Fan heater units	3	Wood stove	114
Forced air furnace	3	Wood fireplace	520
Natural gas fireplace	58	Wood furnace	6
		Others	22

4.6.2 Impact of supplementary systems on operating costs, energy use, and emissions

The transition from traditional natural gas- or oil-based heating systems to heat pumps, as well as retention of existing systems, has distinct impacts on operating costs, energy consumption, and GHG emissions. Table 15 summarizes the changes in operating cost, energy consumption, and GHG emissions associated with pre- and post-retrofit heating systems, focusing specifically on cases of fuel switching. While the values are reported in relation to heating system changes, it is important to recognize that many of these homes also completed additional retrofits (such as insulation, windows, or air sealing), which likely influenced the magnitude of the observed reductions. Moreover, the reported operating costs, energy consumption, and GHG reductions reflect total household energy use, not just heating system performance.

For homes that retained natural gas as their primary heating source, average changes were modest. Operating costs decreased by approximately $5 per year (0.34%), energy use declined by 18.46 GJ (23.6%), and GHG emissions were reduced by 1.37 tCO_2e (40.4%). In contrast, homes that converted from natural gas to heat pumps realized more substantial benefits. On average, operating costs fell by $28 to $75 (2.1–5.5%), energy use decreased by 38.18 GJ (48.9%), and GHG emissions dropped by 2.7-2.8 tCO_2e (79.6–81.1%).

Homes originally heated with oil exhibited significantly higher pre-retrofit operating costs and GHG emissions than gas-heated homes. Retaining oil as the primary system yielded moderate improvements, with average cost savings of $847.29 (25.1%), energy savings of 17.28 GJ (22.9%), and emissions reductions of 1.45 tCO_2e (39.6%). However, the largest gains were observed in homes that switched from oil to heat pumps. These households reduced operating costs by $753.95-$887.98 (22.3–26.3%), lowered energy use by 9–12 GJ (11.7–16%) and achieved GHG reductions of approximately 3.4 tCO_2e (92.4%).

Overall, the results indicate that while efficiency improvements deliver benefits across all pathways, fuel switching to heat pumps provides the most significant reductions in operating costs, energy use, and especially GHG emissions. The magnitude of these improvements is greatest for oil-heated homes, reflecting both their higher baseline inefficiency and the low-carbon intensity of electricity in British Columbia.

Table 15. Summary of operating cost ($), energy consumption (GJ), and GHG emissions (tCO_2e) in pre- and post-retrofit for the homes having supplementary heating systems along with heat pump

<table>
<tr><th>Pre-retrofit heating system</th><th>Post-retrofit heating system</th><th>Average pre-retrofit operating cost ($)</th><th>Average post-retrofit operating cost ($)</th><th>Average operating cost saving ($)</th><th>Average pre-retrofit energy consumption (GJ)</th><th>Average post-retrofit energy consumption (GJ)</th><th>Average energy saving (GJ)</th><th>Average pre-retrofit GHG emissions (tCO_2e)</th><th>Average post-retrofit GHG emissions (tCO_2e)</th><th>Average GHG emissions reduction (tCO_2e)</th></tr>
<tr><td rowspan="3">Natural gas-based (with/without backup)</td><td>Natural gas-based (with/without backup)</td><td rowspan="3">1361.03</td><td>1356.43</td><td>4.61</td><td rowspan="3">78.13</td><td>59.67</td><td>18.46</td><td rowspan="3">3.39</td><td>2.02</td><td>1.37</td></tr>
<tr><td>Heat Pump (with any backup)</td><td>1332.74</td><td>28.30</td><td>39.95</td><td>38.18</td><td>0.64</td><td>2.75</td></tr>
<tr><td>Heat pump (with natural gas-based backup)</td><td>1286.36</td><td>74.68</td><td>39.42</td><td>38.71</td><td>0.69</td><td>2.70</td></tr>
<tr><td rowspan="3">Oil-based (with/without backup)</td><td>Oil-based (with/without backup)</td><td rowspan="3">3374.31</td><td>2527.02</td><td>847.29</td><td rowspan="3">75.49</td><td>58.22</td><td>17.28</td><td rowspan="3">3.66</td><td>2.21</td><td>1.45</td></tr>
<tr><td>Heat Pump (with any backup)</td><td>2486.33</td><td>887.98</td><td>63.43</td><td>12.06</td><td>0.28</td><td>3.38</td></tr>
<tr><td>Heat pump (with wood-based backup)</td><td>2620.35</td><td>753.95</td><td>66.64</td><td>8.85</td><td>0.27</td><td>3.39</td></tr>
</table>

** The average operating cost, energy consumption, and GHG emissions from all fuels were derived by first calculating the average values for each energy source (electricity, natural gas, and oil) independently. Then the weighted average of these values was obtained.*

4.7 Cost efficiency and pay back period for different upgrades

4.7.1 Cost-efficiency of upgrade bundles in energy savings

Table 16 compares the cost per gigajoule (GJ) of total energy saved across various retrofit upgrade bundles under the Energy Savings Program (ESP) and Home Renovation Rebate (HRR) programs, highlighting the impact of rebates on cost-efficiency. Without rebates, the cost per GJ saved varies widely by upgrade type, with air sealing generally the least expensive standalone measure (~$696/GJ), while energy star windows are the costliest, reaching over $1,100/GJ in the ESP program. When rebates are applied, costs decrease substantially, especially for measures like attic insulation and natural gas furnace upgrades, where costs drop from over $700/GJ to as low as $130/GJ in some cases, reflecting strong financial incentives. Bundled upgrades generally offer better cost-efficiency than single measures; for example, the combination of air sealing + attic insulation + NG furnace achieves one of the lowest costs per GJ, at $121.63/GJ (ESP with rebate) and $140.20/GJ (HRR with rebate). Heat pump-related bundles tend to be more expensive, although rebates significantly improve their cost-efficiency. For instance, air sealing + heat pump reduces from approximately $540/GJ to $250/GJ with rebates under ESP. The HRR program generally shows slightly higher costs per GJ saved than ESP but still benefits from rebates.

Table A30 presents the cost per gigajoule (GJ) of energy saved from electricity, natural gas, and oil across different upgrade bundles under the ESP and HRR programs, both with and without rebates. Costs per GJ saved vary significantly by fuel type and upgrade combination. For example, simple upgrades like air sealing have relatively high costs for natural gas savings ($1,349/GJ) but lower for oil ($208/GJ). Rebates substantially reduce costs, especially for attic insulation and combined upgrade bundles, where costs can drop by more than half. The HRR program generally offers lower costs per GJ saved compared to ESP, with rebates further improving cost-efficiency. Heat pump-related upgrades show moderate costs for electricity savings ($300–$700/GJ) and more favorable costs for natural gas and oil savings when rebates are applied. These findings highlight the impact of rebate programs in enhancing the economic feasibility of energy efficiency upgrades across different fuel types.

4.7.2 Cost-efficiency of GHG emissions reduction by upgrade bundles

Table 17 evaluates the cost per tCO_2e reduced for various retrofit upgrade bundles within the ESP and HRR programs, considering both pre- and post-rebate scenarios. Single-measure retrofits such as natural gas furnace upgrades show the lowest costs, with values of roughly \$1,574/tCO_2e before rebates and under \$700/tCO_2e after rebates in both programs. By contrast, measures such as air sealing on its own are associated with very high costs (over \$51,000/tCO_2e), reflecting their relatively small impact on overall GHG reductions.

Heat pump installations represent a larger investment, with costs of around \$28,000–30,000/tCO_2e before rebates. Rebates substantially improve cost-effectiveness, lowering the cost to approximately \$12,800/tCO_2e under ESP and \$18,200/tCO_2e under HRR. Energy star window replacements also show high costs in the ESP program (over \$34,000/tCO_2e without rebates), though the HRR program improves cost-effectiveness considerably (around \$10,000/tCO_2e before rebates, \$6,900/tCO_2e after rebates).

Combinations of measures generally yield better cost-effectiveness than individual upgrades, as the cumulative GHG reductions offset higher upfront costs. For example: air sealing + attic insulation reduces costs to approximately \$4,400–6,200/tCO_2e with rebates. Air sealing + natural gas furnace upgrades achieve very low costs, around \$765/tCO_2e post-rebate. Multi-measure bundles that include heat pumps (e.g., heat pump + windows, or attic insulation + heat pump) still show higher costs than gas furnace–based bundles but are substantially improved with rebates.

Table A31 shows the cost per tCO_2e reduced from electricity, natural gas, and oil for various upgrade bundles under the ESP and HRR programs, with and without rebates. The cost-efficiency of GHG reductions varies widely by fuel source and upgrade type. Air sealing consistently exhibited the highest cost per tonne of GHG reductions across both programs, exceeding \$99,000/tCO_2e in the electricity category. Similarly, energy-efficient windows showed relatively high costs, particularly under the ESP program without rebates (\$483,222/tCO_2e for electricity). In contrast, natural gas furnace upgrades demonstrated substantially lower costs, averaging \$9,691/tCO_2e under ESP and \$4,276/tCO_2e with rebates, with comparable values under HRR. Heat pumps, while more cost-effective than windows and air sealing, still showed relatively high costs, ranging from \$5,966 to \$25,393/tCO_2e depending on fuel type and rebate application.

Although the ESP program offers larger rebates than the HRR program, the average cost per upgrade is higher for ESP participants. This may reflect a greater degree of deficiency in ESP homes at the outset. For example, poorer insulation levels throughout the house or a larger number of windows requiring replacement, leading to more extensive and costly upgrades. As a result, even with higher rebate values, the relative cost-efficiency of upgrades appears greater in the HRR program. Overall, the results indicate that rebates significantly enhance the cost-effectiveness of all upgrade types, with the most dramatic improvements seen for insulation and window measures. The data also suggest that while individual measures like heat pumps and windows appear costly when assessed in isolation, their inclusion in bundled retrofits can yield more favorable cost-effectiveness outcomes.

Table 16. Cost per GJ of total energy saved ($) with and without rebate for both the ESP and HRR programs for different bundles of upgrades

Type of upgrades	Cost per GJ of total energy saved in ESP ($)	Cost with rebate per GJ of total energy saved in ESP ($)	Cost per GJ of total energy saved in HRR ($)	Cost with rebate per GJ of total energy saved in HRR ($)
Air sealing	696.47	696.47	696.47	696.47
Attic insulation	769.05	129.55	360.61	243.99
NG furnace	305.13	134.62	305.13	134.62
Heat pump	623.39	268.70	583.07	380.38
Energy star windows	1105.38	530.33	323.41	223.49
Air sealing + attic insulation	469.06	144.43	261.72	202.52
Air sealing + NG furnace	260.62	133.65	260.62	133.65
Air sealing + heat pump	541.81	250.45	508.69	342.19
Air sealing + energy star windows	759.75	392.52	260.38	196.57
Attic insulation + heat pump	757.59	282.05	629.56	412.64
NG furnace + heat pump	503.47	218.46	480.12	283.13
Heat pump + energy star windows	727.59	328.94	478.45	315.69
Air sealing + attic insulation + NG furnace	320.99	121.63	254.70	140.20
Air sealing + attic insulation + energy star windows	724.47	308.65	272.08	198.48
Air sealing + energy star windows + NG furnace	564.66	277.87	314.23	179.60
Air sealing + NG furnace + heat pump	476.20	217.40	455.00	276.12

** The highest and lowest cost per GJ of total energy saved ($) for each category are highlighted in orange and green colors, respectively.*

Table 17. Cost per tCO_2e GHG emissions reduced ($) with and without rebate for both the ESP and HRR programs for different bundles of upgrades

Type of upgrades	Cost per tCO_2e GHG reduced in ESP ($)	Cost with rebate per tCO_2e GHG reduced in ESP ($)	Cost per tCO_2e GHG reduced in HRR ($)	Cost with rebate per tCO_2e GHG reduced in HRR ($)
Air sealing	51302.27	51302.27	51302.27	51302.27
Attic insulation	29549.09	4977.63	13855.72	9374.70
NG furnace	1574.26	694.53	1574.26	694.53
Heat pump	29777.01	12834.94	27851.11	18169.51
Energy star windows	34291.28	16452.09	10033.03	6933.20
Air sealing + attic insulation	14320.71	4409.39	7990.52	6183.02
Air sealing + NG furnace	1492.58	765.42	1492.58	765.42
Air sealing + heat pump	18651.77	8621.80	17511.61	11779.95
Air sealing + energy star windows	23448.03	12114.37	8036.20	6066.80
Attic insulation + heat pump	30976.61	11532.76	25741.64	16872.00
NG furnace + heat pump	5372.36	2331.09	5123.22	3021.16
Heat pump + energy star windows	20331.48	9191.79	13369.62	8821.44
Air sealing + attic insulation + NG furnace	2181.92	826.75	1731.31	953.01
Air sealing + attic insulation + energy star windows	19145.40	8156.63	7190.25	5245.15
Air sealing + energy star windows + NG furnace	3977.57	1957.37	2213.47	1265.14
Air sealing + NG furnace + heat pump	5136.03	2344.72	4907.37	2978.08

* *The highest and lowest cost per tCO2e GHG emissions reduced ($) for each category are highlighted in orange and green colors, respectively.*

4.7.3 Payback period analysis of upgrade bundles

Table 18 presents the payback periods (in years) for different retrofit upgrade bundles under the ESP and HRR programs, comparing scenarios with and without rebates. Standalone measures such as air sealing show the shortest payback periods, approximately 1.65 years across both programs, demonstrating their rapid return on investment. Other single upgrades like attic insulation and natural gas furnace replacements exhibit moderate payback periods, significantly reduced by rebates; for instance, attic insulation payback decreases from 6.84 years to 1.15 years in ESP when rebates are applied. In contrast, upgrades involving heat pumps generally have longer payback periods, with an average of 26.43 years without rebates in ESP, reduced to 11.39 years with rebates. Combined upgrade bundles typically see payback periods longer than single measures but benefit similarly from rebates, often halving the time required. For example, the bundle air sealing + attic insulation + NG furnace has a payback period reduced from 9.93 years to 3.76 years in ESP with rebates. The HRR program tends to show slightly shorter payback periods for certain bundles, such as energy star windows, which drop to as low as 4.22 years with rebates. However, more comprehensive bundles involving heat pumps still show payback periods ranging from around 8 to 16.5 years post-rebate.

Table A32 presents the payback periods for various bundles of home energy upgrades under both the ESP and HRR programs, accounting for costs with and without rebates and with the details of average cost savings from all the fuels individually. Results indicate that while single upgrades such as air sealing or attic insulation yield relatively short payback periods, more capital-intensive retrofits, such as heat pumps or energy-efficient windows require longer time horizons to recover costs, even when rebates are applied. Bundled upgrades generally increase the total cost savings but also extend payback periods due to higher upfront costs. Rebate programs substantially improve the financial feasibility of upgrades, often halving the payback period and thereby enhancing the attractiveness of energy efficiency investments. Overall, these findings illustrate that rebates play a critical role in improving the economic attractiveness of energy retrofit investments, particularly for costlier upgrades like heat pumps. Quick payback periods for basic measures like air sealing can encourage early adoption, while bundled approaches offer balanced trade-offs between upfront costs and long-term savings.

Table 18. Payback period (years) with and without rebate for both the ESP and HRR programs for different bundles of upgrades

Type of upgrades	Payback period without rebate in ESP (years)	Payback period with rebate in ESP (years)	Payback period without rebate in HRR (years)	Payback period with rebate in HRR (years)
Air sealing	1.65	1.65	1.65	1.65
Attic insulation	6.84	1.15	3.21	2.17
NG furnace	7.66	3.38	7.66	3.38
Heat pump	26.43	11.39	24.72	16.13
Energy star windows	20.86	10.01	6.10	4.22
Air sealing + attic insulation	7.95	2.45	4.44	3.43
Air sealing + NG furnace	8.27	4.24	8.27	4.24
Air sealing + heat pump	25.30	11.69	23.75	15.98
Air sealing + energy star windows	21.88	11.30	7.50	5.66
Attic insulation + heat pump	22.75	8.47	18.90	12.39
NG furnace + heat pump	29.45	12.78	28.08	16.56
Heat pump + energy star windows	28.31	12.80	18.62	12.28
Air sealing + attic insulation + NG furnace	9.93	3.76	7.88	4.34
Air sealing + attic insulation + energy star windows	22.38	9.53	8.40	6.13
Air sealing + energy star windows + NG furnace	15.68	7.72	8.73	4.99
Air sealing + NG furnace + heat pump	28.51	13.01	27.24	16.53

** The highest and lowest payback periods (years) for each category are highlighted in orange and green colors, respectively.*

4.8 Status of achieving 2030 and 2050 climate plan targets

Table 19 summarizes the total GHG reduction potential from single-family homes for individual and combined retrofit measures, as well as the estimated number of homes (not per year) that would need to adopt each measure to achieve community-wide reduction targets of 56,000 tCO_2e by 2030 and 90,000 tCO_2e by 2050. The results show that single measures such as air sealing (1,366 tCO_2e) or attic insulation (5,964 tCO_2e) provide relatively modest reductions per home, requiring very large numbers of households to meet the reduction targets (e.g., more than 2.8 million homes by 2030 for air sealing alone). In contrast, combined retrofit packages deliver much higher GHG reductions per home, making them far more effective in reaching community targets. For instance, air sealing with foundation insulation (24,801 tCO_2e) or wall insulation (26,402 tCO_2e) markedly increases efficiency, while multi-measure packages that include insulation and window upgrades achieve even greater reductions.

The three most impactful retrofit bundles are: i) air sealing + energy star windows + wall insulation (51,605 tCO_2e) – achieving nearly the full 2030 reduction target with just 27,948 homes and requiring only 44,917 homes by 2050 to surpass the long-term target; ii) air sealing + attic insulation + wall insulation (33,846 tCO_2e) – requiring 33,845 homes by 2030 and 54,393 homes by 2050, and iii) air sealing + energy star windows + foundation insulation (25,333 tCO_2e) – requiring 72,660 homes by 2030 and 116,775 homes by 2050.

Overall, the table demonstrates that while incremental single upgrades contribute to reductions, deep retrofit bundles combining air sealing, insulation, and window improvements offer the most viable pathway to achieving both the 2030 and 2050 community-wide emission reduction goals.

Total GHG reduction will be 16,410 tCO_2e if 100% of oil-based homes covert to a heat pump by 2030. Total GHG reduction will be 11,875 and 29,688 tCO_2e if 40% and 100% of gas-based homes convert to heat pump by 2030 and 2050, respectively. These findings emphasize the critical role of targeting comprehensive upgrade packages, particularly those including heat pumps, to achieve aggressive community-level climate goals within the coming decades.

Table 19. Total GHG emissions reduction from single-family homes and number of homes required to achieve 2030 and 2050 emissions reduction targets for different bundles of upgrades

Types of upgrades	Total GHG reduction potential from single-family homes (tCO_2e)	No of homes needed to reduce 56000 tCO_2e by 2030	No of homes needed to reduce 90000 tCO_2e by 2050
Air sealing	1366	2872927	4617204
Attic insulation	5964	333414	535843
Energy star windows	8963	146494	235436
Air sealing + attic insulation	9736	134488	216142
Air sealing + foundation insulation	24801	58063	93315
Air sealing + wall insulation	26402	46696	75047
Air sealing + energy star windows	17516	93071	149578
Air sealing + energy star doors and windows	17859	67414	108343
Air sealing + attic insulation + foundation insulation	18151	65101	104627
Air sealing + attic insulation + wall insulation	33846	33845	54393
Air sealing + attic insulation + energy star windows	24013	56217	90348
Air sealing + energy star windows + wall insulation	51605	27948	44917
Air sealing + energy star windows + foundation insulation	25333	72660	116775

Building envelope upgrades present a significant opportunity for reducing GHG emissions in residential buildings. Scenario analysis indicates that retrofitting a modest portion of homes can yield substantial emissions savings: achieving upgrades in 40% of homes by 2030 could reduce emissions by 4,968 to 11,885 tCO_2e depending on the package, while increasing this to 80% coverage by 2050 could double these reductions to between 9,936 and 23,770 tCO_2e (Table 20). These findings highlight the critical role of comprehensive envelope improvements as a scalable strategy to contribute meaningfully to municipal and regional climate goals.

Table 20. GHG emissions reduction scenarios from building envelope upgrades

Envelope upgrades	No of homes to reduce 9696 tCO_2e by 2030	Total GHG reduction if 40% of buildings doing these envelop upgrades by 2030 in tCO_2e	Total GHG reduction if 80% of buildings doing these envelop upgrades by 2050 in tCO_2e
Air sealing + attic insulation	23286	4968	9936
Air sealing + energy star windows	16115	7179	14357
Air sealing + attic insulation + energy star windows	9734	11885	23770

5. Conclusion

This analysis confirms that residential retrofits, especially those combining heat pump installations with building envelope improvements such as air sealing, insulation, and high-performance windows are highly effective in reducing energy consumption, lowering household operating costs, and cutting GHG emissions. Homes previously using oil or propane heating achieved the greatest savings, both in energy use (up to 84 GJ) and emissions reductions (up to 5.8 tCO_2e per home), making them priority targets for decarbonization efforts. Bundled upgrades consistently outperformed single measures in terms of cost-efficiency and impact, with rebate programs significantly improving payback periods and encouraging deeper retrofits.

Despite the uptake of heat pumps, many households continue to rely on supplementary systems such as natural gas fireplaces and wood-burning appliances, which may limit full decarbonization. Future policies should address these secondary heating sources to maximize GHG reductions. To align with the District of Saanich's 2030 and 2050 climate targets, if 80% of homes implement key building envelope measures by 2050, cumulative emissions reductions could exceed 48,000 tCO_2e. Strategic program design, financial support, and community outreach will be essential to accelerate adoption, prioritize high-impact retrofits, and ensure equitable access to energy efficiency benefits across all neighborhoods.

References

BC Hydro. (2024a). Get an EnerGuide Home Evaluation. Retrieved from https://www.bchydro.com/powersmart/residential/building-and-renovating/get-a-home-energy-audit.html

BC Hydro. (2024b). Heat pumps. Retrieved from https://www.bchydro.com/powersmart/residential/tips-technologies/heat-pumps.html

BC Hydro. (2025). Residential tiered rate. Retrieved from https://app.bchydro.com/accounts-billing/rates-energy-use/electricity-rates/residential-rates/tiered.html

B.C. Ministry of Energy and Climate Solutions. (2024). 2024 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions. Retrieved from https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/methodology/2024_methodology_for_quantifying_greenhouse_gas_emissions.pdf

City of Vancouver. (2023). Energy requirements for renovations. Retrieved from https://vancouver.ca/home-property-development/energy-requirements-for-single-family-home-renovations.aspx

CleanBC. (2019a). Energy Savings Program. Retrieved from https://www.betterhomesbc.ca/rebates/Energy-Savings-Program

CleanBC. (2019b). Home Energy Improvement Bonus Rebate. Retrieved from https://www.betterhomesbc.ca/rebates/home-energy-improvement-bonus

District of Saanich. (2020). Climate Plan 100% Renewable & Resilient Saanich. Retrieved from https://www.saanich.ca/assets/Community/Documents/Planning/sustainability/2020-climate-plan-web-v13.0.pdf

District of Saanich. (2022). Make the Switch: Exploring the costs and benefits of switching from fossil fuel heating to electric heat pumps in Saanich homes. Retrieved from https://www.saanich.ca/assets/Community/Documents/MakeTheSwitch_SummaryReportFinal_MAY9.pdf

District of Saanich. (2023). Building retrofit strategy. Retrieved from https://www.saanich.ca/assets/Community/Documents/Planning/sustainability/building-retrofit-strategy.pdf

FortisBC. (2025). Residential natural gas rates. Retrieved from https://www.fortisbc.com/accounts/billing-rates/natural-gas-rates/residential-rates

Government of Canada. (2022). Heating and Cooling With a Heat Pump. Retrieved from https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817

Government of Canada. (2024). Keeping The Heat In - Section 4: Comprehensive air leakage control in your home. Retrieved from https://natural-resources.canada.ca/energy-efficiency/homes/make-your-home-more-energy-efficient/keeping-the-heat/section-4-comprehensive-air-leakage-control-your-home/15635

Introba Inc. (2023). District of Saanich Building Retrofit Strategy. Retrieved from https://www.saanich.ca/assets/Community/Documents/Planning/sustainability/Introba-Modelling-Report.pdf

Natural Resources Canada. (2025). Canada Greener Homes Grant. Retrieved from https://natural-resources.canada.ca/energy-efficiency/home-energy-efficiency/canada-greener-homes-initiative/canada-greener-homes-grant-0

Natural Resources Canada. (2025b). Welcome to My EnerGuide. Retrieved from https://natural-resources.canada.ca/energy-efficiency/product-energy-ratings/energuide/welcome-energuide

Statistic Canada. (2022). Census Tract Reference Maps, by Census Metropolitan Areas or Census Agglomerations. Retrieved from https://www12.statcan.gc.ca/census-recensement/2021/geo/maps-cartes/referencemaps-cartesdereference/cma_ca_ct-rmr_ar_sr/map-eng.cfm?CMA=935

The Canadian Press. (2022). Heat pump might help B.C. residents save utility costs, but do your research first. Retrieved from https://www.terracestandard.com/business/heat-pump-might-help-b-c-residents-save-utility-costs-but-do-your-research-first/

Topmoving.ca. (2025). FSA Codes (British Columbia) by Maps. Retrieved from http://www.topmoving.ca/moving-tools/canada-fsas.html?prov=british-columbia

Appendix

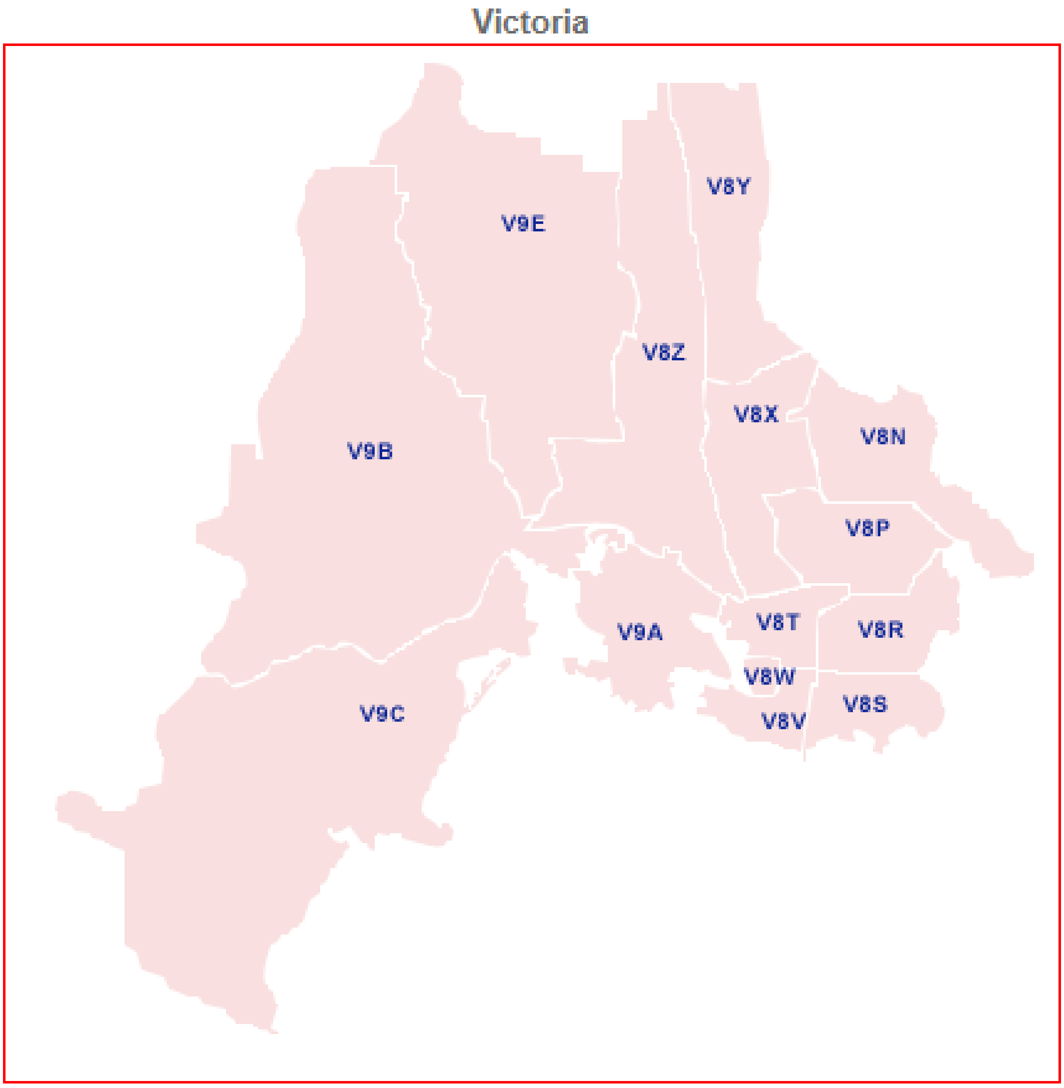


Figure A9. Distribution of FSA in Victoria (Topmoving.ca., 2025)

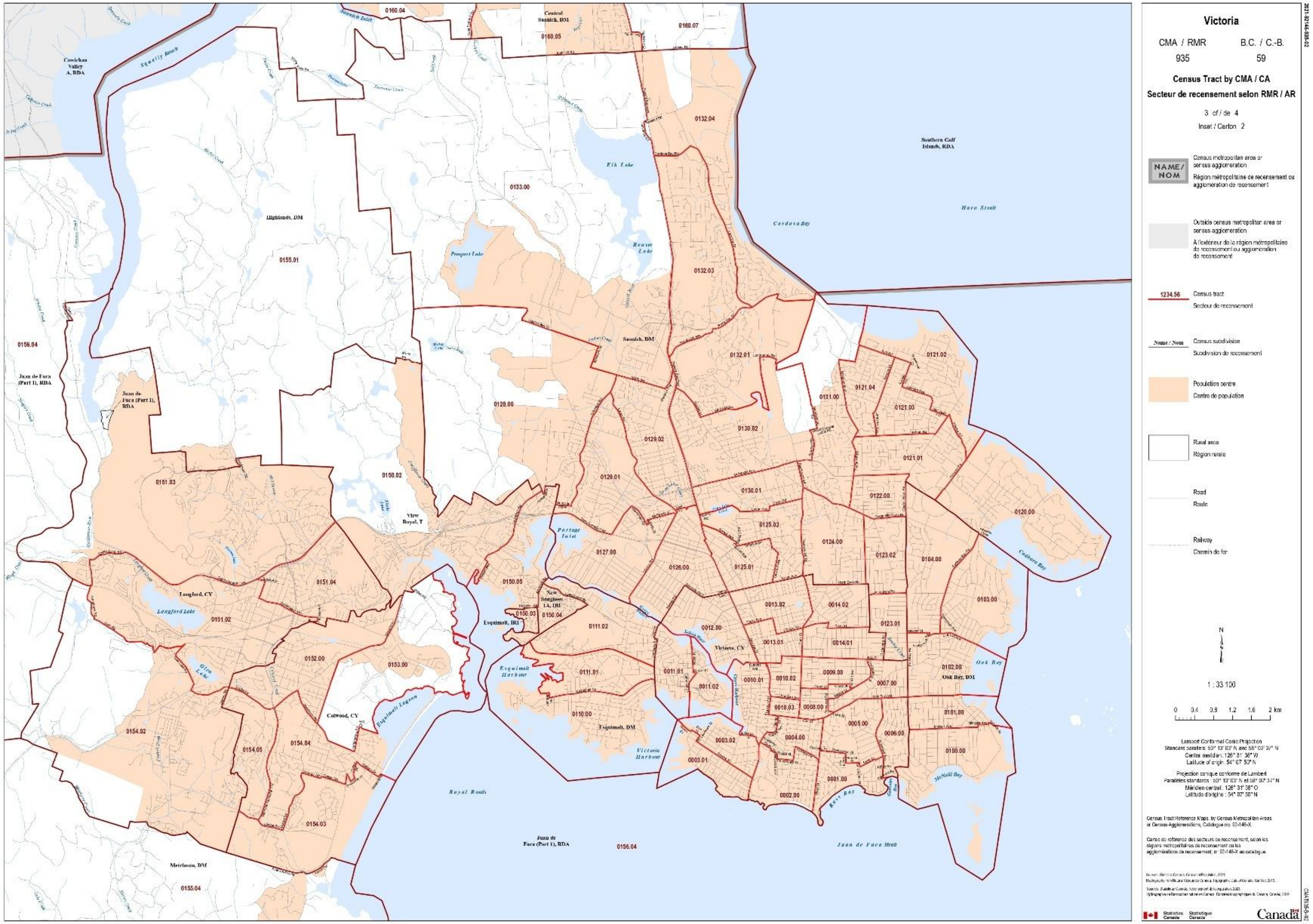


Figure A10. Coverage of census tracts in Victoria (Statistics Canada, 2022)

Table A21. Number of homes that have been doing combination of two types of upgrades

Types of upgrades	Types of upgrades											
	Air sealing	Ventilation	Attic insulation	Ceiling insulation	Foundation insulation	Header insulation	Wall insulation	NG furnace	Heat pump	Domestic hot water	Energy star doors	Energy star windows
Air sealing	4665	26	1343	225	851	417	551	1667	2420	210	408	1777
Ventilation		27	16	5	15	11	9	18	24	9	0	8
Attic insulation			1481	74	460	237	346	409	575	81	175	643
Ceiling insulation				303	92	101	48	133	232	14	18	81
Foundation insulation					946	387	227	370	434	80	147	443
Header insulation						486	131	207	248	41	79	229
Wall insulation							590	189	179	51	111	271
NG furnace								2078	1584	158	130	456
Heat pump									3317	128	146	550
Domestic hot water										247	23	84
Energy star doors											450	368
Energy star windows												2000

Table A22. Number of homes that have been doing different types of upgrades in different years

Year of evaluation	Types of upgrades											
	Air sealing	Ventilation	Attic insulation	Ceiling insulation	Foundation insulation	Header insulation	Wall insulation	NG furnace	Heat pump	Domestic hot water	Energy star doors	Energy star windows
2007	66	0	35	6	31	22	28	31	24	3	17	55
2008	421	0	162	16	150	42	85	223	239	26	80	232
2009	736	0	255	15	170	73	103	214	201	32	125	523
2010	262	0	65	1	53	24	26	112	168	15	27	124
2011	838	0	337	14	170	64	149	228	330	32	102	460
2012	535	0	223	9	110	53	75	160	289	22	54	272
2013	131	0	61	0	29	12	27	29	71	4	4	42
2014	24	0	17	1	12	3	8	6	5	3	2	6
2015	38	0	19	3	17	9	7	37	38	7	2	6
2016	51	2	20	1	20	12	7	50	58	7	0	6
2017	66	6	30	3	24	9	14	53	64	14	1	12
2018	19	4	9	1	6	4	4	17	18	4	0	0
2019	11	4	9	1	5	2	5	5	10	4	0	0
2020	11	1	6	1	3	1	5	6	10	6	0	2
2021	75	0	26	19	11	13	8	34	90	8	1	18
2022	480	3	77	205	83	114	11	321	610	20	12	84
2023	734	7	106	6	44	22	22	458	901	32	14	117
2024	167	0	24	1	8	7	6	94	191	8	9	41
Total	4665	27	1481	303	946	486	590	2078	3317	247	450	2000

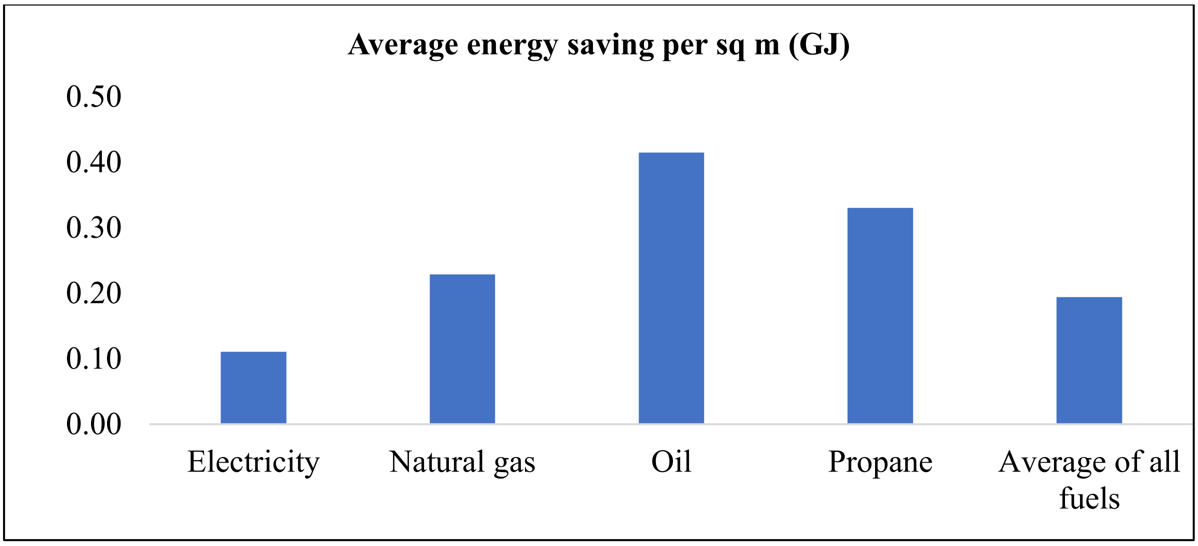


Figure A11. Average energy saving (GJ) per sq m from different fuel sources

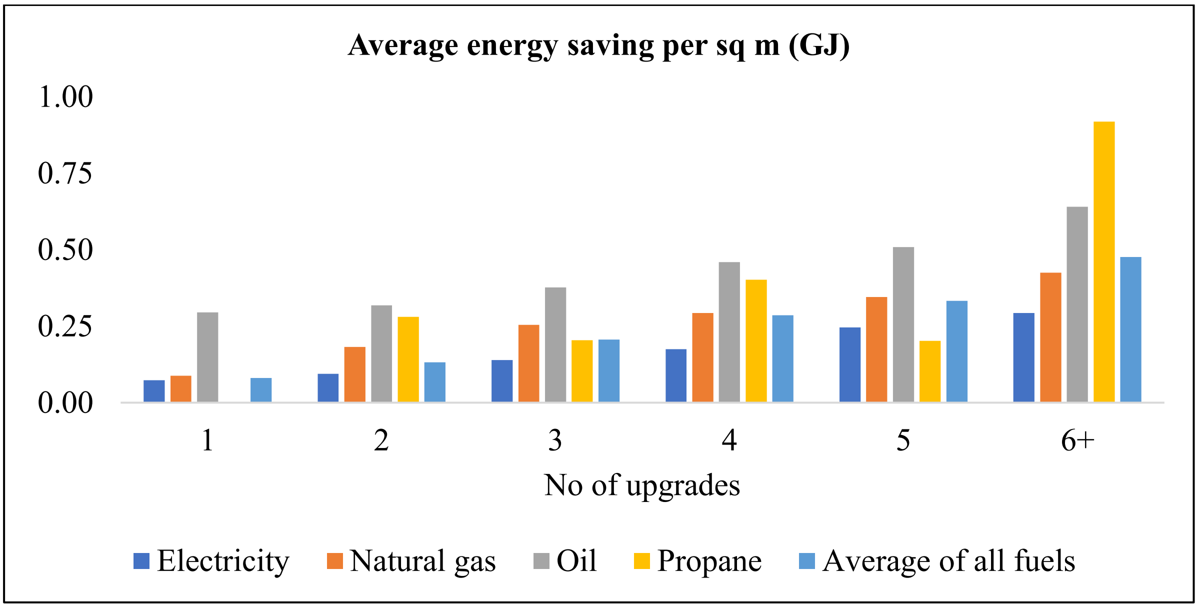


Figure A12. Average energy saving (GJ) per sq m from different fuel sources with number of upgrades

Table A23. Average energy saving (GJ) and average energy saving per sq m (GJ) from different fuel sources for different years of evaluation

Year of evaluation	**Average energy saving (GJ)**					**Average energy saving per sq m (GJ)**				
	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels
2007	32.48	77.06	108.64		69.29	0.17	0.35	0.53		0.34
2008	30.27	54.78	98.92	34.08	59.84	0.14	0.26	0.46	0.18	0.28
2009	20.82	46.84	77.18	76.47	39.93	0.10	0.22	0.38	0.35	0.19
2010	30.13	51.74	92.37	115.23	50.05	0.13	0.24	0.45	0.41	0.24
2011	29.90	43.01	83.35	106.41	43.03	0.13	0.20	0.42	0.20	0.21
2012	30.67	48.39	83.07	215.01	43.75	0.13	0.23	0.42	0.92	0.21
2013	33.52	36.17	85.96		40.82	0.16	0.20	0.44		0.20
2014	44.02	77.42	150.10		53.83	0.21	0.51	0.70		0.26
2015	41.82	100.32	105.03		72.26	0.19	0.42	0.54		0.36
2016	40.94	19.50	111.14		71.61	0.21	0.07	0.51		0.33
2017	37.67	52.01	89.84		57.80	0.16	0.16	0.43		0.27
2018	42.74		99.44		70.24	0.21		0.53		0.37
2019	34.67	107.53	110.36		58.24	0.18	0.65	0.64		0.33
2020	26.36	61.19	82.26		41.40	0.11	0.36	0.39		0.20
2021	24.60	46.09	69.10		32.26	0.10	0.23	0.39		0.15
2022	19.87	53.10	67.91	80.79	31.38	0.09	0.24	0.36	0.41	0.15
2023	18.71	49.51	67.76	46.67	28.58	0.09	0.23	0.35	0.09	0.14
2024	15.07	43.43	65.26	26.38	23.41	0.07	0.21	0.33	0.15	0.11

Table A24. Average energy saving (GJ) and average energy saving per sq m (GJ) from different fuel sources for different bundles of upgrades

Types of upgrades	No of homes	Average energy saving (GJ)				Average energy saving per sq m (GJ)			
		Electricity	Natural gas	Oil	Total	Electricity	Natural gas	Oil	Total
Air sealing	181	3.65	0.74	4.80	1.44	0.02	0.01	0.03	0.01
Attic insulation	23	5.11	4.10	21.33	6.45	0.02	0.01	0.13	0.03
NG furnace	38		13.62	77.99	22.29		0.05	0.37	0.10
Heat pump	409	24.67	56.07	72.92	27.63	0.10	0.24	0.34	0.12
Energy star windows	70	9.86	10.13	20.71	11.86	0.05	0.06	0.10	0.06
Air sealing + attic insulation	146	9.58	11.66	20.99	12.71	0.05	0.06	0.10	0.07
Air sealing + foundation insulation	33	14.29	40.37	27.05	22.70	0.08	0.15	0.14	0.11
Air sealing + wall insulation	36	24.22	39.43	36.18	31.91	0.16	0.21	0.19	0.18
Air sealing + NG furnace	147		22.79	96.59	29.93		0.10	0.49	0.15
Air sealing + heat pump	660	28.54	64.91	67.08	33.64	0.12	0.27	0.34	0.15
Air sealing + energy star windows	542	13.92	25.57	26.12	18.57	0.07	0.11	0.13	0.09
Attic insulation + heat pump	25	24.47	73.95	90.42	29.29	0.12	0.29	0.44	0.14
NG furnace + heat pump	244		58.80	80.13	47.72		0.26	0.40	0.23
Heat pump + energy star windows	27	31.02	91.38	104.18	41.69	0.13	0.33	0.46	0.18
Air sealing + energy star doors and windows	92	23.45	25.01	27.21	23.56	0.10	0.13	0.14	0.11
Air sealing + attic insulation + foundation insulation	54	22.50	21.33	39.10	27.13	0.12	0.13	0.19	0.14
Air sealing + attic insulation + wall insulation	66	34.05	47.42	45.41	41.17	0.18	0.25	0.25	0.22
Air sealing + attic insulation + NG furnace	22		41.00	89.18	39.76		0.22	0.45	0.20
Air sealing + attic insulation + energy star windows	163	21.88	33.96	38.10	26.32	0.11	0.16	0.18	0.13
Air sealing + energy star windows + NG furnace	46		33.81	84.37	37.03		0.20	0.42	0.19
Air sealing + energy star windows + wall insulation	25	39.00	78.04	70.15	54.68	0.26	0.29	0.34	0.28
Air sealing + energy star windows + foundation insulation	38	22.73	37.74	29.79	26.68	0.13	0.20	0.15	0.15
Air sealing + NG furnace + heat pump	654	3.65	60.12	83.27	52.55	0.02	0.28	0.40	0.25

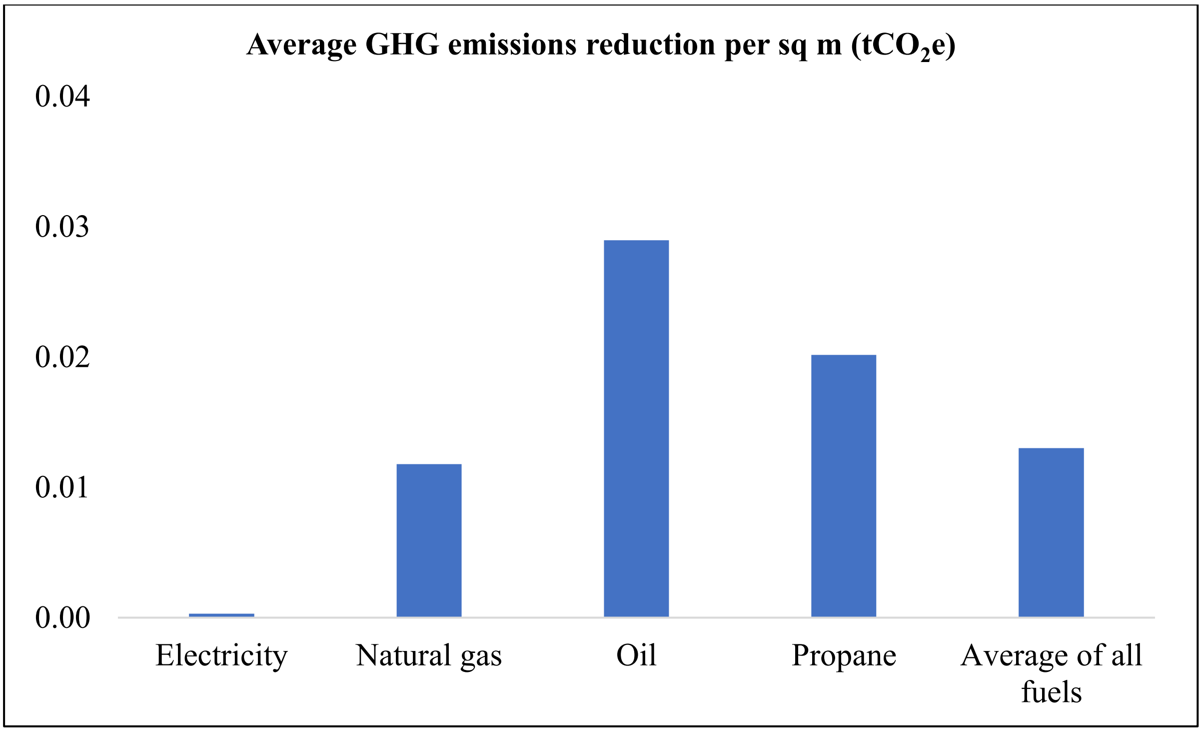


Figure A13. Average GHG emissions reduction per sq m (tCO_2e) from different fuel sources

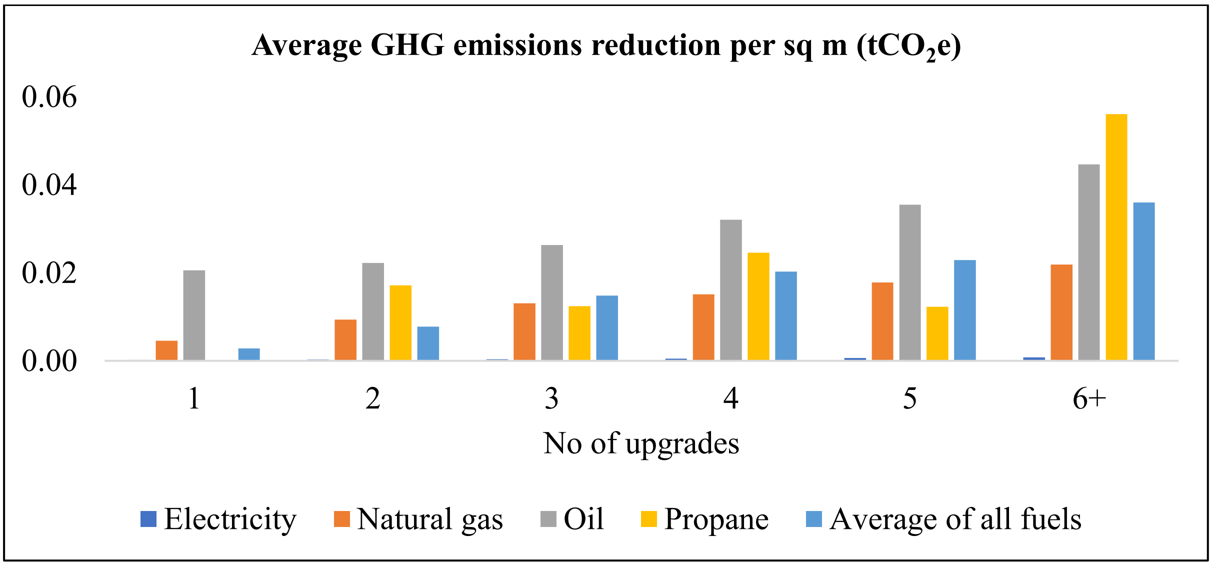


Figure A14. Average GHG emissions reduction per sq m (tCO_2e) from different fuel sources with number of upgrades

Table A25. Average GHG emissions reduction (tCO_2e) and GHG emissions reduction per sq m (tCO_2e) from different fuel sources for different years of evaluation

Year of evaluation	**Average GHG emissions reduction (tCO_2e)**					**Average GHG emissions reduction per sq m (tCO_2e)**				
	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels
2007	0.09	3.97	7.58		5.20	4.7E-04	0.018	0.037		0.025
2008	0.08	2.82	6.90	2.08	4.90	3.8E-04	0.013	0.032	0.011	0.023
2009	0.06	2.41	5.39	4.67	2.70	2.8E-04	0.011	0.026	0.021	0.013
2010	0.08	2.66	6.45	7.03	3.67	3.6E-04	0.012	0.031	0.025	0.018
2011	0.08	2.22	5.82	6.50	2.68	3.6E-04	0.010	0.029	0.012	0.013
2012	0.08	2.49	5.80	13.12	2.50	3.7E-04	0.012	0.029	0.056	0.012
2013	0.09	1.86	6.00		1.79	4.4E-04	0.010	0.031		0.009
2014	0.12	3.99	10.47		2.50	5.7E-04	0.026	0.049		0.012
2015	0.12	5.17	7.33		5.86	5.3E-04	0.022	0.038		0.030
2016	0.11	1.00	7.76		6.05	5.8E-04	0.004	0.035		0.028
2017	0.10	2.68	6.27		4.59	4.3E-04	0.008	0.030		0.022
2018	0.12	0.00	6.94		5.46	5.8E-04	0.000	0.037		0.029
2019	0.10	5.54	7.70		2.90	5.1E-04	0.034	0.044		0.017
2020	0.07	3.15	5.74		2.73	3.1E-04	0.018	0.027		0.013
2021	0.07	2.37	4.82		1.57	2.7E-04	0.012	0.027		0.008
2022	0.05	2.73	4.74	4.93	1.98	2.5E-04	0.012	0.025	0.025	0.010
2023	0.05	2.55	4.73	2.85	1.71	2.4E-04	0.012	0.025	0.005	0.009
2024	0.04	2.24	4.55	1.61	1.37	1.9E-04	0.011	0.023	0.009	0.007

Table A26. Average GHG emissions reduction (tCO_2e) and GHG emissions reduction per sq m (tCO_2e) from different fuel sources for different bundles of upgrades

Types of upgrades	Average GHG emissions reduction (tCO_2e)					Average GHG emissions reduction per sq m (tCO_2e)				
	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels
Air sealing	0.01	0.04	0.34		0.02	4.6E-05	2.4E-04	0.002		1.1E-04
Attic insulation	0.01	0.21	1.49		0.17	5.4E-05	0.001	0.009		0.001
NG furnace		0.70	5.44		4.32		0.003	0.026		0.020
Heat pump	0.07	2.89	5.09		0.58	2.9E-04	0.012	0.024		0.003
Energy star windows	0.03	0.52	1.45		0.38	1.3E-04	0.003	0.007		0.002
Air sealing + attic insulation	0.03	0.60	1.46		0.42	1.4E-04	0.003	0.007		0.002
Air sealing + foundation insulation	0.04	2.08	1.89		0.96	2.2E-04	0.008	0.010		0.005
Air sealing + wall insulation	0.07	2.03	2.52		1.20	4.4E-04	0.011	0.013		0.006
Air sealing + NG furnace		1.17	6.74		5.23		0.005	0.034		0.026
Air sealing + heat pump	0.08	3.34	4.68	7.03	0.98	3.2E-04	0.014	0.024	0.025	0.005
Air sealing + energy star windows	0.04	1.32	1.82		0.60	1.8E-04	0.006	0.009		0.003
Attic insulation + heat pump	0.07	3.81	6.31		0.72	3.3E-04	0.015	0.030		0.003
NG furnace + heat pump		3.03	5.59	1.61	4.47		0.014	0.028	0.009	0.022
Heat pump + energy star windows	0.09	4.71	7.27		1.49	3.6E-04	0.017	0.032		0.006
Air sealing + energy star doors and windows	0.06	1.29	1.90		0.83	2.8E-04	0.007	0.010		0.004
Air sealing + attic insulation + foundation insulation	0.06	1.10	2.73		0.86	3.2E-04	0.007	0.013		0.004
Air sealing + attic insulation + wall insulation	0.09	2.44	3.17	2.59	1.65	4.8E-04	0.013	0.018	0.013	0.009
Air sealing + attic insulation + NG furnace		2.11	6.22		5.85		0.011	0.031		0.030
Air sealing + attic insulation + energy star windows	0.06	1.75	2.66		1.00	3.0E-04	0.008	0.013		0.005
Air sealing + energy star windows + NG furnace		1.74	5.89		5.26		0.010	0.029		0.026
Air sealing + energy star windows + wall insulation	0.11	4.02	4.90		2.00	7.1E-04	0.015	0.024		0.009
Air sealing + energy star windows + foundation insulation	0.06	1.94	2.08	1.57	0.77	3.5E-04	0.011	0.010	0.010	0.004
Air sealing + NG furnace + heat pump		3.10	5.81	3.53	4.87		0.014	0.028	0.014	0.023

Table A27. Distribution of homes doing different upgrades along with the year of construction in different neighbourhoods in the District of Saanich

Year of construction	Types of upgrades											
	Air sealing	Ventilation	Attic insulation	Ceiling insulation	Foundation insulation	Header insulation	Wall insulation	NG furnace	Heat pump	Domestic hot water	Energy star doors	Energy star windows
Built in 2000 or later	143	1	8	15	7	8	1	50	155	8	0	7
Built between 1975 and 1999	1555	5	476	101	221	102	38	271	1198	47	112	728
Built between 1950 and 1974	2170	16	719	131	505	257	280	1357	1525	141	243	936
Built between 1925 and 1949	624	3	213	41	164	96	213	302	340	43	78	260
Built before 1925	173	2	65	15	49	23	58	98	99	8	17	69
Total	**4665**	**27**	**1481**	**303**	**946**	**486**	**590**	**2078**	**3317**	**247**	**450**	**2000**

Table A28. Distribution of homes doing different upgrades along with the median household after tax income ($) in different neighbourhoods in the District of Saanich

Median household after tax income ($)	Types of upgrades											
	Air sealing	Ventilation	Attic insulation	Ceiling insulation	Foundation insulation	Header insulation	Wall insulation	NG furnace	Heat pump	Domestic hot water	Energy star doors	Energy star windows
Less than $60,000	1217	6	365	87	231	122	193	580	871	67	115	545
$60,001 - $70,000	1053	4	339	59	242	123	188	511	734	57	115	436
$70,001 - $80,000	684	4	253	54	135	68	71	266	517	30	62	261
$80,001 - $90,000	1598	13	482	97	313	156	111	671	1140	88	145	706
$90,001 - $100,000	113	0	42	6	25	17	27	50	55	5	13	52
Total	**4665**	**27**	**1481**	**303**	**946**	**486**	**590**	**2078**	**3317**	**247**	**450**	**2000**

Table A29. Distribution of homes doing different upgrades along with the median home energy expenditure ($) in different neighbourhoods in the District of Saanich

Median home energy expenditure ($)	**Types of upgrades**											
	Air sealing	Ventilation	Attic insulation	Ceiling insulation	Foundation insulation	Header insulation	Wall insulation	NG furnace	Heat pump	Domestic hot water	Energy star doors	Energy star windows
$501 - $1000	331	3	101	21	67	42	77	188	196	22	27	154
$1001 - $1500	886	3	264	66	164	80	116	392	675	45	88	391
$1501 - $2000	1053	4	339	59	242	123	188	511	734	57	115	436
More than $2000	2395	17	777	157	473	241	209	987	1712	123	220	1019
Total	4665	27	1481	303	946	486	590	2078	3317	247	450	2000

Table A30. Cost per GJ of energy saved ($) from different fuel sources with and without rebate for both the ESP and HRR programs for different bundles of upgrades

Types of upgrades	ESP program										HRR program									
	Cost per GJ of energy saved ($)					Cost with rebate per GJ of energy saved ($)					Cost per GJ of energy saved ($)					Cost with rebate per GJ of energy saved ($)				
	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels
Air sealing	273.71	1349.15	208.28		696.47	273.71	1349.15	208.28		696.47	273.71	1349.15	208.28		696.47	273.71	1349.15	208.28		696.47
Attic insulation	971.20	1211.56	232.67		769.05	163.60	204.09	39.19		129.55	455.40	568.11	109.10		360.61	308.12	384.38	73.82		243.99
NG furnace		499.11	87.19		305.13		220.20	38.47		134.62		499.11	87.19		305.13		220.20	38.47		134.62
Heat pump	698.33	307.27	236.24		623.39	301.00	132.44	101.83		268.70	653.16	287.39	220.96		583.07	426.11	187.49	144.15		380.38
Energy star windows	1328.86	1294.01	632.84		1105.38	637.55	620.83	303.62		530.33	388.80	378.60	185.16		323.41	268.68	261.63	127.95		223.49
Air sealing + attic insulation	622.43	511.24	284.07		469.06	191.65	157.41	87.46		144.43	347.30	285.25	158.50		261.72	268.74	220.73	122.65		202.52
Air sealing + NG furnace		342.24	80.75		260.62		175.51	41.41		133.65		342.24	80.75		260.62		175.51	41.41		133.65
Air sealing + heat pump	638.56	280.80	271.73	158.18	541.81	295.17	129.80	125.61	73.12	250.45	599.52	263.64	255.12	148.51	508.69	403.30	177.35	171.62	99.90	342.19
Air sealing + energy star windows	1013.80	551.66	540.08		759.75	523.78	285.01	279.03		392.52	347.45	189.07	185.10		260.38	262.30	142.73	139.74		196.57
Attic insulation + heat pump	906.97	300.08	245.41		757.59	337.67	111.72	91.37		282.05	753.70	249.36	203.93		629.56	494.00	163.44	133.67		412.64
NG furnace + heat pump		408.64	299.85	910.79	503.47		177.31	130.10	395.20	218.46		389.69	285.94	868.55	480.12		229.80	168.62	512.19	283.13
Heat pump + energy star windows	978.07	331.97	291.17		727.59	442.18	150.08	131.64		328.94	643.16	218.30	191.47		478.45	424.37	144.04	126.33		315.69
Air sealing + attic insulation + NG furnace		311.28	143.12		320.99		117.95	54.23		121.63		246.99	113.56		254.70		135.96	62.51		140.20
Air sealing + attic insulation + energy star windows	871.55	561.58	500.56		724.47	371.31	239.25	213.26		308.65	327.32	210.91	187.99		272.08	238.77	153.85	137.14		198.48
Air sealing + energy star windows + NG furnace		618.33	247.83		564.66		304.28	121.96		277.87		344.09	137.91		314.23		196.67	78.83		179.60
Air sealing + NG furnace + heat pump		416.26	300.55	432.29	476.20		190.03	137.21	197.35	217.40		397.73	287.17	413.04	455.00		241.36	174.27	250.66	276.12

Table A31. Cost per tCO_2e GHG reduced ($) from different fuel sources with and without rebates for both the ESP and HRR programs for different bundles of upgrades

Types of upgrades	ESP program										HRR program									
	Cost per tCO_2e GHG reduced ($)					Cost with rebate per tCO_2e GHG reduced ($)					Cost per tCO_2e GHG reduced ($)					Cost with rebate per tCO_2e GHG reduced ($)				
	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels
Air sealing	99530.37	26196.49	2984.56		51302.27	99530.37	26196.49	2984.56		51302.27	99530.37	26196.49	2984.56		51302.27	99530.37	26196.49	2984.56		51302.27
Attic insulation	353162.56	23524.91	3334.04		29549.09	59491.25	3962.84	561.63		4977.63	165599.77	11030.95	1563.35		13855.72	112043.84	7463.48	1057.75		9374.70
NG furnace		9691.20	1249.48		1574.26		4275.53	551.24		694.53		9691.20	1249.48		1574.26		4275.53	551.24		694.53
Heat pump	253937.37	5966.17	3385.32		29777.01	109455.94	2571.63	1459.19		12834.94	237513.38	5580.29	3166.37		27851.11	154948.98	3640.47	2065.68		18169.51
Energy star windows	483221.86	25125.72	9068.44		34291.28	231837.57	12054.68	4350.81		16452.09	141382.24	7351.34	2653.27		10033.03	97700.43	5080.05	1833.51		6933.20
Air sealing + attic insulation	226338.08	9926.65	4070.60		14320.71	69690.14	3056.44	1253.35		4409.39	126289.75	5538.77	2271.27		7990.52	97722.35	4285.87	1757.50		6183.02
Air sealing + NG furnace		6645.34	1157.15		1492.58		3407.87	593.41		765.42		6645.34	1157.15		1492.58		3407.87	593.41		765.42
Air sealing + heat pump	232203.17	5452.34	3893.89	2591.51	18651.77	107336.11	2520.35	1799.96	1197.93	8621.80	218008.85	5119.05	3655.86	2433.09	17511.61	146653.15	3443.55	2459.28	1636.72	11779.95
Air sealing + energy star windows	368653.72	10711.54	7739.27		23448.03	190464.12	5534.09	3998.47		12114.37	126346.35	3671.10	2652.43		8036.20	95383.22	2771.44	2002.41		6066.80
Attic insulation + heat pump	329807.92	5826.55	3516.63		30976.61	122789.30	2169.26	1309.26		11532.76	274071.29	4841.88	2922.33		25741.64	179636.18	3173.54	1915.40		16872.00
NG furnace + heat pump		7934.64	4296.71	14921.38	5372.36		3442.88	1864.37	6474.47	2331.09		7566.69	4097.46	14229.44	5123.22		4462.07	2416.27	8391.09	3021.16

Types of upgrades	ESP program										HRR program									
	Cost per tCO_2e GHG reduced ($)					Cost with rebate per tCO_2e GHG reduced ($)					Cost per tCO_2e GHG reduced ($)					Cost with rebate per tCO_2e GHG reduced ($)				
	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels	Electricity	Natural gas	Oil	Propane	Average of all fuels
Heat pump + energy star windows	355662.85	6445.95	4172.43		20331.48	160793.90	2914.19	1886.34		9191.79	233877.61	4238.74	2743.72		13369.62	154315.38	2796.78	1810.34		8821.44
Air sealing + attic insulation + NG furnace		6044.09	2050.87		2181.92		2290.16	777.09		826.75		4795.86	1627.32		1731.31		2639.90	895.77		953.01
Air sealing + attic insulation + energy star windows	316927.27	10904.11	7172.89		19145.40	135022.41	4645.54	3055.91		8156.63	119025.29	4095.15	2693.85		7190.25	86826.65	2987.33	1965.11		5245.15
Air sealing + energy star windows + NG furnace		12006.07	3551.33		3977.57		5908.22	1747.62		1957.37		6681.23	1976.27		2213.47		3818.76	1129.57		1265.14
Air sealing + NG furnace + heat pump		8082.46	4306.85	7082.14	5136.03		3689.84	1966.19	3233.17	2344.72		7722.63	4115.11	6766.85	4907.37		4686.54	2497.29	4106.51	2978.08

Table A32. Payback periods (years) for different bundles of upgrades for both the ESP and HRR programs considering both costs of upgrades with and without rebates

Types of upgrades	Average cost saving in electricity consumption ($)	Average cost saving in gas consumption ($)	Average cost saving in oil consumption ($)	Average cost savings of all fuels ($)	Cost in ESP program ($)	Cost in HRR program ($)	Cost with rebate in ESP program ($)	Cost with rebate in HRR program ($)	Payback period without rebate in ESP (years)	Payback period with rebate in ESP (years)	Payback period without rebate in HRR (years)	Payback period with rebate in HRR (years)
Air sealing	172	42	1603	606	1000	1000	1000	1000	1 years and 8 months	1 years and 8 months	1 years and 8 months	1 years and 8 months
Attic insulation	363	34	1779	725	4963	2327	836	1575	6 years and 10 months	1 years and 2 months	3 years and 3 months	2 years and 2 months
NG furnace	-712	52	3323	888	6800	6800	3000	3000	7 years and 8 months	3 years and 5 months	7 years and 8 months	3 years and 5 months
Heat pump	39	133	1783	652	17227	16113	7425	10512	26 years and 5 months	11 years and 5 months	24 years and 9 months	16 years and 2 months
Energy star windows	356	21	1508	628	13109	3835	6289	2650	20 years and 10 months	10 years and 0 months	6 years and 1 months	4 years and 3 months
Air sealing + attic insulation	368	29	1853	750	5963	3327	1836	2575	7 years and 11 months	2 years and 5 months	4 years and 5 months	3 years and 5 months
Air sealing + NG furnace	-691	28	3494	944	7800	7800	4000	4000	8 years and 3 months	4 years and 3 months	8 years and 3 months	4 years and 3 months
Air sealing + heat pump	1	131	2030	721	18227	17113	8425	11512	25 years and 4 months	11 years and 8 months	23 years and 9 months	15 years and 12 months
Air sealing + energy star windows	373	18	1543	645	14109	4835	7289	3650	21 years and 11 months	11 years and 4 months	7 years and 6 months	5 years and 8 months
Attic insulation + heat pump	225	114	2587	976	22190	18440	8261	12086	22 years and 9 months	8 years and 6 months	18 years and 11 months	12 years and 5 months
NG furnace + heat pump	-910	226	3132	816	24027	22913	10425	13512	29 years and 5 months	12 years and 9 months	28 years and 1 months	16 years and 7 months
Heat pump + energy star windows	223	101	2890	1071	30335	19948	13715	13162	28 years and 4 months	12 years and 10 months	18 years and 7 months	12 years and 3 months
Air sealing + attic insulation + NG furnace	-599	-18	4471	1285	12763	10127	4836	5575	9 years and 11 months	3 years and 9 months	7 years and 11 months	4 years and 4 months
Air sealing + attic insulation + energy star windows	419	21	2116	852	19072	7163	8125	5225	22 years and 5 months	9 years and 6 months	8 years and 5 months	6 years and 2 months
Air sealing + energy star windows + NG furnace	-552	-93	4644	1333	20909	11635	10289	6650	15 years and 8 months	7 years and 9 months	8 years and 9 months	4 years and 12 months
Air sealing + NG furnace + heat pump	-903	209	3328	878	25027	23913	11425	14512	28 years and 6 months	13 years and 0 months	27 years and 3 months	16 years and 6 months