Current State of Heat Pump Adoption in the Township of Langley

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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 the Township of Langley 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 Township of Langley or the University of British Columbia.

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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.

The following work was conducted for the place now called the Township of Langley on the ancestral and unceded territories of the q̓ʷɑːn̓ƛ̓ən̓ (Kwantlen), q̓iċəy̓ (Katzie), Máthekwi (Matsqui), and se'mya'me (Semiahmoo) First Nations. I recognize and respect them as the traditional custodians of the land on which this work was conducted.

EXECUTIVE SUMMARY

In January 2021, the Township of Langley (TOL) adopted its Climate Action Strategy which includes five Big Moves that will help the Township decrease its carbon pollution to net zero by 2050 and adapt to climate change. Big Move 3 focuses on existing buildings and states that all hot water and heating system replacements will be zero emissions by 2030. Meeting this goal will involve replacing fossil fuel equipment, such as natural gas furnaces, with electric heat pumps powered by BC's clean electricity grid. This study consisted of two public surveys (residents and HVAC contractors) to investigate the current state of heat pump adoption in the Township. In total, 382 residents and 36 HVAC contractors took part in the survey.

Survey respondents mainly live in older, single-family homes that were built between 1970 and 1990, and 69% of respondents have a natural gas-based system (furnace, fireplace, boiler) as their primary heating system (Figure ES1). About 30% of natural gas furnaces and boilers are more than 16 years old which represents a significant opportunity to ensure these systems are soon replaced with electric options like heat pumps. Over 80% of natural gas-based system users reported they are not planning to change their system in the next year, highlighting the need for targeted programming to assist in the transition to net zero.

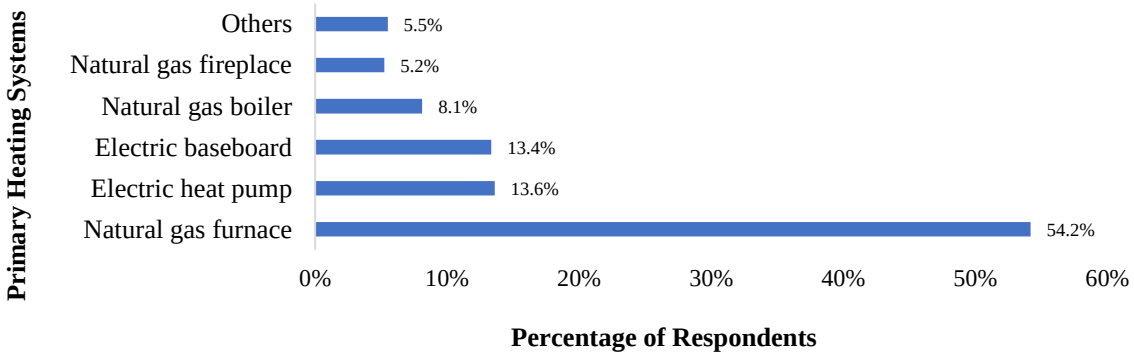

Figure ES1. *Primary heating systems in the respondents' homes*

When examining heating performance, electric heat pumps were ranked similarly to natural gas furnaces, and much better than electric baseboards. Regarding cooling performance, central air conditioners and electric heat pumps received very similar ratings. For GHG emissions, electric systems received more 'Good' and 'Excellent' ratings (55%) than natural gas-based systems (32%); however, very few people believe natural-gas systems emit high GHG emissions with more people actually rating electric heating systems as having worse GHG emissions, which points toward a knowledge gap among respondents (Figure ES2).

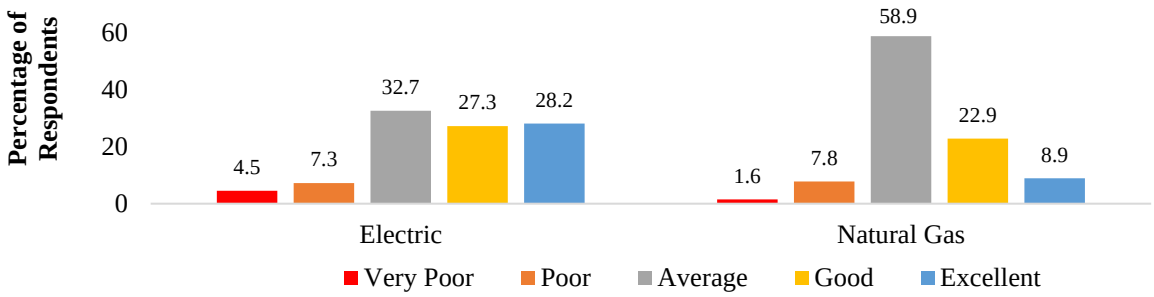

Figure ES2. *Respondents' opinions of GHG emissions from electric and natural gas-based primary heating systems (poor = high GHGs, good = low GHGs)*

21% of respondents have a heat pump either as a primary or secondary heating system. Heat pump users who led the retrofit process were asked about economic aspects of their retrofitting journey. Over a third of heat pump users did not access any rebates to help with their retrofit. 27% of heat pump users said the rebate process was too much work, and 16% said there was a lack of information regarding rebates, which both support further work to be done simplifying and promoting rebate programs. Among rebate recipients who gave details on their annual household income, 58% had an annual household income of more than $150,000 (Figure ES3), indicating that heat pumps are generally bought by people with a higher income even with available rebates.

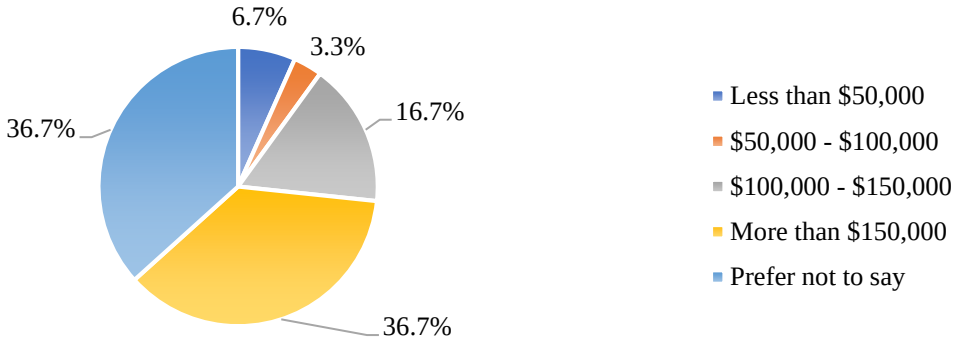

Figure ES3. *Annual household income distribution of the respondents who accessed rebates*

Heat pump users mentioned cooling benefits, improved thermal comfort, and reduced energy bills as the main factors that motivated them to install a heat pump (Figure ES4). When asked about the failure, or potential failure, of their previous heating system, most users did not rate these concerns highly in their decision to retrofit. This result shows that users are generally switching to a heat pump because of the benefits they provide and not because their previous heating system failed, which is indicative of a longer planning and design period being needed instead of a snap decision to switch heating systems at an unexpected failure.

Non-heat pump users, which make up 79% of respondents, are knowledgeable of common heat pump benefits: addition of cooling (72%), reduce GHG emissions (50%), and energy-efficiency (44%). Unfamiliarity with heat pumps is not likely a large barrier for switching. High initial cost of purchasing (54%), electrical panel upgrade cost (33%) and perceived increased operating cost (19%) compared to their current systems are listed as significant obstacles for non-users. 69% of non-users do not have any immediate or future heat pump retrofit plans.

This study also includes insights from 36 HVAC contractors among which 32% have installed more than 200 heat pumps in the last five years. When asked about heating systems prior to retrofitting a client's home, natural gas furnace (72%), electric baseboard (42%), and natural gas boiler (36%) were selected most often. Contractors cite the addition of cooling (82%) and availability of rebates (61%) as the most common benefits they hear of when installing heat pumps. HVAC contractors also mentioned that homeowners struggle with the high initial cost of a new heat pump and that they hesitate to go into debt for the retrofit.

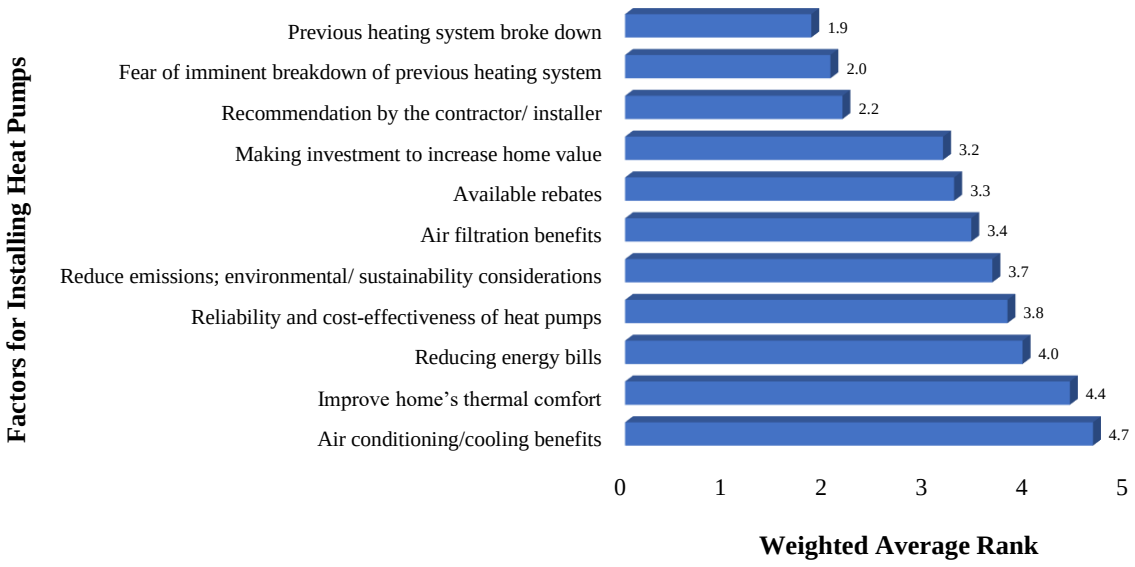

Figure ES4. *Weighted average ranks of motivating factors for installing heat pump ('Not important' = 1 and 'Very important' = 5)*

Respondents from both surveys were asked about their opinions on ways to motivate more people to switch to a heat pump, with more rebates or financial plans receiving the highest response from all respondents. Heat pump users emphasized simplifying the rebate process and educating people about the benefits of heat pumps. Punitive or regulatory measures received very few responses (Figure ES5). 'Other' input from respondents included reducing electricity costs, concern about restrictive strata councils, and concern about grid capacity.

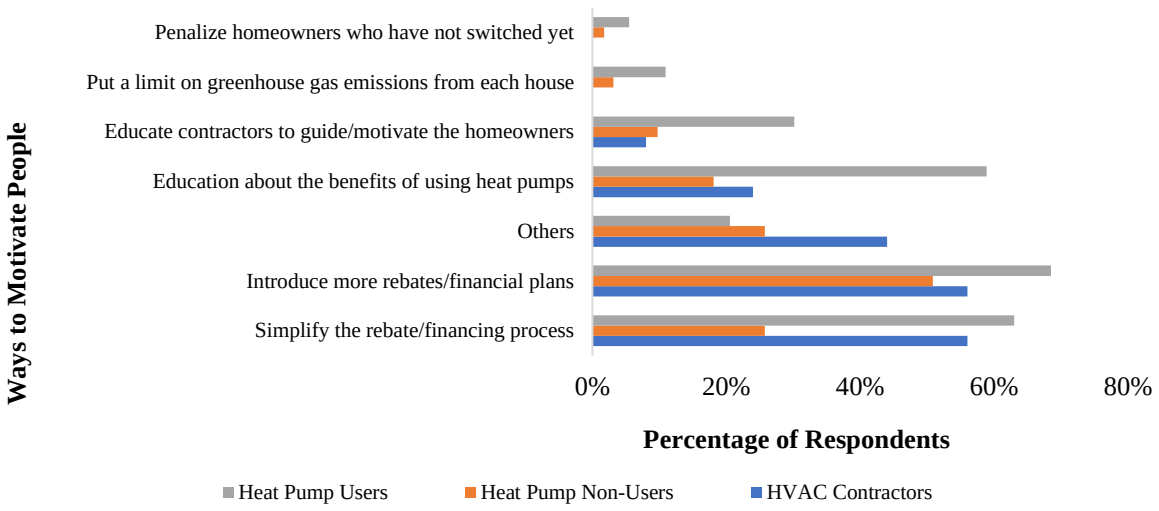

Figure ES5. *Strategies to motivate more people to install a heat pump according to heat pump users, non-users, and HVAC contractors*

Based on the findings of these surveys, this study recommends the Township of Langley and similar municipalities consider the following actions:

a. **Advocate for increased heat pump rebate amounts and give funding for top-ups:** The rebate amount should cover a significant amount of the initial purchase cost, especially for lower income groups, to make heat pumps more competitive with natural gas options.

b. **Advocate for a simplified rebate process:** Onerous rebate processes can discourage people to access them and buy a heat pump.

c. **Advocate for quick and easy financing options:** Availability of zero/very low-interest loans, installment plans, etc. will enable people to upgrade to heat pumps without any savings.

d. **Expand education on building decarbonization and advocate for education from all levels of government and BC Hydro:** Knowledge gaps and misinformation can be addressed by increasing education and sharing stories from heat pump users.

e. **Ensure enough electrical capacity and supply for building decarbonization and be transparent with this information (BC Hydro lead):** Lack of transparency around BC's electricity supply can be an excuse against switching to electric heat pumps. The province and BC Hydro should ensure there is enough electricity and grid capacity to support full electrification to 2050, and clearly communicate these plans to BC residents.

f. **Collaborate and ensure consistent messaging between all levels of government:** There should be consistency among the measures taken and messaging at different levels of government.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. BACKGROUND

Climate change and its associated impacts are two of the greatest challenges that we are facing in recent times. Human activities like rapid urbanization and industrialization are releasing increasing amounts of greenhouse gases (GHGs) that trap heat in the atmosphere, warming our planet. The Intergovernmental Panel on Climate Change (IPCC) has suggested a maximum threshold of 1.5°C of warming above pre-industrial levels as beyond that climate change impacts will be increasingly harmful and dangerous (IPCC, 2019). The Paris Agreement, an international treaty on climate change, was passed at the UN Climate Change Conference (COP21) in Paris on December 12th, 2015. It is a legally binding international treaty effective from November 4th, 2016. A total of 194 parties including Canada have joined this agreement to reduce global GHG emissions substantially and work towards achieving net-zero emissions targets. To achieve this global net-zero emissions target, emissions need to be reduced by 45% by 2030 and 100% by 2050 (United Nations, 2022).

The net-zero target is very important for Canada considering its northern latitude and warming climate. Canada is experiencing approximately twice the warming rate of the global average (Environment and Climate Change Canada, 2019). Canada is committed to achieving net-zero emissions by 2050 following the global target. Several provinces and cities have already developed a climate action plan to meet emissions reduction targets. Moreover, the Canadian Net-Zero Emissions Accountability Act has been adopted since June 29th, 2021, to embody the global commitment in legislation (Government of Canada, 2022b).

The Township of Langley (Township or TOL) is a district municipality in southwestern British Columbia, Canada (Figure 1). It extends south from the Fraser River to the Canada–United States border, with the City of Abbotsford to the east, and the cities of Surrey and Langley to the west. The Township has an area of 316 km^2 with a population of approximately 145,000 (Township of Langley, n.d.). The Township adopted its Climate Action Strategy in January 2021 to meet emissions reduction targets, adapt to climate change, and build a sustainable, healthy, and inclusive community. Long summers, extreme weather like flooding and windstorms, and other climate change effects pose serious threats to residents and natural systems. To prevent these adverse effects, the Township committed to the IPCC emission reduction goals of 45% less emissions by 2030, and 100% by 2050 (Township of Langley, 2021).

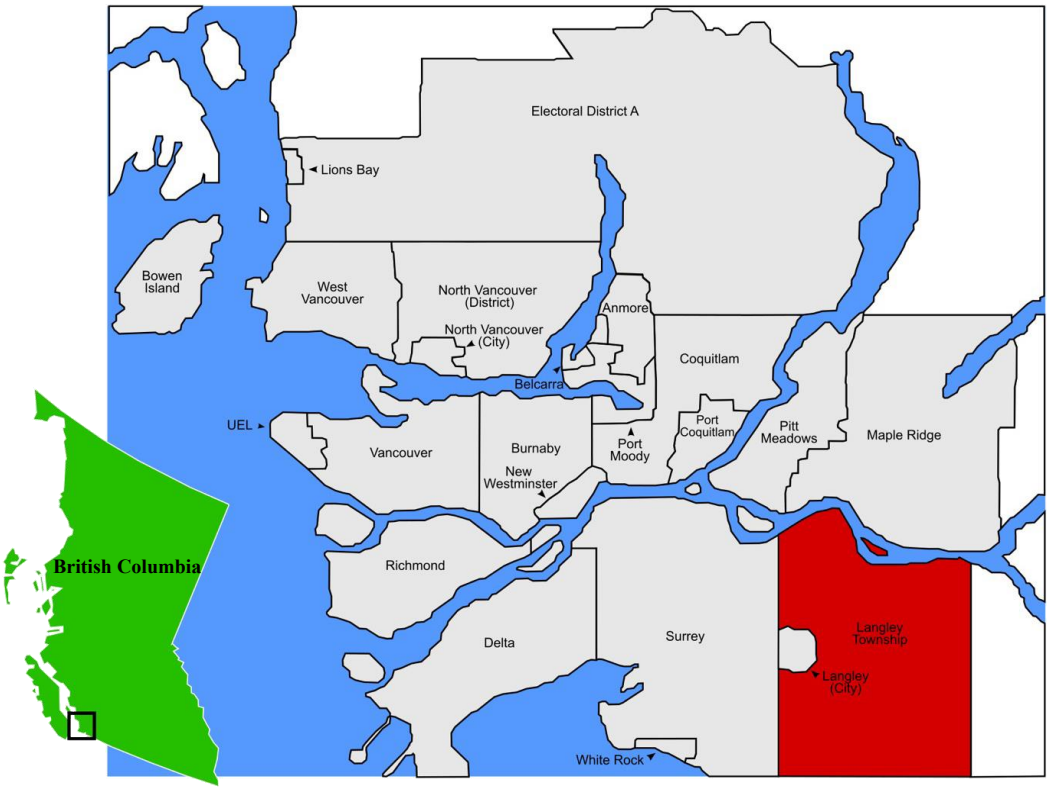

Figure 1. *Location of the Township of Langley (Wikipedia, 2023)*

In the Climate Action Strategy, the Township set 5 Big Moves with specific targets for sectors such as transportation, buildings, corporate operations, and natural systems (Figure 2). Among them, Big Move 3 focuses on existing buildings and states that all hot water and heating system replacements will be zero emissions by 2030.

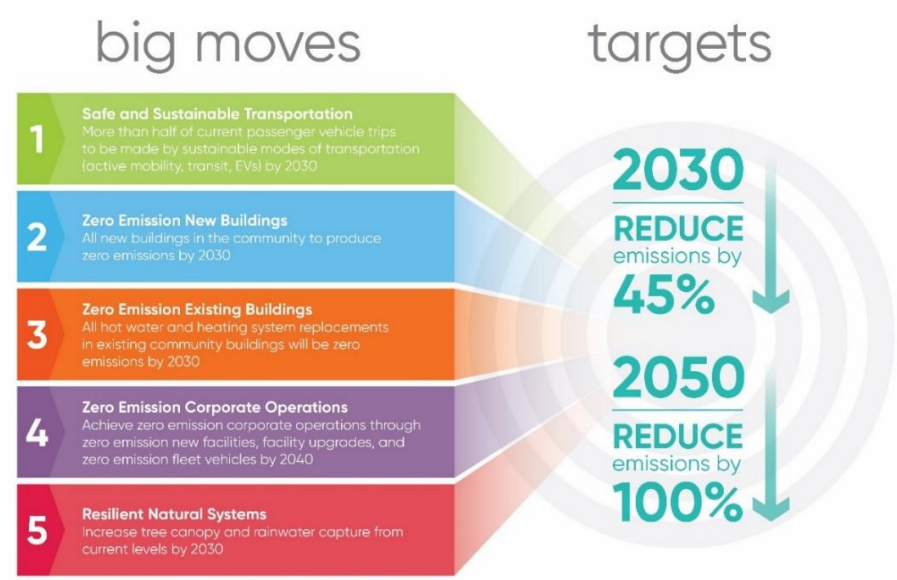

Figure 2. *Big Moves and Targets of the Township of Langley's Climate Action Strategy (Township of Langley, 2021)*

Retrofitting and decarbonizing existing buildings are essential tasks on the path toward zero emissions as around 30% of the Township's total emissions come from buildings (Figure 3; Township of Langley, 2021). For this purpose, searching for a sustainable, low-carbon, and energy-efficient heating and cooling source and encouraging residents to make the switch should be a high priority for the Township. Heat pumps are a key solution for decarbonizing homes in British Columbia considering its clean hydroelectricity grid. In the next section, a brief description of heat pumps with their benefits and potential of being used in BC is illustrated.

Figure 3. *GHG emissions from different sectors in the Township of Langley (Township of Langley, 2021)*

2. HEAT PUMP: A CLEAN, ENERGY-EFFICIENT, AND SUSTAINABLE HEATING AND COOLING SYSTEM

2.1 Heat Pump Benefits

Heat pumps are energy-efficient alternatives to heating systems commonly used in Langley (i.e., natural gas furnaces and electric baseboards) and they have an additional cooling capacity which reduces the use of conventional air conditioners and keeps homes comfortable year-round. Heat pumps are highly energy efficient as they do not generate hot/cold air, but rather transfer heat from one place to another. Additionally, heat pumps are preferable for use in BC as the electricity grid is 97% clean hydroelectricity, which reduces GHG emissions compared to natural gas heating by about two tonnes of CO_2e per year per home– about the same carbon footprint as driving a gas-powered car 8,000 kilometres. They are approximately 300% more efficient than electric baseboards and natural gas furnaces, and 50% more than a typical window air conditioner unit. Currently, an electric heat pump is approximately 12%

less expensive to operate than a natural gas furnace, with the cost difference expanding further in heat pump's favour as the cost of polluting carbon continues to increase (BC Hydro, 2023b; Government of Canada, 2022a). Savings are even greater when switching from electric baseboard heating to an electric heat pump. For a townhouse in Burnaby B.C., its utility bills declined by about 40% after switching to a heat pump from electric baseboard heating (The Canadian Press, 2022). Table 1 contains information on estimated savings on utility bills after installing electric heat pumps for different dwelling types in the Southwest BC region (BC Hydro, 2023a).

Table 1. *Estimated savings after installing heat pumps for different dwelling types compared to various heating systems (BC Hydro, 2023a).*

Type of Home	Current Primary Heating Source	Approximate Age of Current Heating System	Heat Pump Efficiency Level	Savings on heating costs (CAD/Year)
Single-family detached home	Natural Gas Furnace	< 2 years	A heat pump with an HSPF[1] of 10 or 11	13
		2 – 10 years		54
		10 – 30 years		193
		> 30 years		459
	Electric baseboard	-		419
	Natural Gas Furnace	< 2 years	A higher efficiency heat pump (HSPF ≥ 11.5)	111
		2 – 10 years		153
		10 – 30 years		292
		> 30 years		557
	Electric baseboard	-		460
Townhouse/ row home	Natural Gas Furnace	< 2 years	A heat pump with an HSPF of 10 or 11	91
		2 – 10 years		116
		10 – 30 years		197
		> 30 years		353
	Electric baseboard	-		273
	Natural Gas Furnace	< 2 years	A higher efficiency heat pump (HSPF ≥ 11.5)	149
		2 – 10 years		174
		10 – 30 years		255
		> 30 years		410
	Electric baseboard	-		300
Mobile home	Natural Gas Furnace	< 2 years		67
		2 – 10 years		93

[1] HSPF: Heating Seasonal Performance Factor

Type of Home	Current Primary Heating Source	Approximate Age of Current Heating System	Heat Pump Efficiency Level	Savings on heating costs (CAD/Year)
		10 – 30 years	A heat pump with an HSPF of 10 or 11	177
		> 30 years		338
	Electric baseboard	-		256
	Natural Gas Furnace	< 2 years	A higher efficiency heat pump (HSPF ≥ 11.5)	127
		2 – 10 years		152
		10 – 30 years		236
		> 30 years		397
	Electric baseboard	-		281

2.2 Types of Heat Pumps

There are a few different types of heat pumps – air-source heat pumps (ducted or ductless), ground-source heat pumps, gas heat pumps, water-source heat pumps, cold climate heat pumps, and low-GWP refrigerant heat pumps.

2.2.1 Air-Source Heat Pumps

Air-source heat pumps use outdoor air to transfer thermal energy from one place to another. They can be either air-air (ducted or ductless) or air-water heat pumps. If the indoor coil is in a duct and the heated or cooled air is distributed through ductwork, then the system is called a ducted air-air heat pump. On the other hand, in ductless heat pumps, the indoor coil is in an indoor unit which is typically located on the floor or wall. They can be either mini-split (single indoor unit) or multi-split (multiple indoor units), but they are always served by a single outdoor unit. The air-air system is more efficient in locations where the difference between inside and outside temperatures is smaller; in BC this is the best option (BC Hydro, 2023b; Government of Canada, 2022a). Berardi and Jones (2022) investigated the efficiency and GHG emissions of air-source heat pumps across Canada under future climate scenarios and found that this type of heat pump would be best suited for residential use in Vancouver across different climate scenarios (present (1998-2014), near future (2030-2041), and far future (2056-2075)) as this region has mild annual temperatures.

Air-water heat pumps are not as common as air-air in Canada. They are mainly for homes with hydronic (water-based) distribution systems (i.e., low-temperature radiator, radiant floor, fan coil unit). This type of heat pump provides thermal energy to the hydronic system. They are efficient for heating water to lower temperatures (< 45 to 50°C) (BC Hydro, 2023b; Government of Canada, 2022a).

2.2.2 Ground-Source Heat Pumps

Ground-source heat pumps' main source of thermal energy is the earth or groundwater. They have two key components – a ground heat exchanger and a heat pump. The ground heat exchanger is used to add or remove thermal energy from the ground. The heat pump uses a fluid which flows through the heat exchanger. Ground-source heat pumps are compatible with both air and hydronic systems (Government of Canada, 2022a). Abdel-Salam et al. (2021) investigated the heating performance of ground-source heat pumps in Canadian single-family houses. They reported that they were able to meet the peak heating load without using any secondary heating system and concluded that ground-source heat pumps can operate at high efficiency without any operational problems, even in very cold weather like Toronto given that they are designed, sized, and installed correctly (Abdel-Salam et al., 2021).

2.2.3 Gas Heat Pumps

In recent years, FortisBC completed a pilot program to install highly efficient gas heat pumps in 20 homes across the Lower Mainland and Southern Interior of BC. This type of heat pump cuts energy use and GHG emissions by around 50% and reduces utility bills. Approximately 50% of BC homes use natural gas as an energy source. Gas heat pumps can be hydrogen-enabled, allowing them to operate on gas-hydrogen blends. Customers can reduce GHG emissions by about 2 tonnes of CO_{2eq} per year going from an average use of 85 GJ to 40 GJ natural gas use each year, compared to a standard natural gas furnace and hot water heater (BC Hydro, 2022; FortisBC Energy Inc., 2022).

2.2.4 Water-Source Heat Pumps

Water-source heat pumps are one of the most efficient and environmentally sustainable home heating options and have self-contained units that can be placed in virtually any location within a building. They respond to the heating or cooling load of an individual zone to provide an excellent comfort level and better control of energy use to lower utility bills. They are compatible with both geothermal closed-circuit or open-well loops, or on a traditional boiler/tower loop system (Daikin Applied, n.d.).

2.2.5 Cold Climate Heat Pumps

For parts of Canada where temperatures drop below -10°C, cold climate heat pumps are recommended as they are built to work efficiently even below -25°C. Some systems are more than 200% efficient at -18°C (BC Hydro, 2022). Heat pumps with a coefficient of performance (COP) of 1.8 or higher at -15°C are classified as cold climate one (CleanBC Better Homes,

2022b). Cold climate heat pumps will work very efficiently in freezing temperatures if they are carefully chosen and properly installed. The key feature of these heat pumps is a variable-speed compressor which is powered by an inverter. This variable-speed system holds a steadier temperature and humidity level than a conventional single-speed HVAC system. This variable-speed system saves energy due to being steadier. Another key feature is flash or vapour injection, which allows them to open a shortcut in the refrigerant loop at lower temperatures (McCabe, 2022).

2.2.6 Low-GWP Refrigerant Heat Pumps

Refrigerants (i.e., hydrofluorocarbons (HFCs)) are contributing to global warming to a great extent and global phasedown of HFCs can prevent 0.5°C of warming by 2100. It is very important to replace the refrigerants in existing air conditioners or heat pumps with lower Global Warming Potential (GWP) refrigerants. The replacement substance should have a similar volumetric capacity to provide comparable cooling capacity and similar or higher energy efficiency. R-32 and an HFO (Hydrofluoroolefins) of R-1234yf are some potential low GWP refrigerants for replacing R-410A as they have around 70% lower GWPs than R-410A and they have minor flammability (Bo and Ally, 2020; Bo et al., 2021). Another option is CO_2 heat pumps which use CO_2 as a refrigerant and allows it to achieve 30-40% more efficiency, plus CO_2 is ozone-friendly (Lync by Watts, 2022; Small Planet Supply, n.d.).

2.3 Potential of Heat Pumps in BC

Heat pumps are a key solution for BC municipalities that are aiming to have zero emissions by 2050, and the BC and Canadian governments are encouraging people to make the switch by offering rebates for new heat pumps. If a home is currently using electricity for heating, rebates can be up to $7,000. Rebates can be up to $11,000 if the current heating system uses natural gas, oil, or propane (BC Hydro, 2023b).

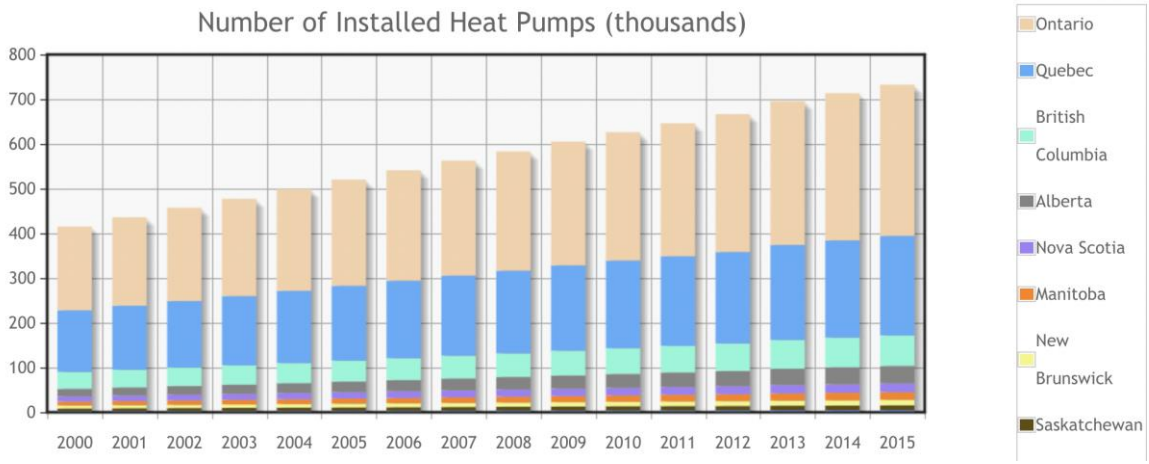

Figure 4. *The increasing number of heat pumps installed in different Canadian provinces between 2000 and 2015 (Canada Energy Regulator, 2018)*

More people are becoming motivated to install heat pumps in their homes and the number is increasing steadily across Canada (Figure 4). With the provincial sales tax (PST) exemption and the launch of new incentives (i.e., Northern Residential Heat Pump Top-up Incentive), heat pumps are becoming more affordable in BC (BC Gov News, 2022). Even so, the number of households switching from natural gas-based heating systems to electric heating systems per year is not enough to achieve our GHG emissions reduction goals.

To meet our 2030 and 2050 GHG emissions reduction goals, it is important that people understand the benefits of using heat pumps, and the ways to motivate them to make the switch to heat pumps should be identified. Information from both heat pump users and non-users can portray the current picture of adopting heat pumps. Thoughts on the benefits of using heat pumps both from users and non-users, challenges in the retrofitting journey from users, and obstacles/barriers for the non-users, can help sustainability and climate action practitioners develop strategies to promote heat pumps more effectively, which will help us meet GHG emissions reduction targets faster.

3. OBJECTIVES OF THE STUDY

The overarching goal of this study is to investigate the current state of heat pump adoption in the Township of Langley to help them meet Big Move 3 of their Climate Action Strategy. The specific objectives are:

i. To develop and administer a resident survey to better understand the current state of heat pump adoption in the Township, learn about the heat pump retrofit journey from those who have switched, and the obstacles/barriers faced by non-users;
ii. To find heat pump owners who would be interested in engaging with Township of Langley staff in the future as part of heat pump case studies or testimonial videos; and
iii. To develop and administer a survey for HVAC contractors to understand the state of heat pump installation from their perspective

4. METHODOLOGY

4.1 Resident Survey Design

A resident survey targeted to be at around 10 minutes in length was designed with the goal of better understanding heat pump adoption in the Township and investigating residents' experience during the heat pump retrofit process. This survey also included questions for the non-heat pump user group to determine their knowledge of heat pumps and the obstacles/barriers to switching to heat pumps. The questionnaire is given in **Appendix A.** The survey questionnaire consisted of four parts. Part 1 included general information regarding residents' current heating and cooling system(s), their satisfaction with the system(s), and their plans for retrofitting. Part 2 contained specific questions for heat pump users including general information about the installed heat pump(s), installation cost, rebates, advantages of using heat pumps, factors that motivated them to switch to heat pumps, and the whole retrofit experience. Heat pump users were also asked if they want to participate in future testimonial videos and case studies.

Part 3 contained questions for residents who do not own a heat pump. It included questions on their knowledge of heat pumps, future installation plans, how they can be motivated to switch, and the obstacles/barriers they experience when considering switching to

a heat pump. Part 4 contained demographic questions such as respondents' neighbourhood, home type, age and size of the home, and age and income of respondents.

4.2 HVAC Survey Design

An additional short (~ 5 minutes) survey was designed for HVAC professionals to determine their experiences with and opinions of heat pumps. This survey included questions about the type of home where they installed most heat pumps, the number of homes they have installed heat pumps in, previous heating sources of those homes, reasons for installing heat pumps, types of heat pumps installed, rebates and electrical service upgrade cost, challenges they face, and their preparedness level for increasing demand. The questionnaire for HVAC contractors is given in **Appendix B.**

4.3 Administering and Marketing Surveys

After the surveys were designed, they were entered into the online survey tool, Survey Monkey. To reach as many people as possible, Township staff led the advertisement of the surveys through its social media channels, print media, in-person advertising, and industry contacts. **Table 2** gives details on the marketing strategies used to advertise the surveys.

Table 2. *Marketing strategies used to advertise the surveys.*

Advertising Type	Advertising Details	Survey(s) Advertised	Date	Reach	Description
In-person advertising	Posters at select stores and HVAC businesses in Langley *(See **Appendix C** for poster)*	Public, HVAC	January 10, 11	~20 businesses	TOL staff visited cafes, stores, and HVAC businesses around Langley and asked them to put up a poster advertising the survey.
	Sandwich boards at TOL Facilities	Public	January 11, 12	Six TOL facilities	TOL staff put out sandwich boards at six TOL facilities.
	Posters at TOL offices	Public	January 11	Civic Facility, Operations Centre	Posters advertising the survey were affixed at the Township of Langley Civic Facility and Operations Centre.
Newspaper advertising	Newspaper ad in two TOL newspapers *(See **Appendix C** for example)*	Public	January 12, 26	Two Langley-area newspapers	A small survey ad was placed in the TOL section of the Langley Advance Times and Aldergrove Star.

Advertising Type	Advertising Details	Survey(s) Advertised	Date	Reach	Description
Social Media	Facebook post (boosted) *(See **Appendix C** for example)*	Public, HVAC	January 10 - 23	Reach: 9,958 Link clicks: 669	Facebook posts advertising the public and HVAC surveys.
	Facebook post	Public	January 25	Reach: 1,442 Link clicks: 14	Facebook posts advertising the public survey.
	Facebook ad (paid) *(See **Appendix C** for example)*	HVAC	January 25 - 31	Reach: 10,460 Link clicks: 138	The Facebook ad targeted specifically HVAC professionals in Langley.
	LinkedIn Post	Public, HVAC	January 11	Reach: 340 Link clicks: 6	LinkedIn post advertising the public and HVAC surveys
	Instagram Post	Public	January 25	Reach: 819	Instagram post advertising the public survey
	Instagram Story *(See **Appendix C** for example)*	Public	January 11	Link clicks: 7	Instagram story advertising the public survey.
	TOL Staff Internal Website Ad	TOL Staff	January 11	Views: 180	Post to TOL staff notifying them of the survey on the internal Hub website.
Tol.ca webpages	Tol.ca/news post	Public, HVAC	January 12	Views: 38	Tol.ca/news advertisement for the surveys (initially appears on the main tol.ca webpage).
	Tol.ca/engagetol	Public, HVAC	January 10	Views: 1,162	The main webpage housing the surveys.
	Tol.ca/climateaction, tol.ca/greenhomes, tol.ca/Greenbuildings banner ad for survey at top of webpages	Public, HVAC	January 11	Unknown	Call-out bubble at the top of multiple tol.ca webpages advertising the surveys.
Email advertising	TOL General ENews	Public	January 13	Subscribers: 4,290	Ad in the Township's monthly E-Newsletter advertising the survey.

Advertising Type	Advertising Details	Survey(s) Advertised	Date	Reach	Description
	TOL Sustainability and Climate ENews	Public	January 31	Subscribers : 910	Ad in the Township's bimonthly Sustainability and Climate E-Newsletter advertising the survey.
	Tourism Langley	Public, HVAC	January 24	Reach: 134	Email to their subscribers advertising the survey.
	Greater Langley Chamber of Commerce	Public, HVAC	January 26	Members: ~1,000	Email to their subscribers advertising the survey.
	Canadian Home Builders' Association – Fraser Valley	Emailed	January	Members: 236; Prospects: 387	The membership list was emailed with the survey three times and the prospect list was emailed twice.
	Empower Me	Emailed	January	Reach: 5,500	Translated ads for the survey were sent to Empower Me's WeChat groups, as well as to their School District 35 contacts and an English language school in the Township.
	Fort Langley Community Association	Public, HVAC	January	Facebook followers: ~1,700 Email list: 500	Included in two newsletters to their email list, and one Facebook post.
	MCABC	HVAC	January	Email list: 9 LinkedIn: 285 reach Twitter: 21 reach	The survey was sent to 9 MCABC members in Langley posted social media accounts (LinkedIn and Twitter)
	TECA	HVAC	January 10	Email list: 40	Email to their subscribers advertising the survey.

For the public survey, the largest increase in recipients came after the first boosted Facebook post. The HVAC survey saw a large increase in participation during a paid Facebook ad from January 25 to 31, but also had modest increases after TOL staff went to home and HVAC businesses and handed out physical posters, and after TECA and MCABC's industry-

focused emails. Overall, three types of in-person advertising, two newspaper advertisements, seven social media posts, five TOL webpages, two TOL E-newsletters, and seven external organizations advertised the survey, reaching over 30,000 people for 3 weeks (some examples of the advertising are shown in **Appendix C**). The survey was open from January 11 to 31, 2023 (21 days). In total, 382 people participated in the public survey, and 36 people participated in the HVAC survey.

4.4 Data Analysis

After survey completion, data was extracted from the Survey Monkey platform for further analysis and reporting. To illustrate the findings, different types of graphs and tables have been prepared. Both quantitative and qualitative analyses were performed, and Microsoft Excel was used to do the analyses. Along with presenting the findings from each question, analyses were carried out to investigate the relationship among different variables. Responses from heat pump users and non-users are described separately and a separate section describes the findings from the HVAC contractors' survey.

Heat pump users were asked to rank eleven reasons that may have influenced their decision to install a heat pump from 'Not important' to 'Very important'. Along with presenting the raw results in a graph, the weighted average rank for each reason was calculated with 'Not important' represented by 1 and 'Very important' represented by 5. The weighted average rank of each factor is illustrated in Figure ES4; the higher the rank, the more influential the reason is.

5. RESULTS OF RESIDENTS' SURVEY

5.1 Demographic Profile of Respondents

Considering an unlimited population, to reach a 95% confidence level that the real value is within ± 5% of the surveyed value, the sample size would need to be 385 based on the following equation (Calculator.net, 2023).

$$n = \frac{z^2 \times \rho(1-\rho)}{\varepsilon^2}$$

Where, n = sample size,
z = z score,
ε = margin of error,
ρ = population proportion (50% if unsure) (Calculator.net, 2023).

In total, 382 residents filled out the survey, which is virtually statistically significant. As the survey was done online and respondents were chosen based on their availability and ease of responding to the survey, it is a non-probability sampling survey (also known as convenience sampling) (Stratton, 2021). It is argued that though there might be possibilities to have biases in this sampling method, it also gathers informative and actionable data, especially with larger sample size.

5.1.1 Location distribution of the respondents

The highest number of respondents (26.0%) reside in the Willoughby-Willowbrook area followed by the Walnut Grove (20.3%) area. 14.7% of respondents reside in the Brookswood-Fernridge community. Only 3.4% of respondents are not from the Township of Langley (Figure 5).

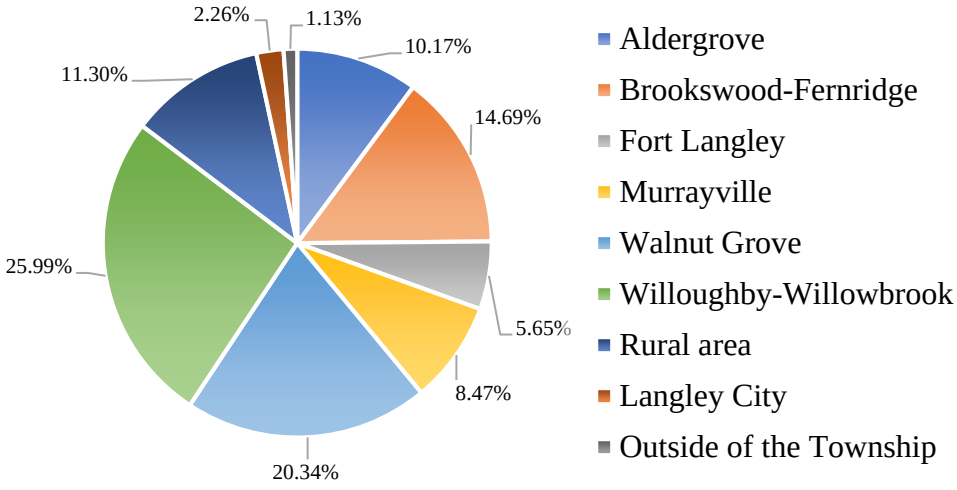

Figure 5. *Location of the respondents' homes in the Township*

5.1.2 Information about respondents' homes

Most of the respondents (72.4%) live in detached/single-family homes. 20.5% of the respondents live in townhouses/row houses (Figure 6). Home sizes range from 550 to 8,000 sq. ft, with a mean of 2405 sq. ft. 36.9% of homes have an area between 1,000 to 2,000 sq. ft and another 34.3% of them are between 2,000 to 3,000 sq. ft. 27.4% of the houses have a larger area ranging from 3,000 to 8,000 sq. ft (Figure 6). 40.8% of these homes are built between 1970 to 1990 and 34.5% are built between 1990 to 2010. Only 1.4% of the homes were built before 1950 and 3.4% were built between 1950 to 1970. 19.8% of the homes were built in or after 2010 (Figure 6).

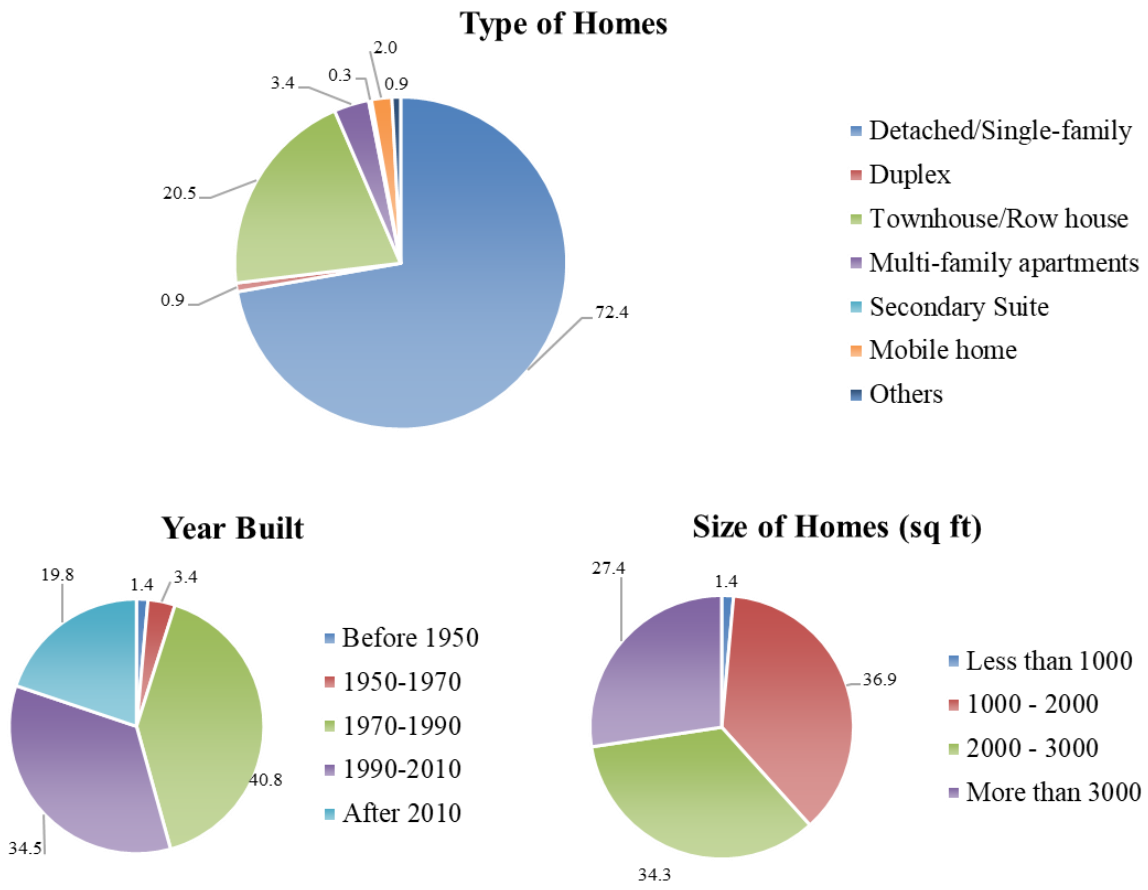

Figure 6. *Distribution of respondents (%) according to the type of homes, year built, and size of homes (sq. ft)*

5.1.3 Age and income distribution of the respondents

Most respondents (29.8%) are older than 65 years, followed by 20.7% between 55 to 64 years old, and 22.4% between 35 to 44 years (Figure 7). The respondents are distributed almost uniformly among different income groups. 23.2% have an annual household income in the range of $100,000 to $150,000, followed by 21.8% making more than $150,000 per year. 17.6% have an annual household income in the range of $50,000 to $100,000. Only 10.2% make less than $50,000 and 27.2% did not disclose their annual household income (Figure 7).

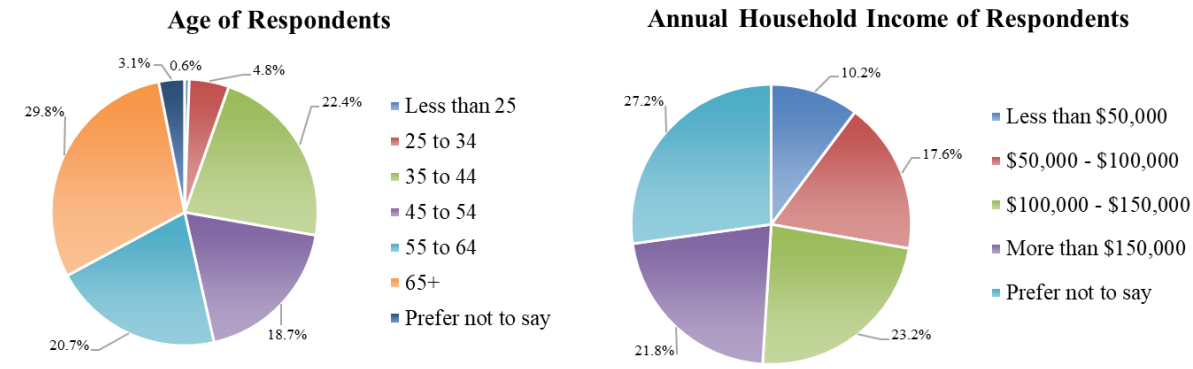

Figure 7. *Distribution of age and annual household income of the respondents*

5.2 Current Heating and Cooling System

5.2.1 Primary heating systems

Most respondents (54.2%) use a natural gas furnace as their primary heating system. 13.6% use an electric heat pump, 13.4% have electric baseboards, and 8.1% have a natural gas boiler in their homes (Figure 8). The respondents also listed natural gas combination on-demand boiler/hot water, combined boiler (gas + electricity), natural gas geothermal, groundwater geothermal, and oil boiler as their primary heating systems. In total, 68.6% of respondents use natural gas as their primary energy source for heating and 30.4% use electricity.

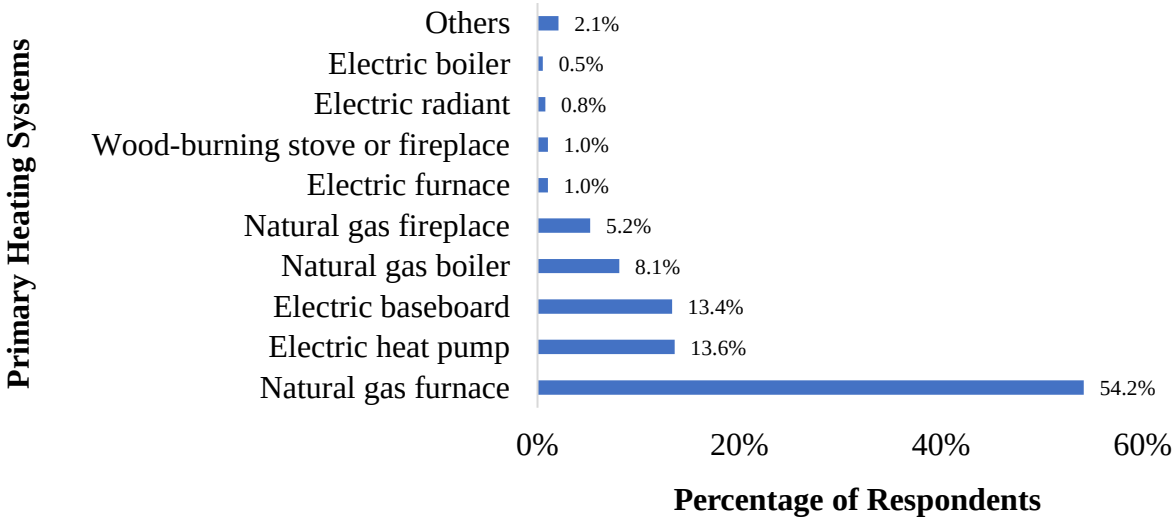

Figure 8*. Primary heating systems in the respondents' homes*

31.2% of respondents' homes have primary heating systems that are less than or equal to 5 years old, whereas 23.8% of them have heating systems that are 6 to 10 years old. 19.6% of respondents mentioned the age of their heating systems in the range of 11 to 15 years old. Around 23.6% of them have a heating system which is more than 16 years old (Figure 9).

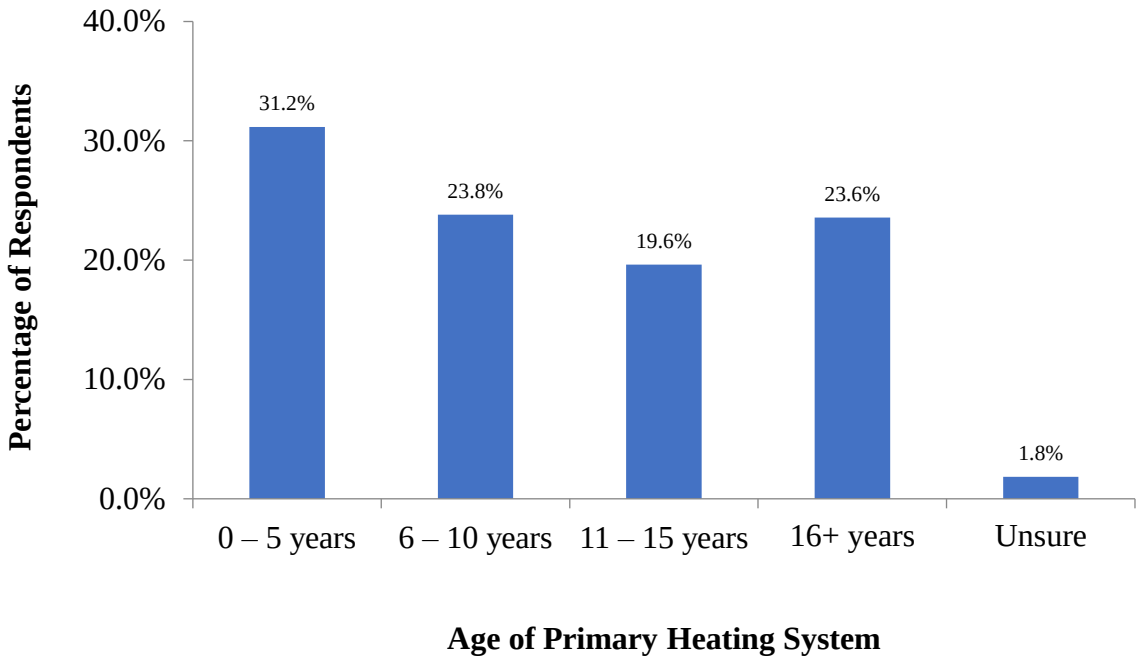

Figure 9*. Distribution of age of primary heating systems of the respondents*

From the age distribution of different natural gas-based heating systems, it can be said that a significant number of natural gas-based systems are very old (16+ years) and might need replacement soon (Figure 10). 23.4% of furnaces, 43.3% of boilers, and 21.1% of fireplaces are more than 16 years old. The relationship between the age of the heating systems and their performances was analyzed and findings are provided in **Appendix D.** Interestingly, most of the natural-gas furnaces (32.7%) and 23.3% of boilers are very new (0 – 5 years old). They may be either a recent replacement of older natural gas-based systems or included in new houses. Among the homes with these newer natural gas-based systems, 18.6% were built in or after 2010, and 12.9% were built within last 5 years. Among the homes using natural gas-based systems as a primary source of heating, 13.8% of the homes are built in or after 2010. Among the homes that were built in or after 2010, around 42% of them have electric baseboards, 21.7% have electric heat pumps, 18.8% have natural gas furnaces, others are using electric radiant, boilers, and furnaces, natural gas boilers and fireplaces.

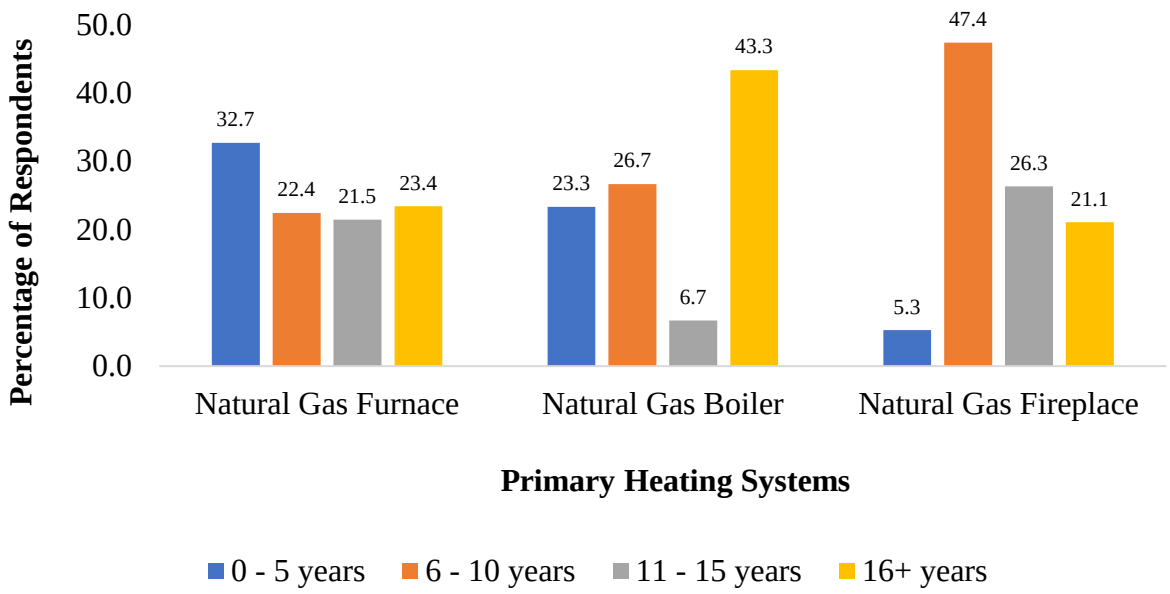

Figure 10. *Distribution of age of different natural gas-based heating systems*

Analysis has been carried out to identify the distribution of heating system types in Township communities and among types of homes. Almost 50% or more respondents from each community are using natural gas furnaces as a primary heating system. Brookswood-Fernridge has the highest proportion of natural gas furnaces as the primary heating system (70.8%) and 65.5% of the Murrayville area's residents are using natural gas furnaces. The highest number (25%) of heat pump users are in the Fort Langley area. 16.3% of Willoughby-Willowbrook homes, 18.3% of Walnut Grove homes, and 12.5% of Brookswood-Fernridge homes have heat pumps as primary heating systems. Usage of other electric systems (i.e., electric baseboards) is higher in the Willoughby-Willowbrook (29.4%) and Aldergrove (22.9%) areas (Figure 11).

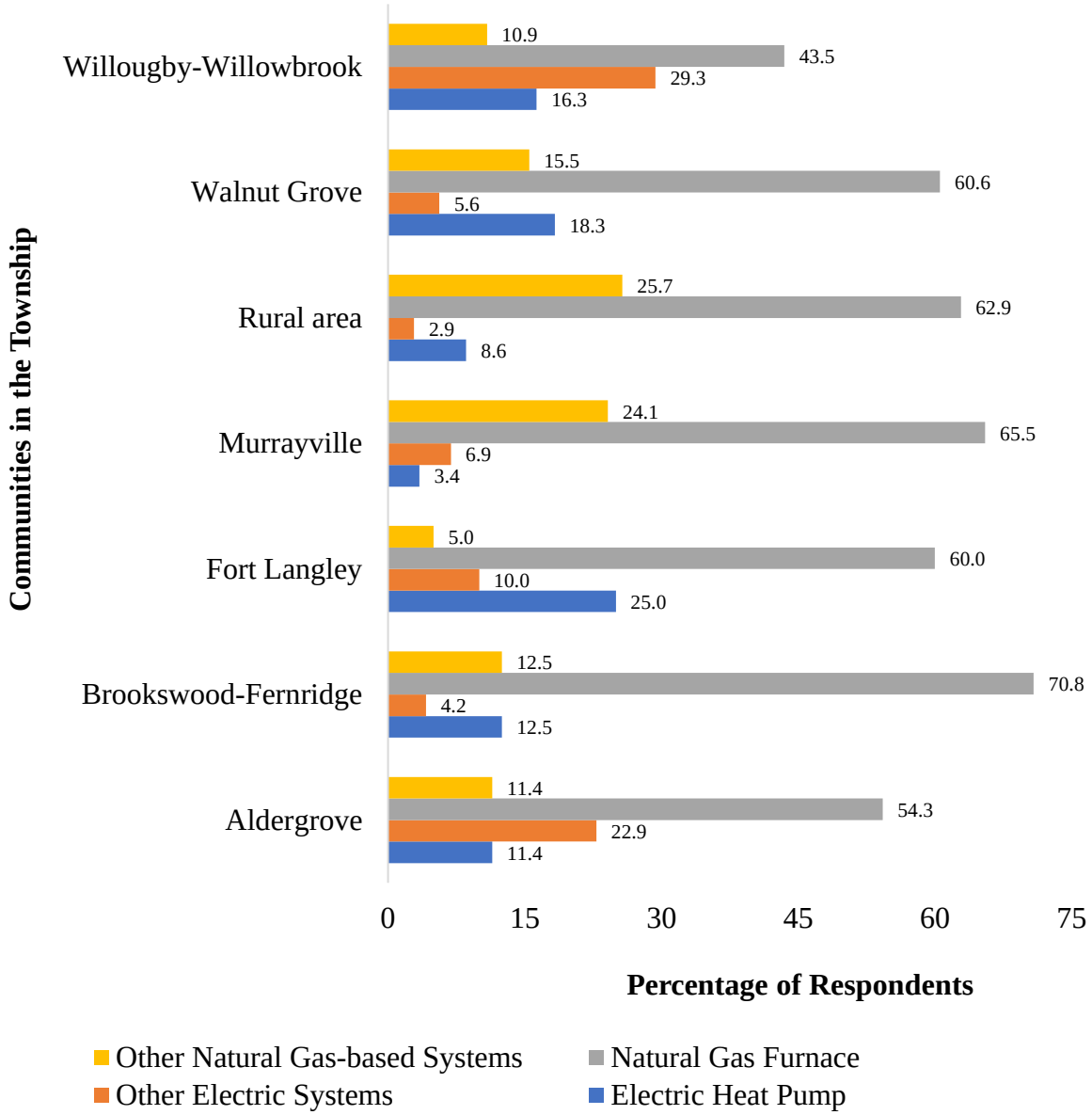

Figure 11. *Distribution of Primary Heating Systems according to different communities in the Township*

Natural gas furnaces are very common in detached/single-family homes (66.1%). Only 13.9% of total detached/single-family homes use electric heat pumps as primary heating systems. In townhouses/row houses, both natural gas furnaces (35.2%) and other electric systems (mostly electric baseboards) (38%) are very commonly used. Only 12.7% of townhouses/row houses have heat pumps as primary heating sources (Figure 12).

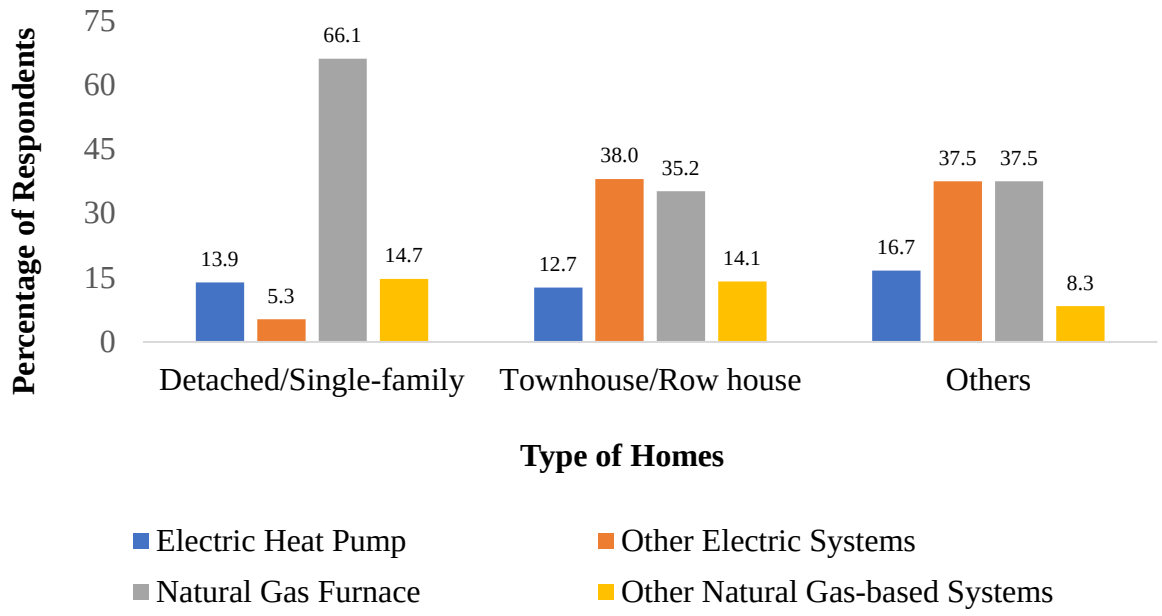

***Figure 12**. Distribution of Primary Heating Systems according to different types of homes in the Township*

5.2.2 Secondary heating system

17.6% of respondents do not have any secondary source of heating. 53.3% use natural gas fireplaces, 21.8% use electric baseboards, 9.4% use natural gas furnaces, and 8.2% use a wood-burning stove or fireplace as a secondary heating system (Figure 13). 36.4% of respondents use both natural gas and electricity for heating. Among this 36.4% of respondents, 64% use natural gas as the primary heating source and electric baseboards or electric heat pumps as secondary heating systems, and the rest of them use electricity as the primary source and natural gas as a secondary. Among the respondents using both natural gas and electricity for heating, 24.5% have heat pumps as primary heating systems but they also have natural gas fireplaces or furnaces as secondary heating systems.

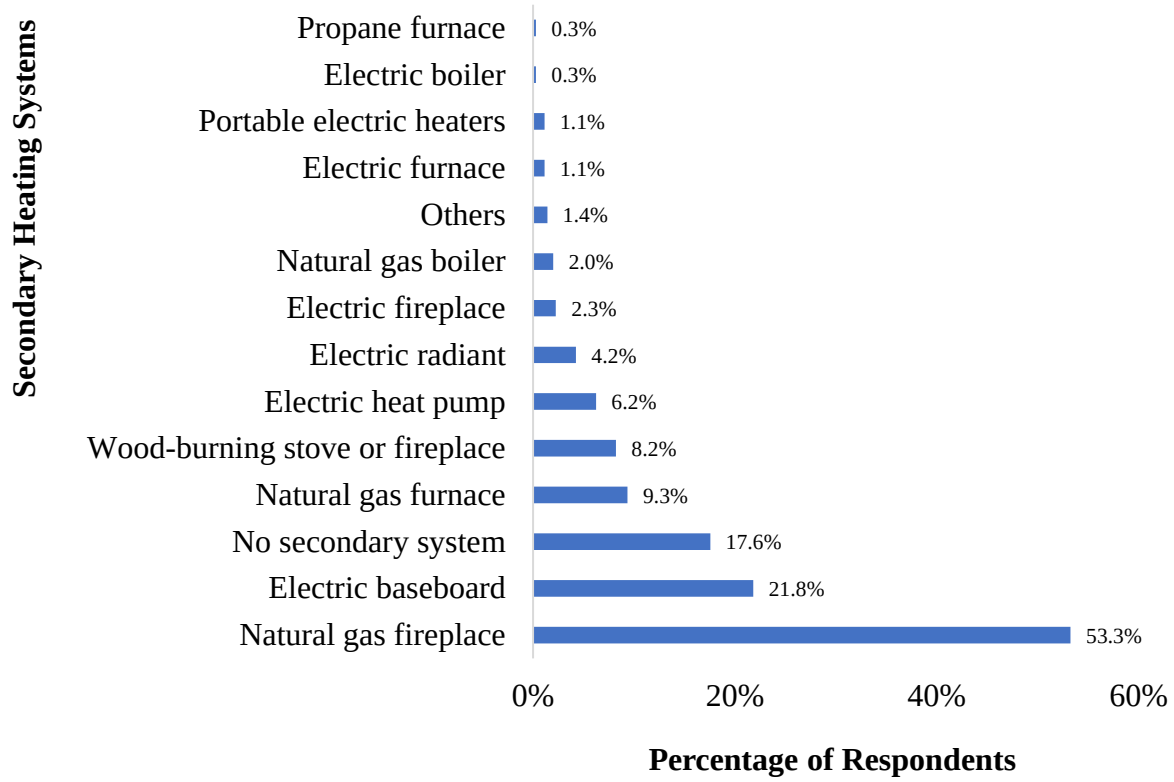

Figure 13. *Secondary heating systems in the respondents' homes*

5.2.3 Cooling system

Considering the historically mild climate, using a cooling system is not that common in Langley and the surrounding area, and 25.1% of respondents do not have any type of cooling system in their homes. 24.1% mentioned using central air conditioners followed by 23.6% using portable air conditioners. 18.9% of respondents use a heat pump as their cooling system (Figure 14).

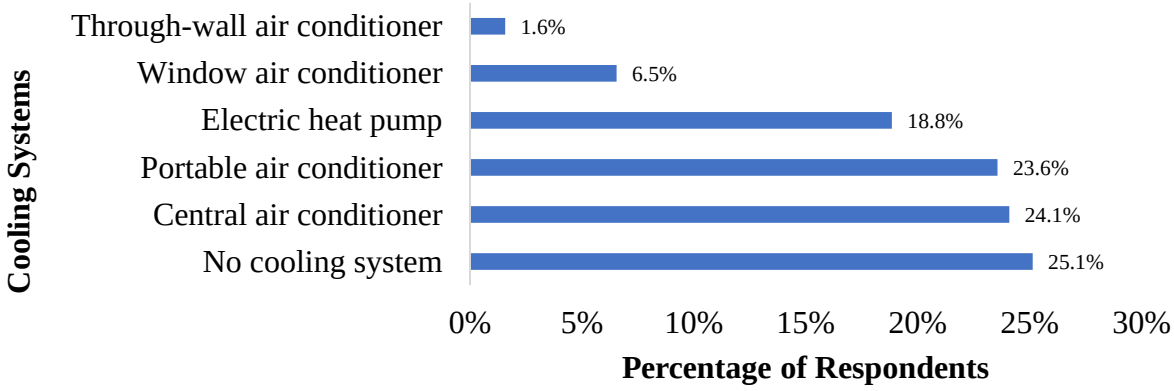

Figure 14*. Cooling systems in the respondents' homes*

5.2.4 Performance of current heating and cooling systems

The respondents were asked to rate their home's performance on a variety of attributes on a scale ranging from very poor to excellent. The attributes examined were how comfortable the indoor temperature is in winter and summer, GHG emissions, and utility costs. For GHG emissions, very poor indicates high emissions and excellent means low emissions. 36.1% of respondents mentioned their heating system performs 'Good' in winter, while 30.6% mentioned 'Excellent' performance. On the other hand, these percentages for 'Good' (24.4%) and 'Excellent' (23.6%) scales decreased slightly for cooling performance in summer likely given that 25.1% of respondents do not have a cooling system installed in their homes. Most people rated their GHG emissions as average (50.5%), with 10.2% believing their home has poor or very poor GHG emissions (high GHGs) and 39.2% believing their home has good or excellent GHG emissions (low GHGs). For utility costs, 31.9% felt they had good or excellent utility costs, 41.6% had average costs, and 26.4% thought they had poor to very poor costs (Figure 15).

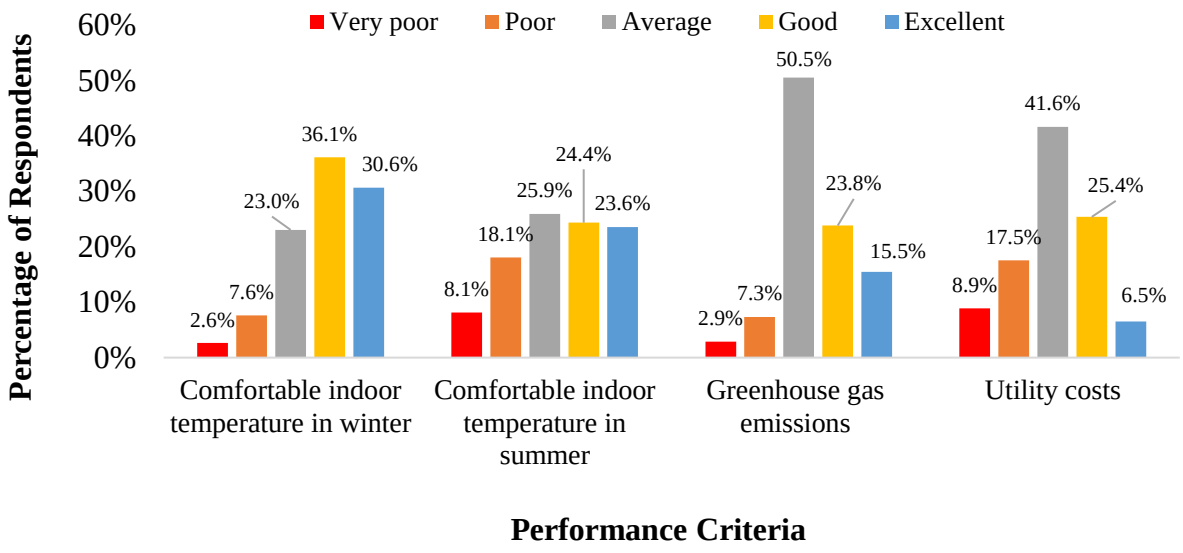

Figure 15. *Respondents' opinions of the performance of their heating and cooling systems*

5.2.4.1 Heating performance of different systems

Analysis was carried out to investigate the respondents' thoughts on the heating performance of natural gas furnaces, electric baseboards, and electric heat pumps according to the respondents who are using these as primary heating systems. 38% of the respondents with electric baseboards selected 'Average' heating performance, while 18% said 'Good' and 4% said 'Excellent'. Natural gas furnace users are generally satisfied with their system as 43% of

them selected ‘Good’ and around 30% selected ‘Excellent’ performance during winter. Electric heat pumps have slightly better performance than natural gas furnaces and significantly better performance than electric baseboard heaters in winter since 47.1% of heat pumps users mentioned ‘Excellent’ and 33.3% of them mentioned ‘Good’ performance (Figure 16).

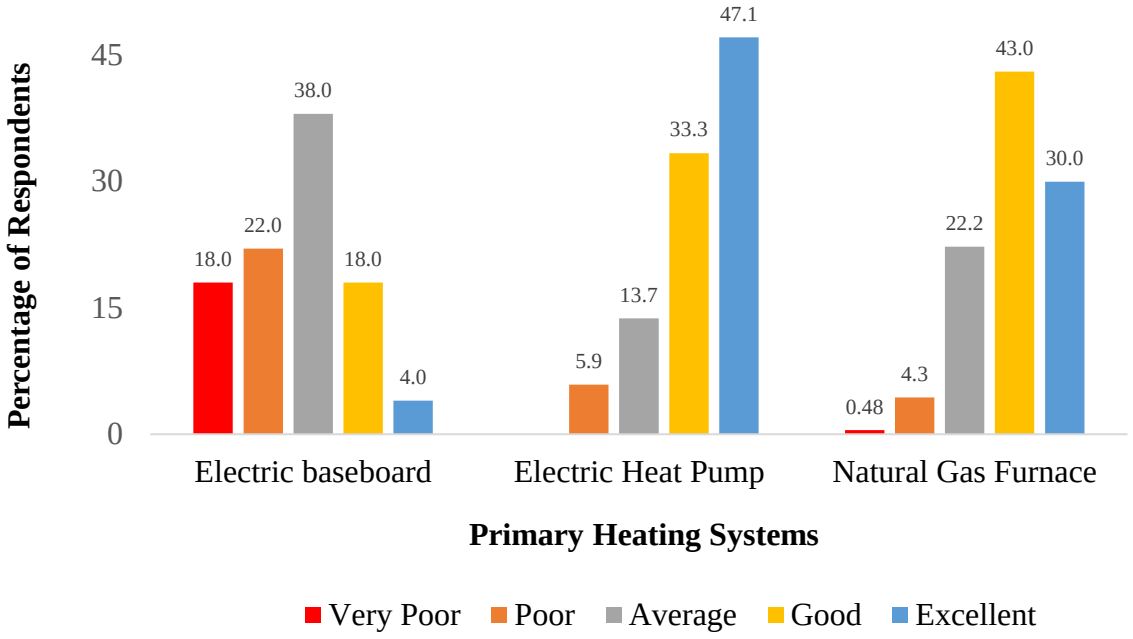

Figure 16. *Heating performance of electric baseboard, electric heat pump, and natural gas furnace as primary heating system*

5.2.4.2 Cooling performance of different systems

Analysis was carried out to investigate the cooling performance of different systems like central air conditioners, window air conditioners, portable air conditioners, and electric heat pumps compared to no cooling system. The central air conditioner and electric heat pump received the most ‘Good’ and ‘Excellent’ responses. 46.7% and 49.3% of total users selected ‘Excellent’ for central air conditioner and electric heat pump, respectively. 39.1% and 32.4% of respondents selected ‘Good’ for them respectively. On the other hand, window (36%) and portable (35.6%) air conditioners along with no cooling system (42.7%) received the ‘Average’ response mainly. 37.8% of portable air conditioner users responded with ‘Poor’ performance for the system in the summer season (Figure 17).

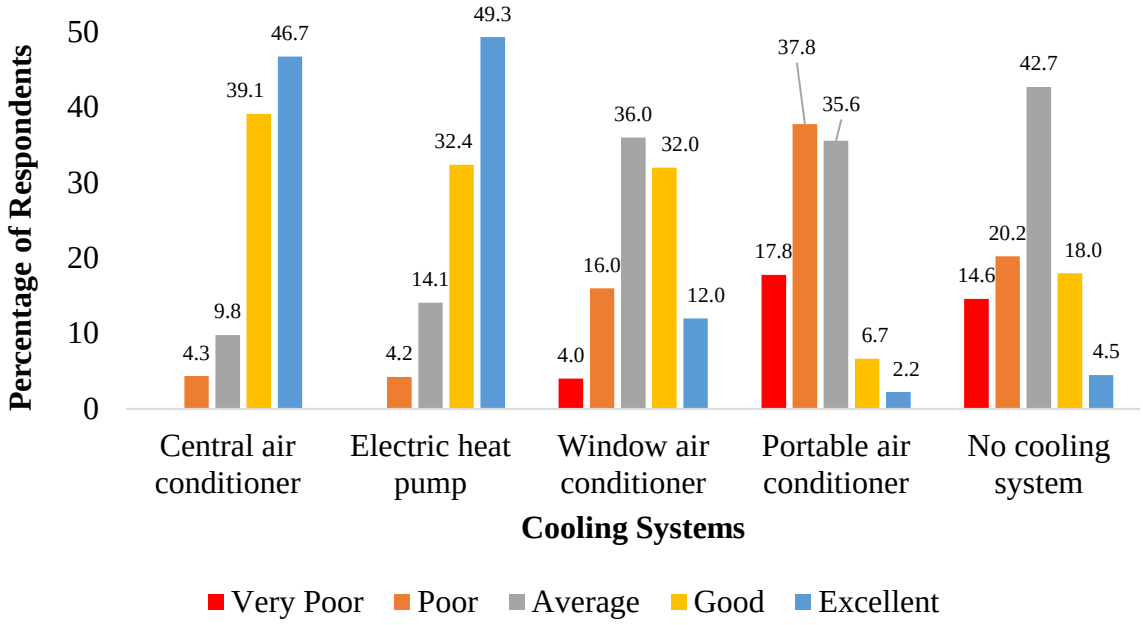

Figure 17. *Cooling performance of central air conditioner, electric heat pump, window air conditioner, and portable air conditioner, and no cooling system*

Analysis was also carried out to find out the distribution of the 'No Cooling System' among different communities (Figure 18). The highest number (28%) of respondents with 'No Cooling System' reside in the Willoughby-Willowbrook community followed by 17.1% in the Brookswood-Fernridge community. Fort Langley (4.7%) has the lowest number of respondents without a cooling system. Respondents from the Fort Langley community use central air conditioners (20%), electric heat pumps (35%), and portable air conditioners (20%).

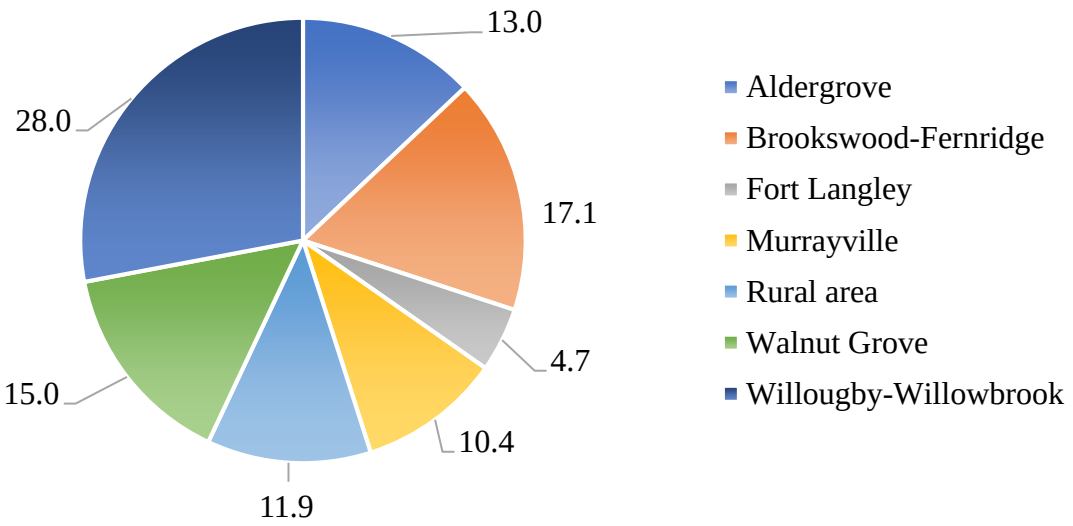

Figure 18. *Distribution of respondents with no cooling system in Township communities*

5.2.4.3 Respondents' opinions of GHG emissions from natural gas vs electric heating systems

Respondents' opinions of GHG emissions from different electric and natural gas-based primary heating systems have been analyzed. 28.2% of electric system users responded 'Excellent' GHG performance (i.e., low GHGs), 27.3% selected 'Good', and 32.7% selected 'Average'. Respondents believed that natural gas-based systems perform 'Average' (58.9%) regarding GHG emissions and 31.8% selected 'Good' or 'Excellent'. Interestingly, only 7.8% and 1.6% of respondents believe that natural gas-based heating systems have 'Poor' and 'Very poor' performances in terms of GHG emissions whereas, in reality, natural gas heating systems have the highest GHG emissions out of common heating systems in Langley. On the other hand, 7.3% and 4.5% have rated electric systems as 'Poor' and 'Very poor' in terms of GHG emissions, which shows that some residents do not understand how GHG emissions from electricity are compared to natural gas (Figure 19).

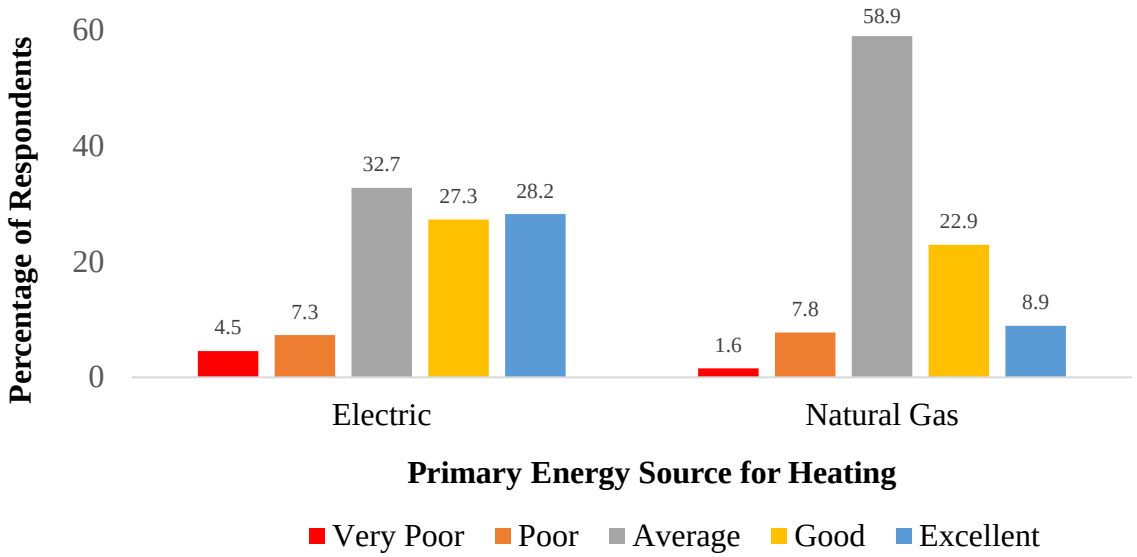

Figure 19. *Respondents' opinions of GHG emissions from electric and natural gas-based primary heating systems (poor = high GHGs, good = low GHGs)*

5.2.4.4 Respondent's opinions of utility costs associated with different systems

Respondents' opinions of utility costs depend on the condition of the primary heating system, the building envelope, and whether it is electric or natural gas based. From the analysis, electric heat pump users felt they had the best (i.e., lowest) utility costs. 47.1% and 17.7% of heat pump users listed it as having 'Good' and 'Excellent' utility costs. On the other hand, most of the respondents selected the 'Average' utility cost for the natural gas boiler (51.6%), natural

gas fireplace (55%), and natural gas furnace (49.8%). 26.1% of natural gas furnace users responded with 'Good' utility cost. Electric baseboards have 'Very Poor' (34%) and 'Poor' (26%) utility costs pointed out by the users (Figure 20).

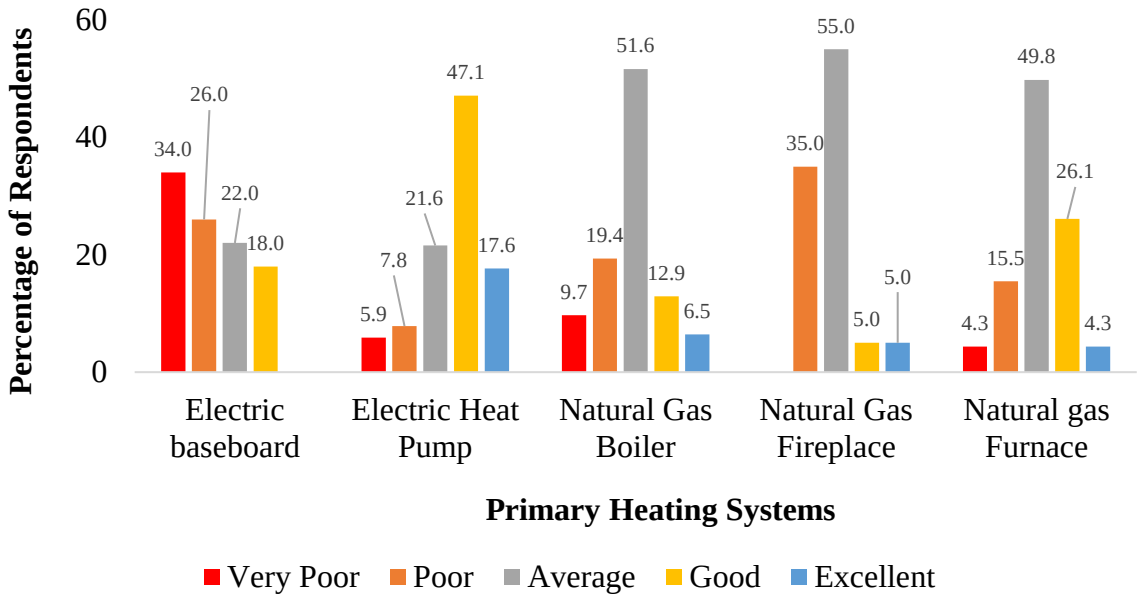

Figure 20. *Respondents' opinions of their electric and natural gas-based primary heating systems' utility costs*

5.2.5 Plan for retrofitting

8.9% of total respondents said that they have plans to replace/upgrade their homes' heating/cooling systems in the next year. The majority (71.5%) of respondents do not have any plans and the other 19.6% were unsure. Additional analyses were carried out to investigate the relationship between having a retrofitting plan and the demographic profile (annual household income, age, community) of respondents and findings are given in **Appendix D.**

5.2.5.1 Preferences for financing options for retrofitting

Retrofit plans are mostly driven by economic factors and the availability of different financing options like rebates, credit cards, and payment plans. Respondents were asked about their preferences for different financing options. 31.4% of them have plans to retrofit using their savings and 21.0% are looking for rebate options. 15.2% prefer a line of credit or credit cards and 21.5% are not sure about their financial plans (Figure 21). People who have plans to replace their system next year have selected rebates (25%), lines of credit or credit cards (17.7%), and savings (20.8%) (Figure 22).

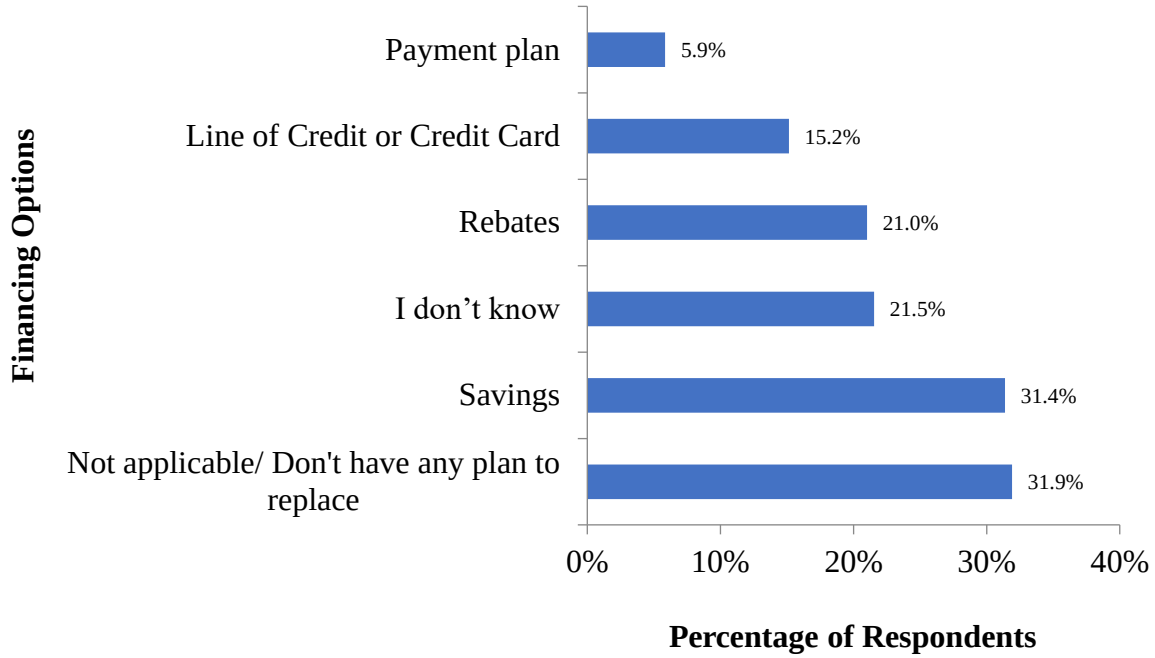

Figure 21. *Responses for different financial plans to replace current heating systems*

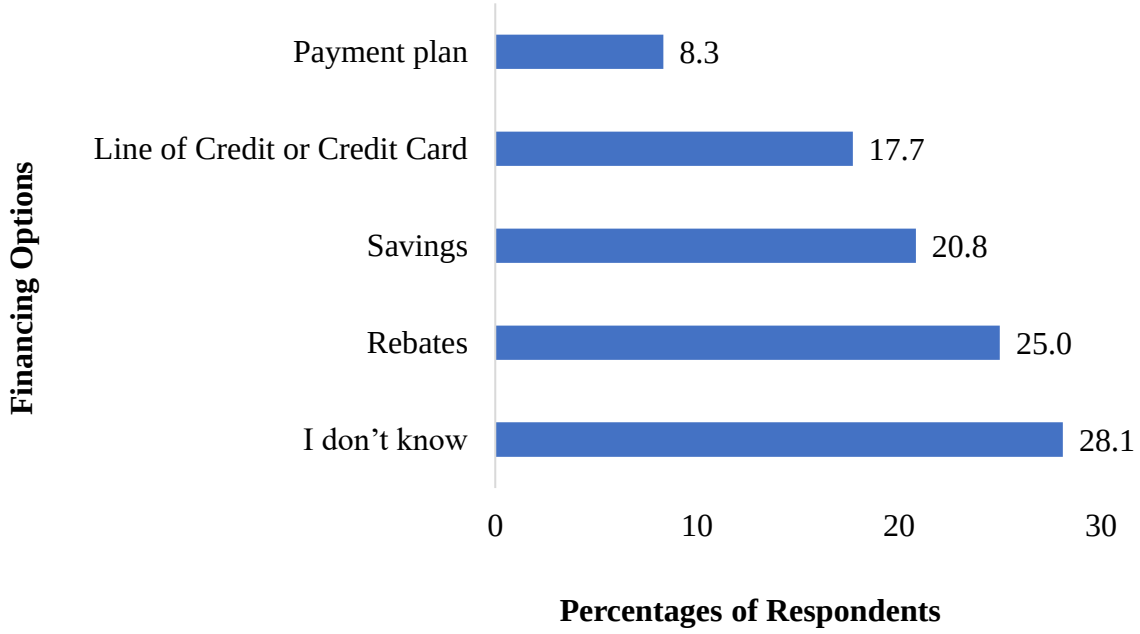

Figure 22. *Responses for different financial plans to replace current heating systems according to the respondents who have plans for next year*

5.2.5.2 <u>Retrofitting plans and current primary heating systems</u>

89.8% of respondents with natural gas furnaces do not have retrofit plans for next year, which can have negative impacts on the pathway of achieving climate action goals. 84.6% of respondents with other natural gas-based heating systems also do not have any plan to replace

in next year (Figure 23). People with older systems (23.2%) are more interested in retrofitting than people with newer systems (83.2% selected no) (Figure 24).

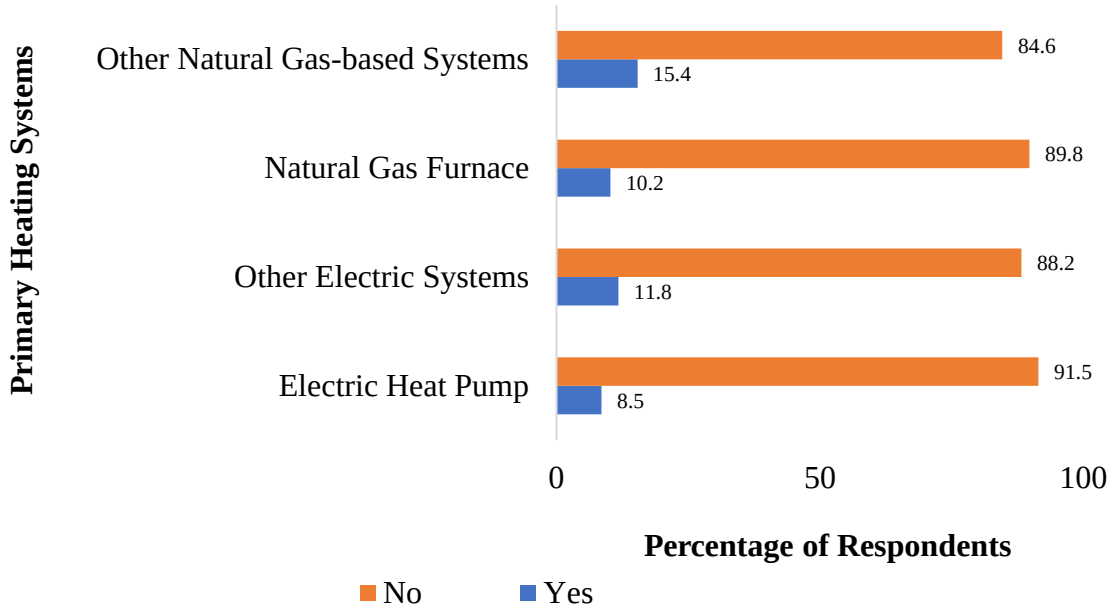

Figure 23. *Primary heating systems of the respondents and their responses for upgrading the systems in the next year*

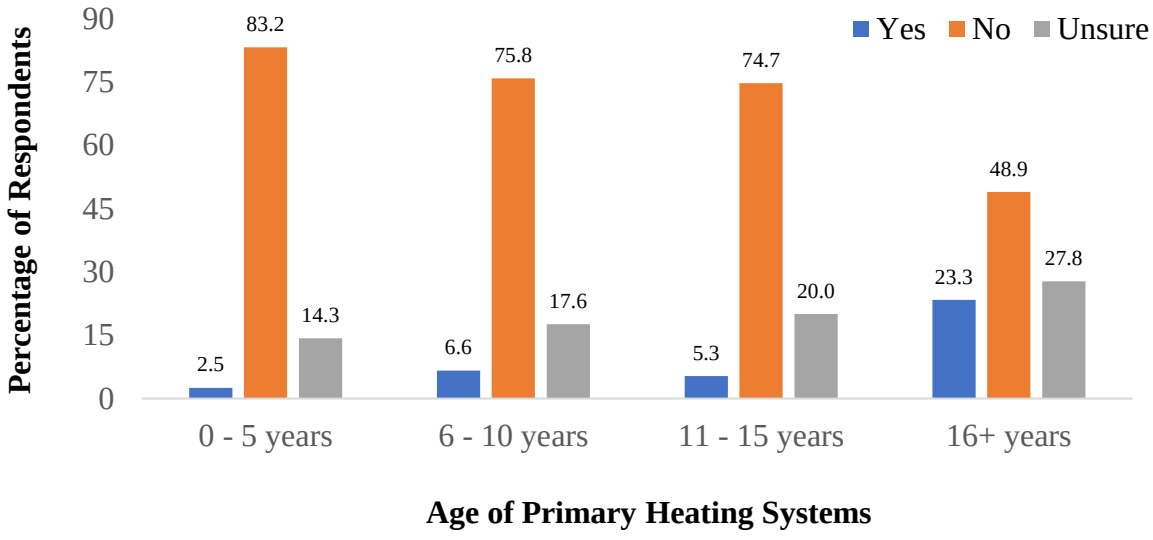

Figure 24. *Ages of primary heating systems and respondents' plans for upgrading the systems in the next year*

5.3 Responses of Heat Pump Users

Among 382 respondents, 79 (20.7%) respondents are currently using electric heat pumps. Heat pump users were asked about the type of heat pump they are using and what their benefits

are. There were questions about different aspects of heat pump installation and their whole retrofit journey. The following sections show the results and analysis of heat pump users' responses.

5.3.1 Information regarding the installation of heat pumps

Respondents were asked whether they installed the heat pump, or if it was there when they moved in. 75.3% of respondents stated the heat pump had been installed since they moved in, while 24.7% stated the heat pump was already in the home. The following sections contain information related to the installation experience of heat pumps for that 75.3% of users, to better understand the retrofit process.

5.3.1.1 Types of heat pumps and their performances

Central heat pumps are the most common heat pump type among the respondents from the Township (70.1%). 16.9% of respondents use multi-split heat pumps which have two or more heads and 7.8% use mini-split heat pumps with only one head. There are also some responses for air-to-water hydronic heat pumps (1.3%), combination air and hot water heat pump (1.3%), ground-source or geothermal heat pump (2.6%), and 2.6% of respondents are unsure about the type (Figure 25). Most heat pumps (48%) were installed between 2016 and 2022. 34.7% of heat pump users installed them between 2010 to 2015. The remaining 17.3% were installed before 2010 but after 2002.

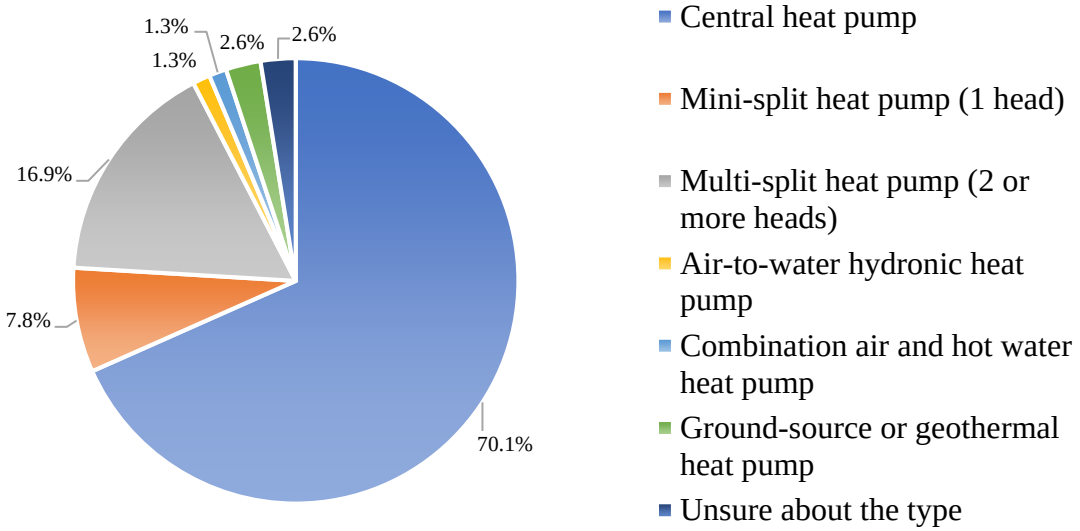

Figure 25. *Distribution of types of heat pumps in respondents' homes*

The heating and cooling performances of these heat pumps were analyzed based on the ratings provided by the users. Most of them rated their heat pumps either 'Good' or 'Excellent'

both for heating and cooling (Figure 26). 44.4% and 38.9% of central heat pump users rated it 'Good' and 'Excellent' in heating respectively. 66.7% of mini-split users and 53.9% of multi-split users responded 'Excellent' for the heating performance. Cooling performances of these heat pumps are also rated as 'Good' or 'Excellent'. 48.2% and 38.9% of central heat pump users mentioned 'Excellent' and 'Good' cooling performance respectively. Mini and multi-spilt heat pumps' cooling performances are 'Excellent' according to 50% and 61.5% of their users respectively (Figure 26).

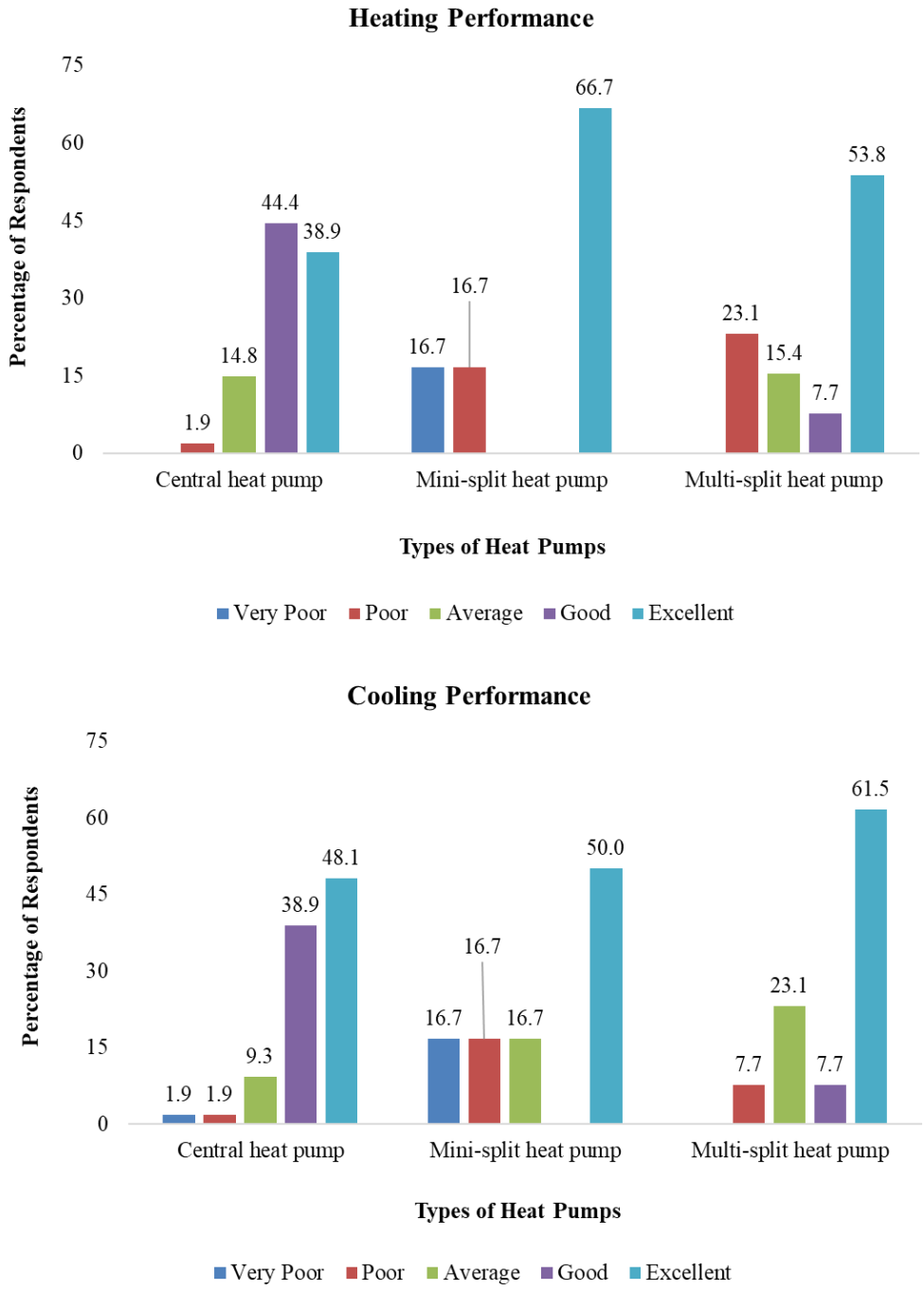

Figure 26. *Heating and cooling performance of different types of heat pumps*

5.3.1.2 Relationship between economic aspects and other factors

Installation costs and other aspects

Installation costs varied widely, and most respondents (35.2%) spent between $5,000 to $10,000. 25.9% paid in the range of $11,000 to $15,000 and 22.2% spent more than $15,000. 16.7% of heat pump users spent less than $5,000 (Figure 27).

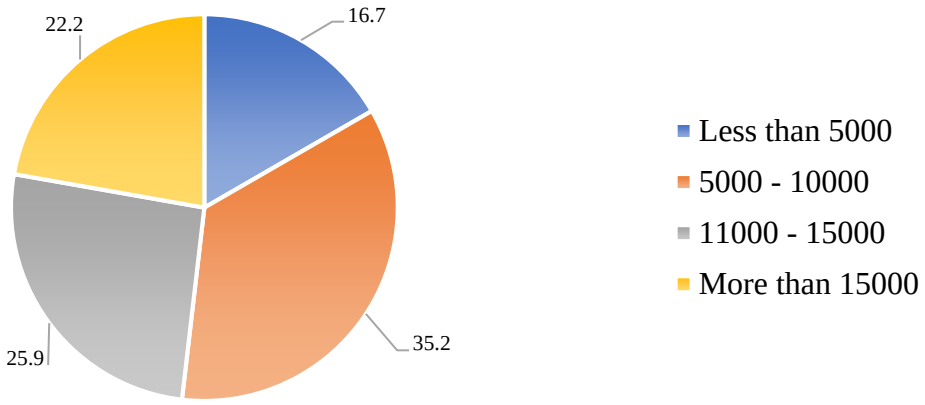

Figure 27. *Distribution of installation costs of heat pumps*

Installation costs may vary based on installation period, home type, year built, and size of home. Analysis revealed that newer systems required greater installation costs. 39.3% of heat pumps installed within the last 5 years had an installation cost between $11,000 to $15,000 and 39.3% costed more than $15,000. Heat pumps installed more than 15 years ago had lesser installation costs. 80% of the older heat pumps were between $5000 and $10000, and 20% were less than $5000 (Figure 28).

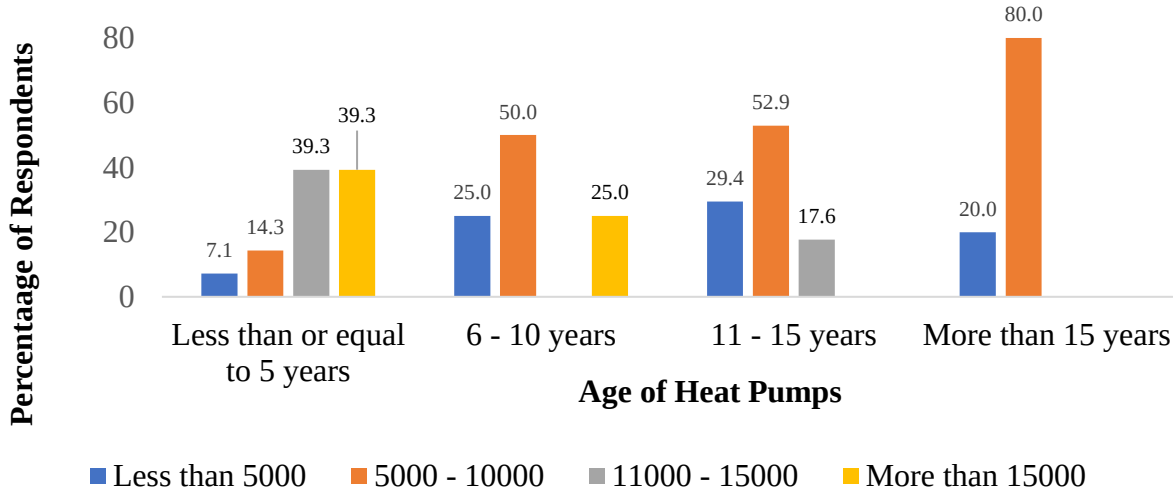

Figure 28. *Relationship between installation costs and age of heat pumps*

Installation costs vary widely for single-family homes, ranging from under $5,000 to over $15,000. 37.2% of the single-family houses spent between $5,000 and $10,000. 25.6% of these homes needed more than $15,000 to install heat pumps. For townhouses/row houses, they spent mostly (66.7%) between $11,000 to $15,000. 11.1% of the total townhouses/row houses paid over $15,000 for heat pump installation (Figure 29).

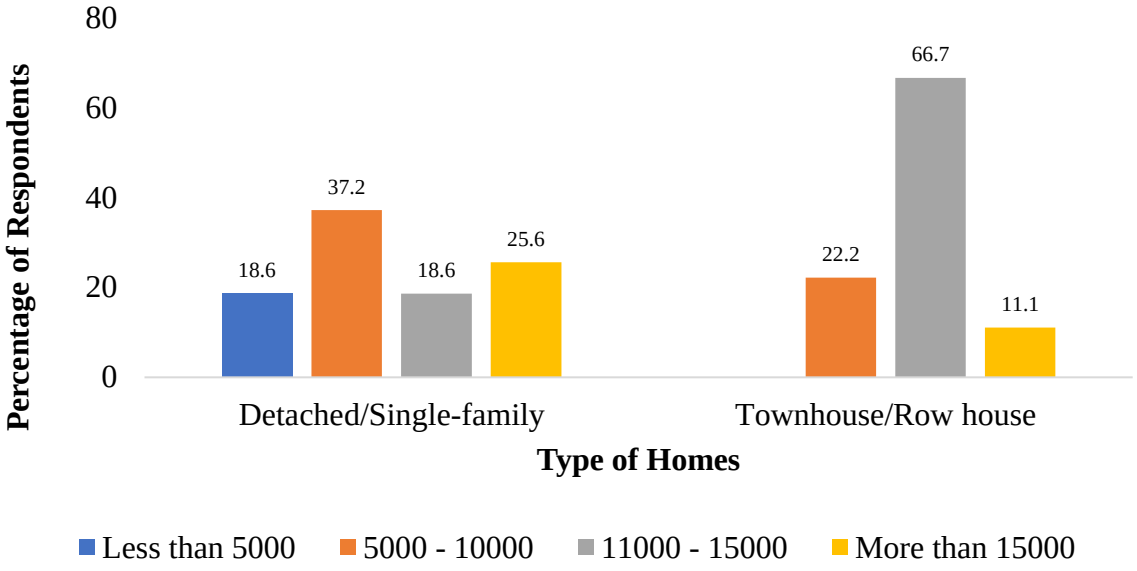

Figure 29. *Relationship between installation costs and type of homes*

For older homes that were built between 1950 to 1970, respondents generally spent more than $15,000 (50%). For newer homes that were built after 2010, installation costs were less. Only 12.5% of them spent more than $15,000 on installing heat pumps (Figure 30). The relationship between installation cost and home size was also explored, but there is no obvious pattern (Figure 31).

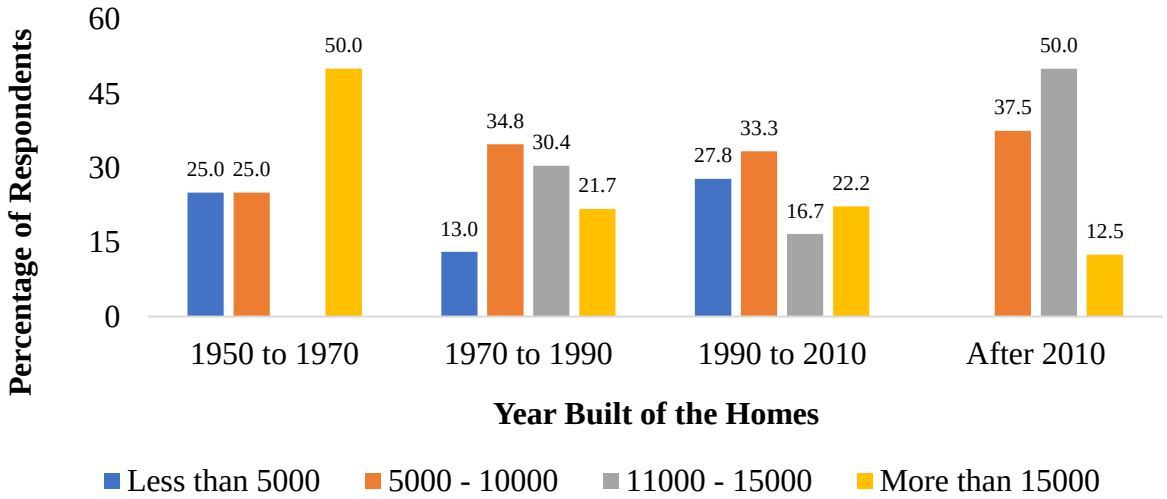

Figure 30. *Relationship between installation costs and year built of the homes*

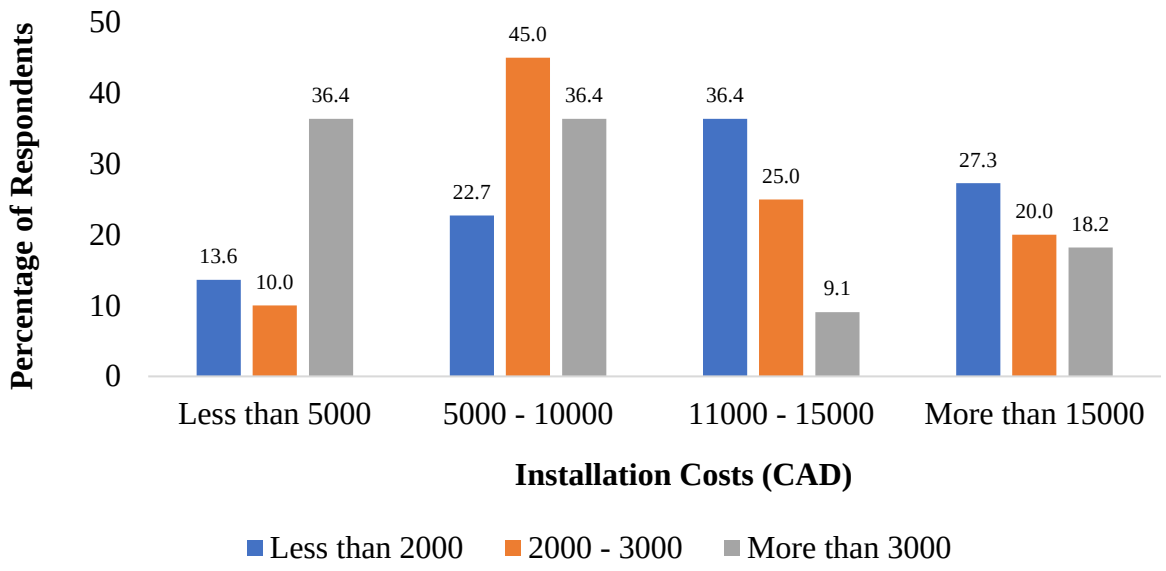

Figure 31. *Relationship between installation costs and sizes of the homes (sq. ft)*

The relationship between the installation period of heat pumps and their performances in terms of heating, cooling, GHG emissions, and utility costs was investigated, and the findings are illustrated in **Appendix D.**

Electrical service upgrade and other aspects

71.4% of heat pump users did not need an electrical service upgrade when installing a heat pump and 8.9% of them were unsure about this (Figure 32). 19.6% of them needed an electrical service upgrade and they paid between $150 to $6,000 for the upgrade. Analyses were carried out to relate the electrical service upgrade scenario with the type of home, size of the home, and year built of home (Figure 32). Among all the houses that needed an electrical service upgrade, 81.8% were detached/single-family houses, and the rest of them (18.2%) were townhouses/row houses. Considering the size of the homes, 45.5% of the houses between 2000 and 3000 sq. ft needed an electrical service upgrade and 36.4% of the house with an area less than 2000 sq. ft also needed an electrical service upgrade. Many older homes built between 1970 and 1990 needed an upgrade (54.5%), compared to 18.2% of newer homes built after 2010.

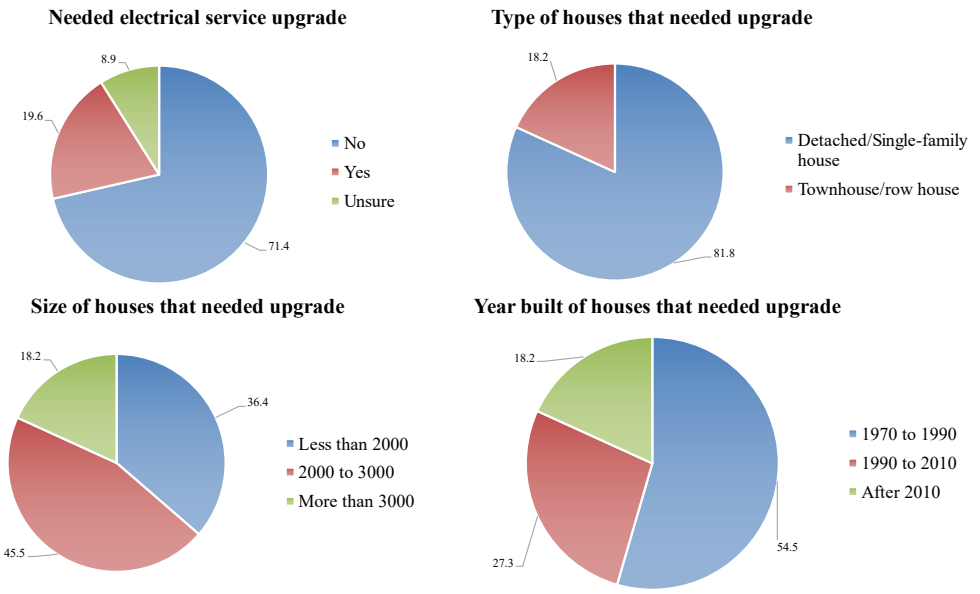

Figure 32. *Relationship between electrical service upgrade and demographic variables*

Rebates and other aspects

Respondents were asked about the rebate programs they accessed when installing a heat pump. 35.7% of them did not access any rebates and 12.5% were unsure. Respondents used both provincial (26.8%) and federal (28.6%) rebates along with BC Hydro (25%) and FortisBC (10.7%) rebates (Figure 33). One mentioned that their builder/installer took their rebate and another one added that there was no rebate at that time. One of the respondents mentioned having problems with the Canada Greener Homes program and waited more than 7 months for rebates.

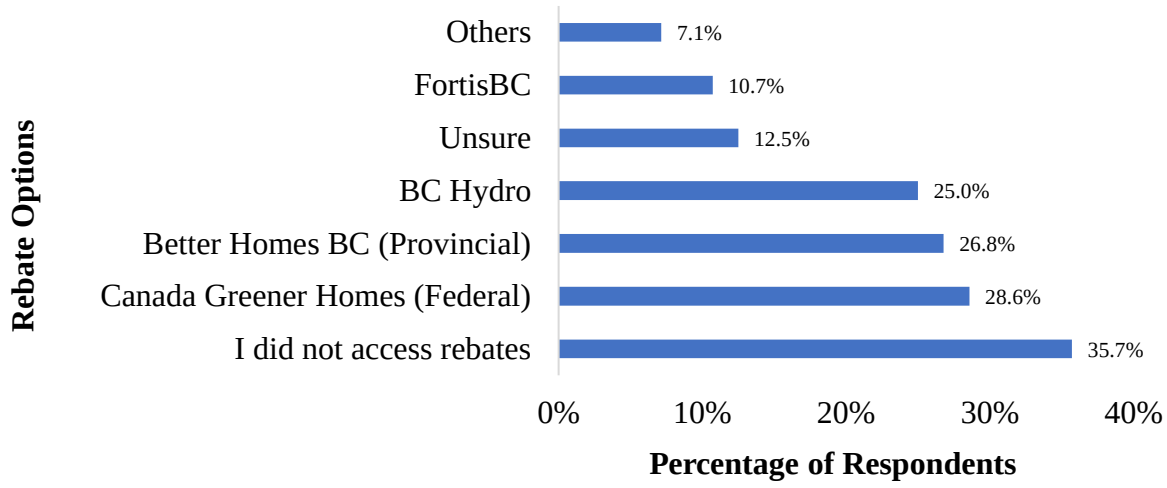

Figure 33. *Percentage of respondents who accessed different rebate options while installing a heat pump*

Among the respondents who accessed a rebate, 76.7% live in a detached/single-family house and the rest of them (23.3%) live in a townhouse/row house. Among the rebate recipients, 36.7% have an annual household income of more than $150,000, and 16.7% have an income between $100,000 and $150,000. 36.7% did not mention their income and only 3.3% and 6.7% have an income between $50,000 and $100,000, and less than $50,000 respectively (Figure 34).

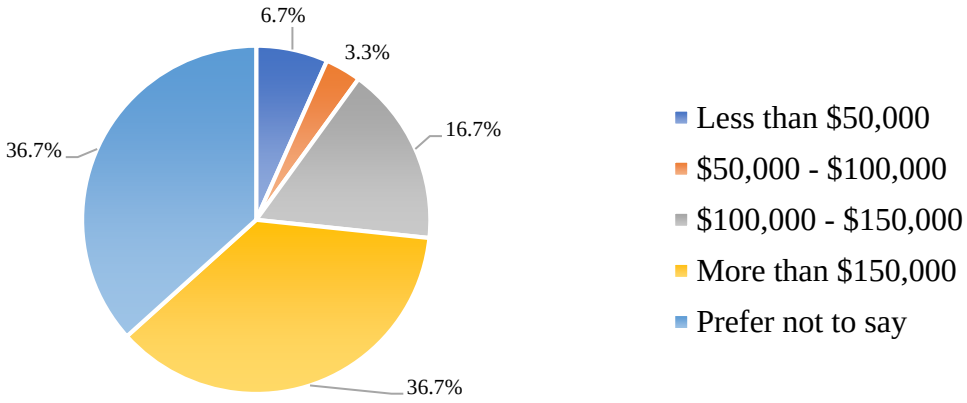

Figure 34. *Annual household income distribution of the respondents who accessed rebates*

5.3.2 Relative merits of using heat pumps

Before installing heat pumps, 87.3% of respondents did not have a cooling system. The addition of cooling systems is one of the main advantages of using heat pumps. The majority of heat pump users responded that their utility bills have decreased either significantly (16.4%) or slightly (43.6%) since installing a heat pump. Only 12.7% did not notice any change in the utility bills. On the other hand, some of the heat pump users noticed that their utility bills increased slightly (10.9%) or significantly (16.4%) (Figure 35).

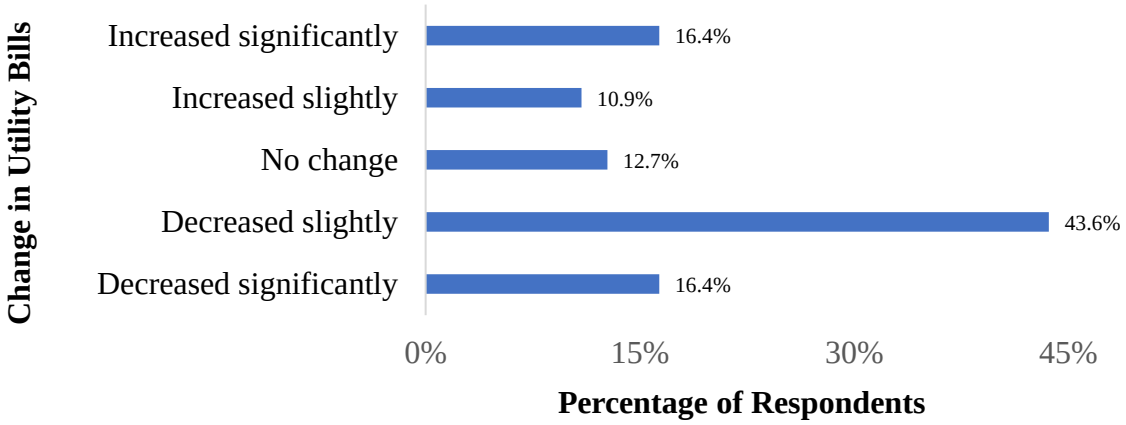

Figure 35. *Change in utility bills noticed by respondents after installing heat pumps*

47.3% of the respondents rated the overall performance of the heat pump 'Much better' compared to the previous heating system and 25.5% rated it 'Better'. Only 14.6% rated 'Worse' and 1.8% rated 'Much worse'. 10.9% of them did not see any difference between the previous heating systems and heat pumps (Figure 36).

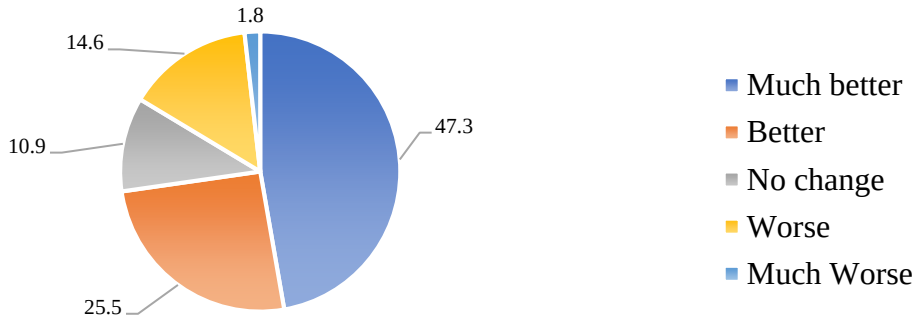

Figure 36. *Overall performance of heat pumps according to users compared to their previous heating systems*

According to heat pump users, heat pumps reduce energy bills (33.3%), improve thermal comfort (38.9%), reduce GHG emissions (38.9%), add cooling (66.7%), improve air quality (22.2%), and increase the home value (33.3%) compared to their previous heating systems (Figure 37). Heat pump users were asked about their opinion on the disadvantages of using heat pumps in an open-ended question. Only 18 heat pump users answered that question and 12 of them mentioned no disadvantage. Very few respondents added some disadvantages they have experienced while using heat pumps such as in very cold temperatures heat pumps are insufficient and a second heating source is needed (2 users); in wet climates, it does not dry the air like a furnace (1 user); and it is very expensive to operate and repair (2 users).

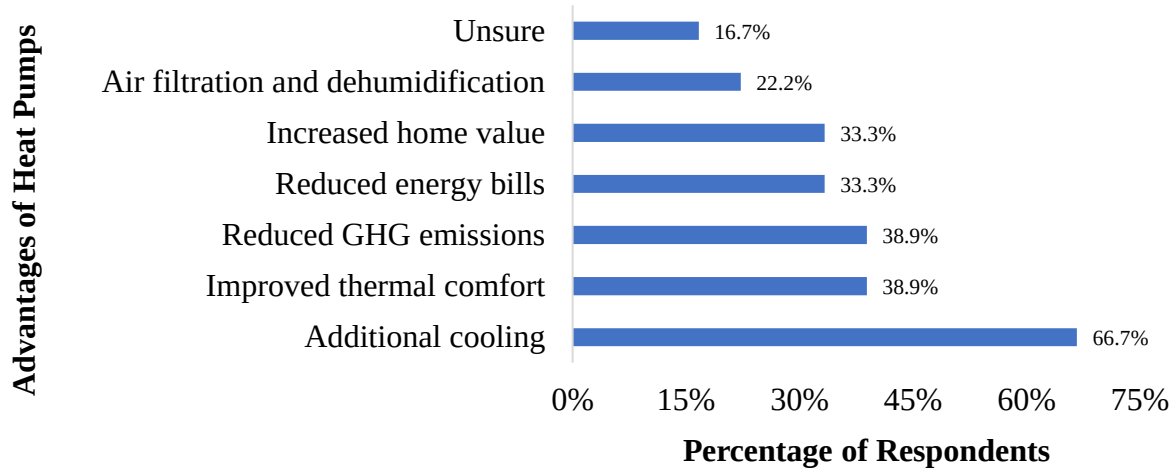

Figure 37. *Advantages of using heat pumps according to users*

5.3.3 *Factors/reasons for upgrading to heat pumps*

Heat pump users were asked to rank eleven potential reasons why they upgraded to a heat pump on a scale ranging from 'Very important' to 'Not important'. Air conditioning/cooling benefits got the highest (72.7%) response as 'Very important', and improved home's thermal comfort got 54.6% responses as 'Very important' factor. 40% and 30.9% selected reducing energy bills and reliability/cost-effectiveness of heat pumps as 'Very important' factors respectively (Figure 38). 65.5% and 56.4% of them responded 'Not important' for the previous heating system broke down and fear of imminent breakdown of previous heating system options respectively (Figure 38).

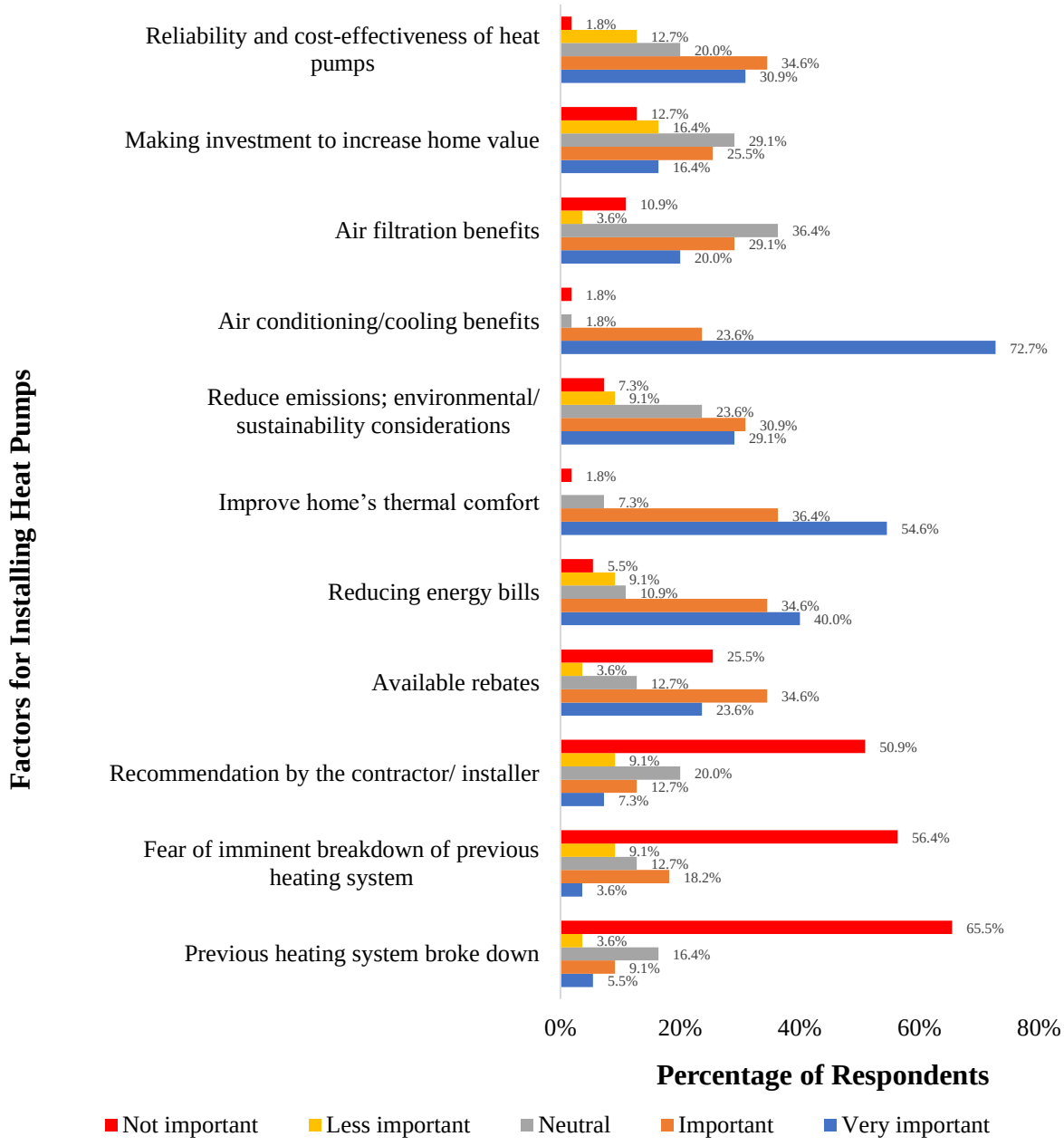

Figure 38. *Importance of different factors for installing heat pumps*

An open-ended question regarding other important factors for installing heat pumps collected some useful thoughts from the respondents. Most of their thoughts are driven by economic factors (i.e., operational cost) followed by thermal comfort (i.e., keeping manageable temperatures during the summer months). A couple of respondents mentioned that heat pumps are not that efficient for very low temperatures, and they use a furnace as a backup on colder winter days. A few people are concerned about the noise it makes which can make the neighbours complain.

5.3.4 Retrofitting experiences

43.6% of heat pump users had 'Satisfactory' and 10.9% had 'Highly satisfactory' overall experiences from researching heating/cooling system options to the end of the heat pump installation process. Only 5.5% of them had an 'Unsatisfactory' experience with 40% of them having 'Neutral' feelings (Figure 39).

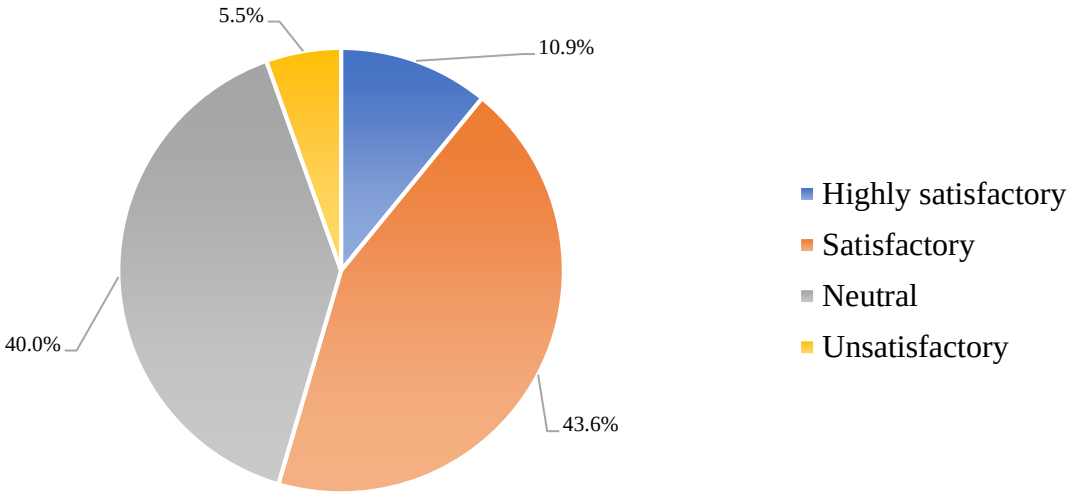

Figure 39. *Overall retrofitting experience of heat pump users*

Respondents were also asked to list the challenges they faced during retrofitting. 43.6% of them did not face any challenges during the whole process. 27.3% mentioned having difficulties with the rebate process as this was too much work or too confusing for them. Among the users who said the rebate process was too much work, 44.4% accessed rebates. Besides, among the users who said there was a lack of information regarding rebates, 53.3% accessed rebates. It is evident that they are reflecting on their experience while accessing rebates. Other challenges were scarcity of qualified contractors (20%), busy contractors (20%), and lack of rebate-related information (16.4%) (Figure 40).

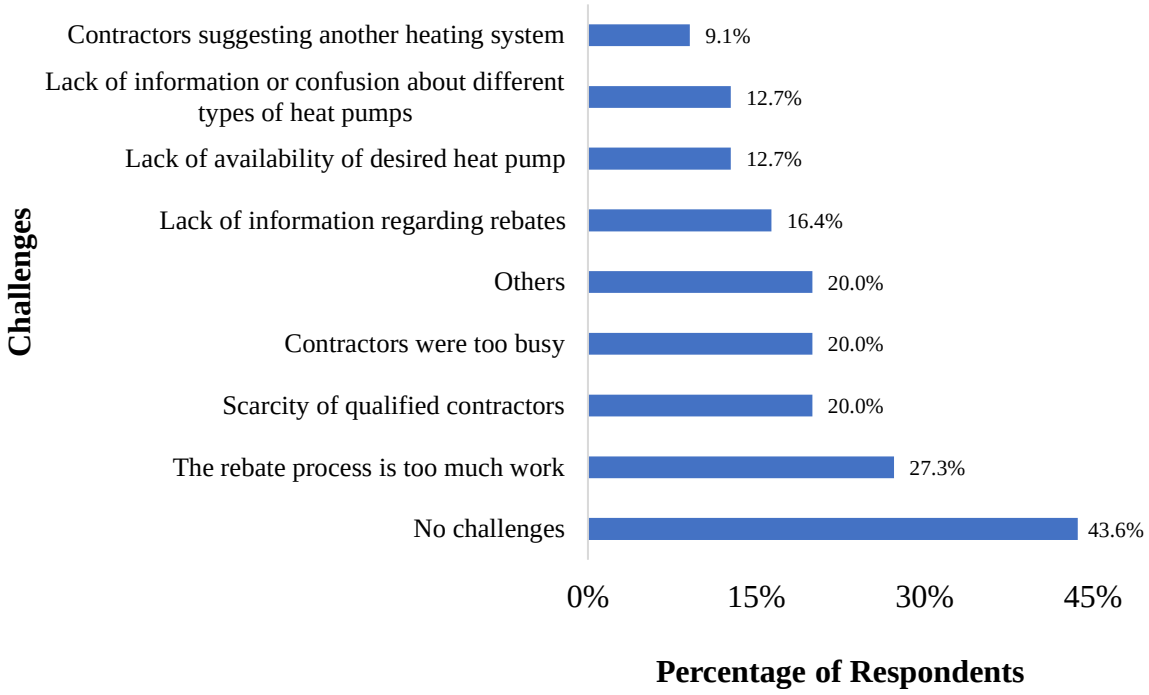

Figure 40. *Challenges faced by heat pump users during the installation process*

Respondents who selected 'Other' mentioned a couple of different challenges including complexity with rebates (i.e., not enough rebates, not qualified for having a secondary suite, pre-installment assessment requirement of the Federal rebate, etc.) followed by high installation cost, strata-related problems, and concern about noise generated by heat pumps.

36.4% of respondents mentioned having some issues after installing a heat pump. Most of them are related to poor installation work such as undersized heat pumps, missing parts like drains, wrong coil, wrong placement of the outdoor unit, etc. Some of them faced technical problems like condenser motor failure, refrigerant leaks, leaks from pipes, blown capacitors, and heat pumps not starting up after a power outage. Additionally, some of them mentioned noise from heat pumps, not having enough heat in low temperatures and high operational costs as their problems.

5.4 Responses of Heat Pump Non-Users

5.4.1 Knowledge of heat pumps

79.3% (303 people) of respondents do not use a heat pump. Among the non-users, 95.8% have heard of heat pumps, which means 'heat pump' is not a new word for them. They were asked to rate their knowledge about heat pumps on a scale of 1 to 5, where 1 means no knowledge, and 5 means heat pump expert. Only 10.8% mentioned that they have no

knowledge about heat pumps. Most of them selected either 2 (17.1%) or 3 (34.2%) or 4 (25.4%). Around 12.5% of non-users mentioned having really good knowledge about heat pumps.

5.4.2 Perceived benefits of heat pumps

Heat pump non-users were asked about their opinion regarding the benefits of using heat pumps. 72.1% of them mentioned additional cooling as the most important benefit of heat pumps. Other benefits were reducing GHG emissions (49.5%), energy efficiency (43.6%), cheaper operation cost than electric baseboard (43.6%), subsidized by rebates (36.6%), and no risk of CO poisoning (35.2%) (Figure 41).

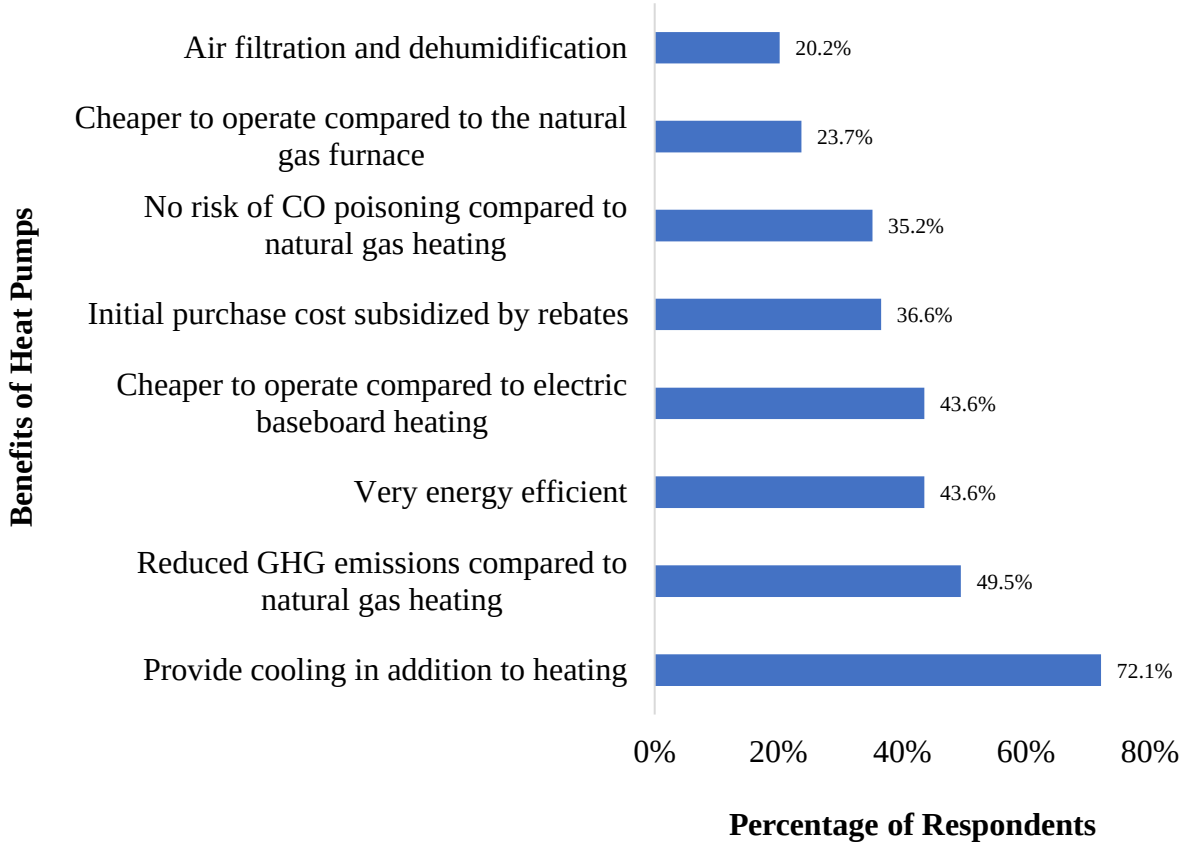

Figure 41. *Perceived benefits of using heat pumps according to non-users*

5.4.3 Plan to switch to heat pumps

Heat pump non-users were asked about their plans to switch to heat pumps within 5 or 10 years. 69% responded that they do not have any plans to switch, 10.5% mentioned having plans within the next 5 years, and 8.4% have plans within the next 10 years. 12.2% of non-users mentioned having plans to switch but further in future. In total, 31% of respondents

mentioned having any sort of plans for switching to heat pumps and among them, 39% believed a benefit of heat pumps was ‘reduced GHG emissions compared to natural gas heating’.

5.4.4 Obstacles/barriers to switching to heat pumps

Non-users were asked to list the obstacles/barriers in switching to a heat pump. The responses from the ‘Other’ option were reclassified to be included in the listed options. Most of them are concerned about economic factors – initial purchase cost (54.4%), operational cost (18.5%), and cost of upgrading electrical panels/ductwork (33.1%). Another significant barrier (37.3%) is that they are satisfied with their current system, and they do not want to change it before it breaks down. Moreover, 18.5% mentioned a lack of space for the new set-up or ductwork and 17.4% mentioned that they know heat pumps will not be enough for either heating or cooling and they need to have a backup like a furnace for colder and hotter days (Figure 42). Moreover, they were also concerned about the unknown/low return on investment and long payback period. Other obstacles faced by the non-users were receiving no benefits from rebates as installation cost is too high, purchasing a new furnace or new home recently, and having radiant heat or boiler system.

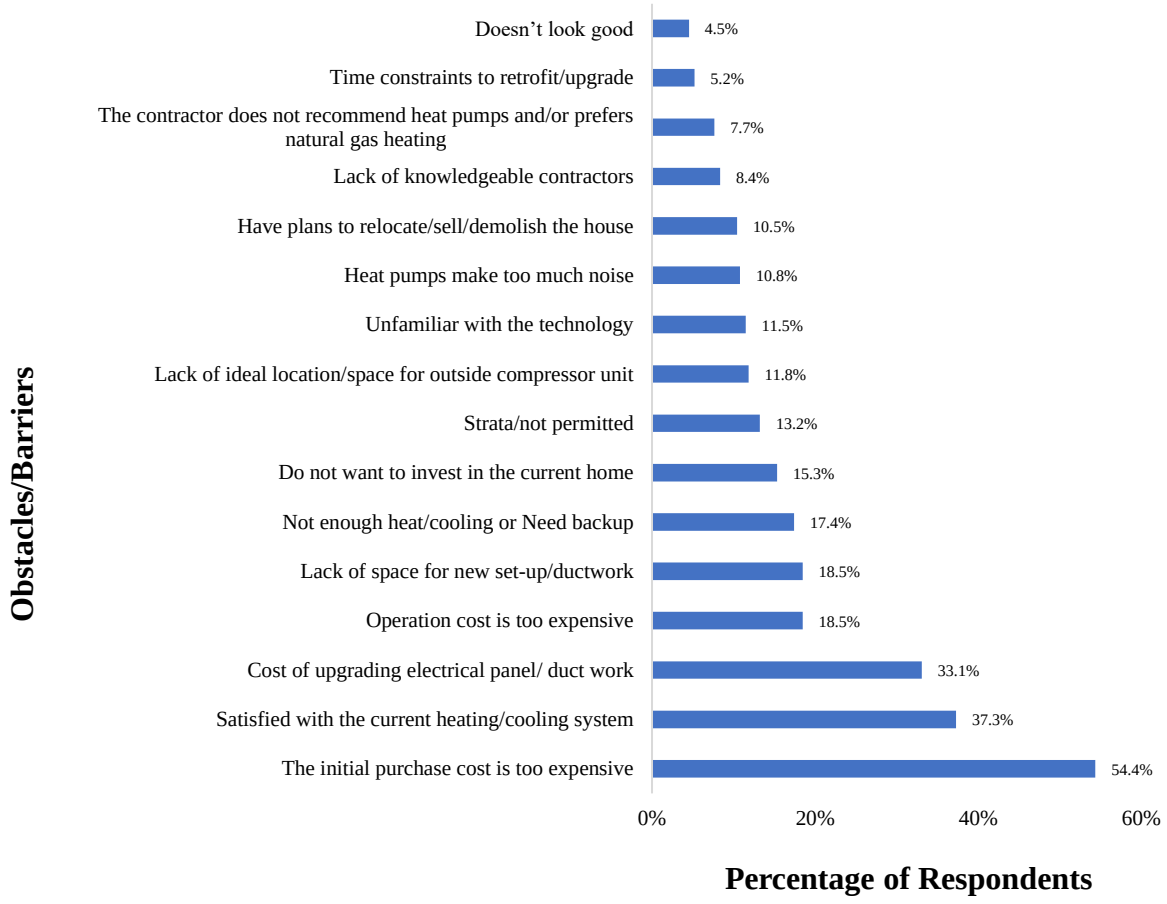

Figure 42. *Responses for different obstacles/barriers for non-users to switch to heat pumps*

Obstacles/barriers for the respondents who mentioned having plans of switching to heat pumps were identified. Around 73% of them are worried about the high initial cost and 44.9% are concerned with the cost of upgrading electrical panels. Additionally, lack of space for new set-up (19.1%) and lack of knowledgeable contractors (16.9%) were other important obstacles for them (Figure 43). They also mentioned being satisfied with current/comparatively new systems and the need for secondary heating systems for colder days as their obstacles/barriers in making the switch.

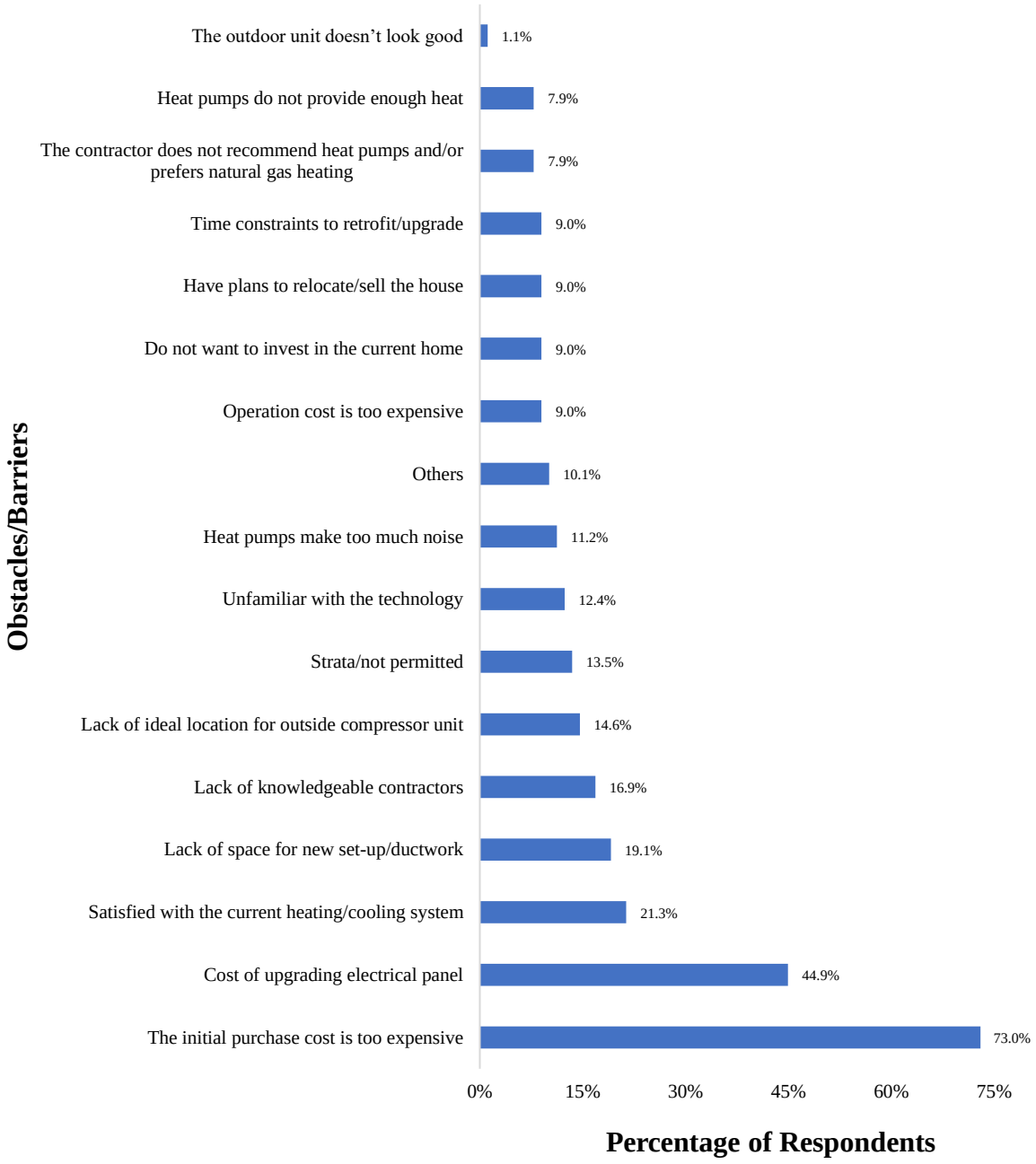

Figure 43. *Responses of non-users who have plans to switch to heat pumps for different obstacles/barriers*

6. RESULTS OF HVAC CONTRACTORS' SURVEY

A total of 36 HVAC contractors filled out the survey. They were asked about the dwelling types where they install heat pumps mostly, the types of heat pump they install, the status and preparedness of installing heat pumps in the Township, their clients' reasons for switching to heat pumps, and information regarding rebates and their benefits. The following sections will illustrate the findings from the HVAC survey.

6.1 Current Status of Installing Heat Pumps

88.9% of HVAC contractors have installed heat pumps in existing detached/single-family homes. 50% of the contractors also installed in existing townhouses/row houses and 19.4% in multi-family apartments (Figure 44). The number of houses they installed a heat pump within the last five years ranged from 1 to 850. 32.3% of HVAC professionals installed more than 200 heat pumps in the last five years.

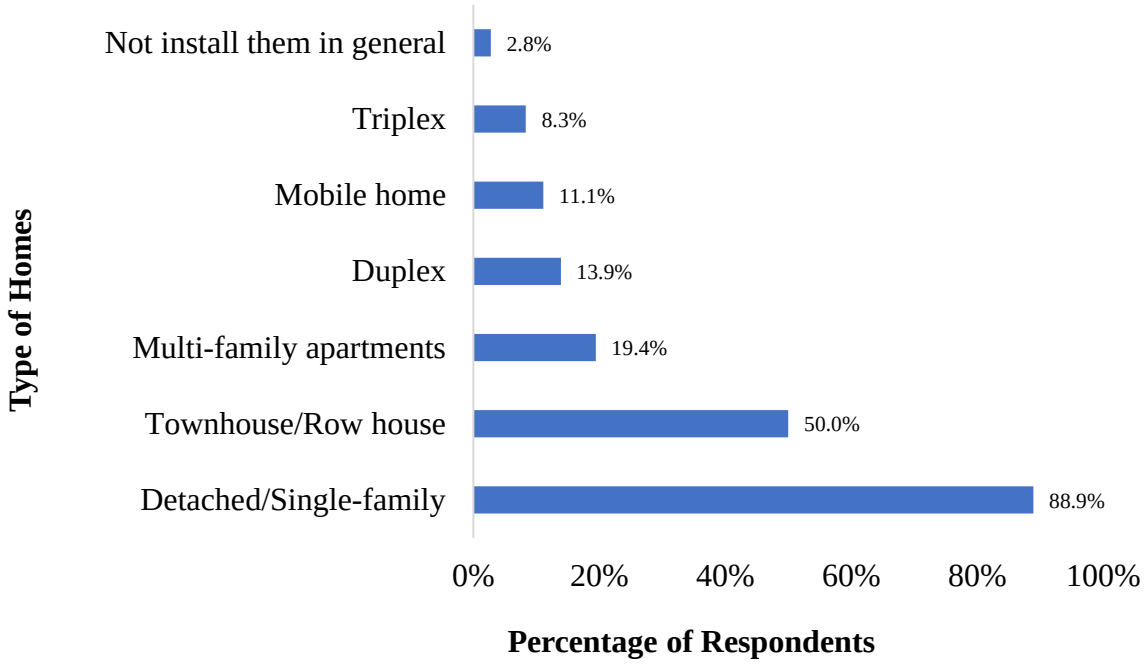

Figure 44. *Types of homes where HVAC contractors installed heat pumps*

6.2 Before/During Scenario of Heat Pump Installation

6.2.1 Type of heating system in the home before heat pump was installed

Respondents were asked what types of primary heating systems were in homes before they installed a heat pump. 72.2% of the homes were using natural gas furnaces and 41.7% of them were using electric baseboards. 52.8% were using natural gas-based systems like boilers

(36.1%) and fireplaces (16.7%) (Figure 45). In other homes (5.6%), either they had an existing heat pump, or it was a newly built home.

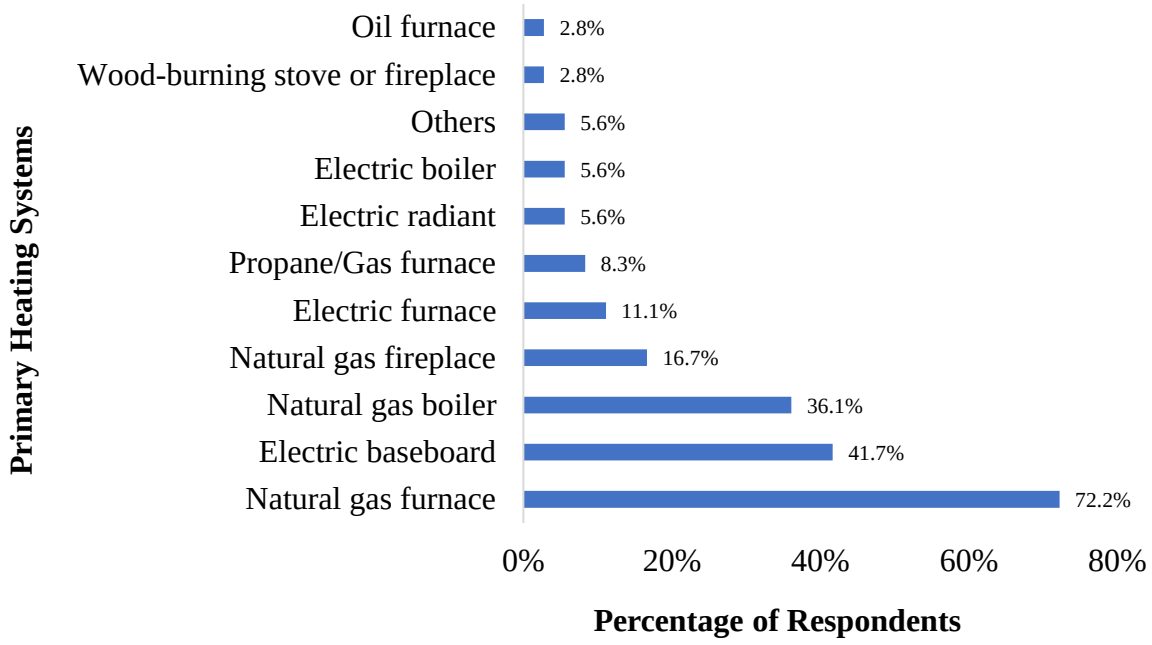

Figure 45. *Primary heating systems in the homes before installing heat pumps according to HVAC contractors*

6.2.2 Types of heat pumps installed

82.1% of HVAC contractors have installed central heat pumps whereas 64.3% and 50% of them also installed multi-split and mini-split heat pumps. Only 7.1% of them have installed air-to-water hydronic heat pumps (Figure 46).

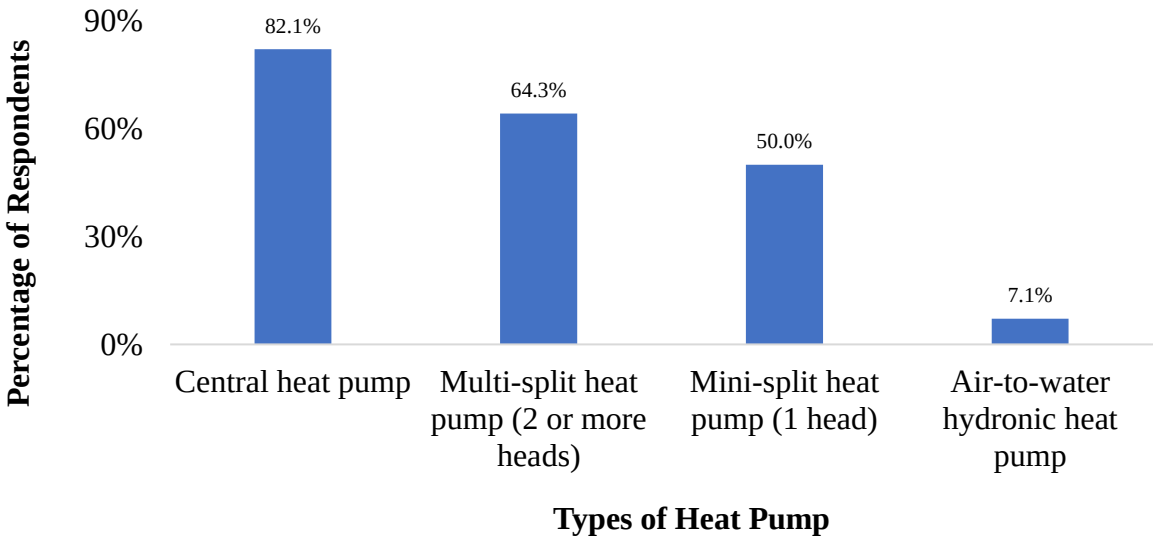

Figure 46. *Types of heat pump mostly installed by the HVAC contractors*

6.2.3 Reasons for installing heat pumps

According to HVAC contractors, 82.1% of their clients installed heat pumps due to their cooling benefits. Around 60.7% were interested because of rebates. 32.1% and 28.6% installed heat pumps for reducing energy bills and improving their home's thermal comfort respectively. Other reasons were – the previous system broke down (25%), fear of imminent breakdown of the previous system (21.4%) and reducing GHG emissions (21.4%) (Figure 47).

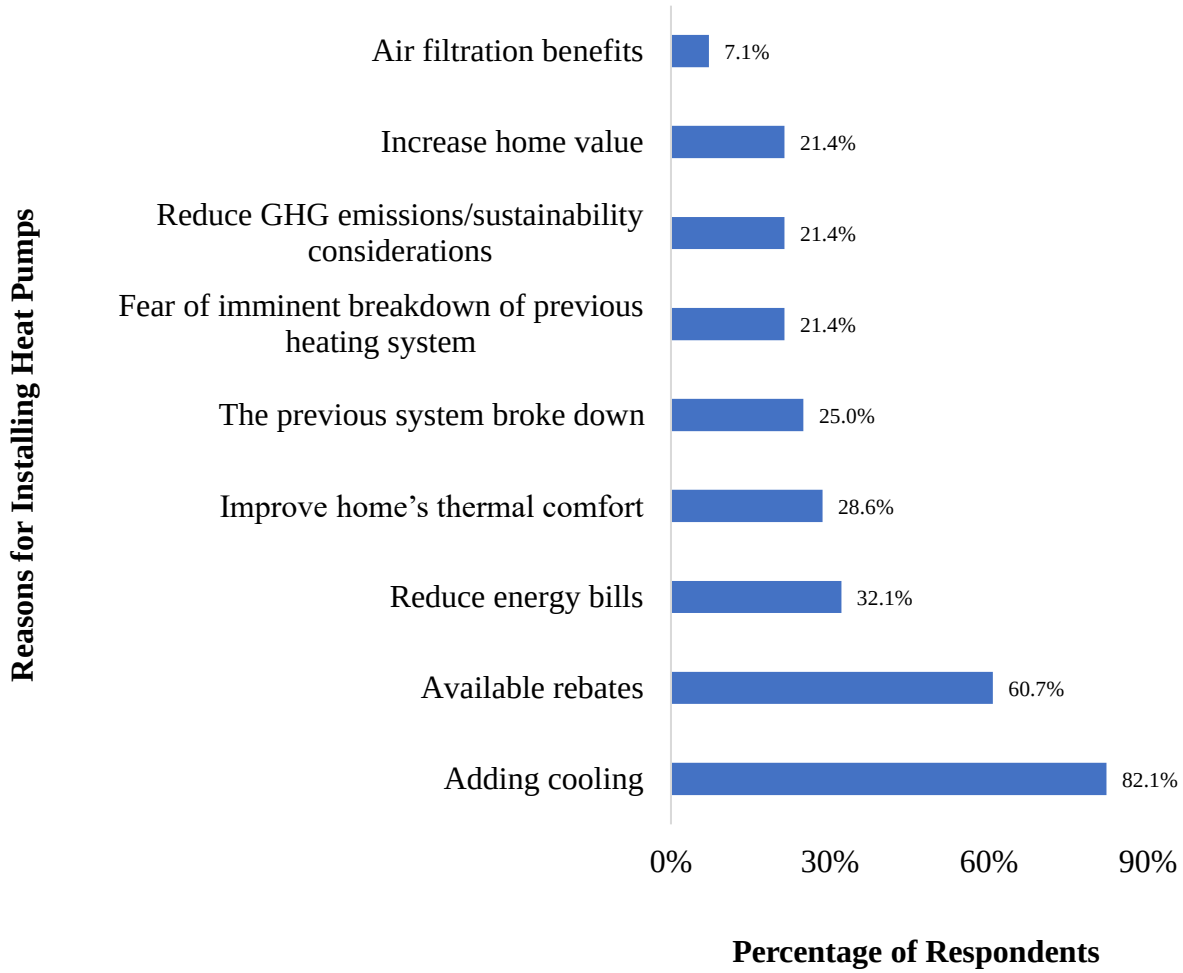

***Figure 47**. Reasons that clients mentioned for installing heat pumps according to HVAC contractors*

6.2.4 Need/Cost for electrical service upgrade

53.6% of HVAC contractors mentioned that less than 30% of homes required an electrical service upgrade. 32.1% of them reported between 30% to 60% requiring an upgrade and only 14.3% of them mentioned more than 60% of total homes required an electrical service upgrade when installing a heat pump. 38.9% of HVAC contractors stated that the electrical

service upgrade cost is less than $5,000 and 55.6% of them stated the cost can be between $5,000 and $10,000. Only 5.6% of them stated the upgrade cost is $15,000 or greater.

6.2.5 Rebates and other benefits

HVAC contractors were asked whether they discuss/promote any rebates while installing heat pumps. 78.6% of them responded affirmatively. Among the rebate options, they mostly discuss BC Hydro (72%), the provincial CleanBC program (60%), and the federal Greener Homes program (56%) (Figure 48).

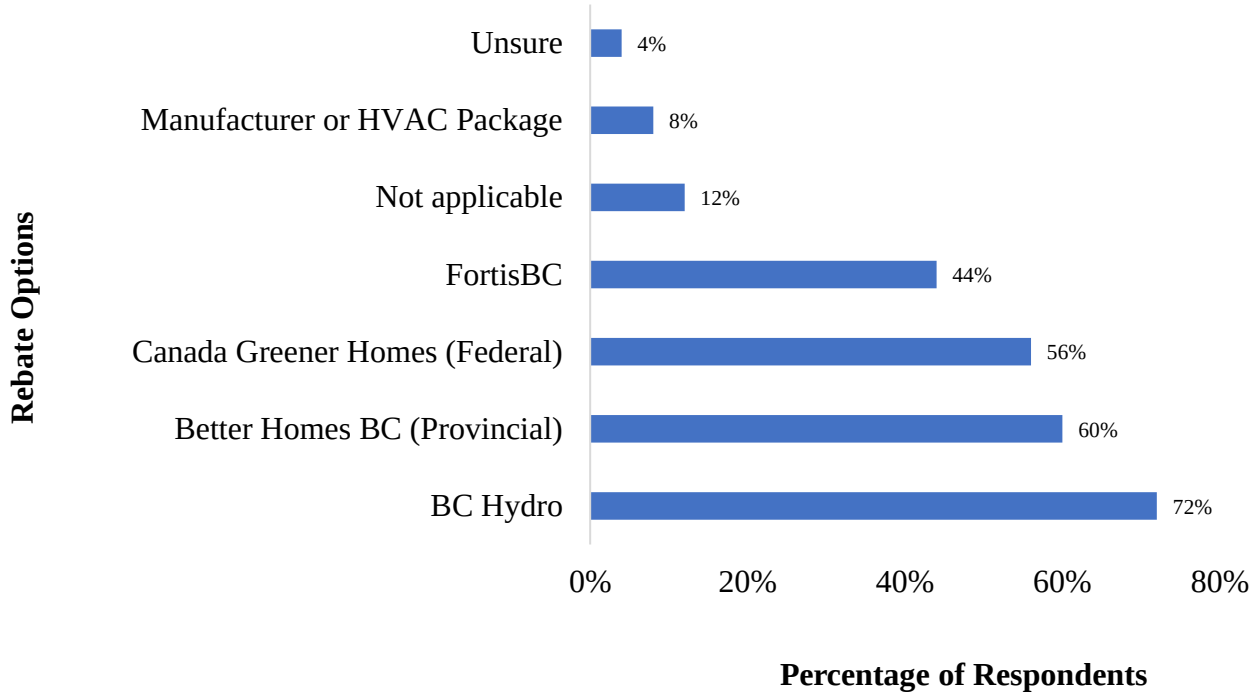

Figure 48. *Rebates that HVAC contractors discuss/promote with clients*

HVAC contractors were asked about whether they receive any incentives for installing heat pumps. Only 24% of them responded that they do. They receive incentives from BC Hydro, manufacturers, and Clean BC.

6.2.6 Challenges homeowners discuss with HVAC contractors during the heat pump installation process

The main challenges that HVAC contractors hear from homeowners during the heat pump installation process are related to economic factors, like the cost of upgrading the electric panel (76%), and hesitancy to take on financing (52%). Additionally, 48% of HVAC contractors mentioned that the rebate process is too much work and sometimes confusing for homeowners. Other challenges homeowners mention to contractors were listed as lack of ideal

space/location for outside compressor unit (60%), supply chain issues (44%), lack of space for net set-up/ductwork (40%), and homeowners' unfamiliarity with the technology (40%) (Figure 49). Some challenges HVAC contractors mentioned in "other" included: strata restrictions, lack of proper training among contractors, homeowners' hesitation to go all-electric considering the cost of electricity, and reliability of heat pumps in colder temperatures.

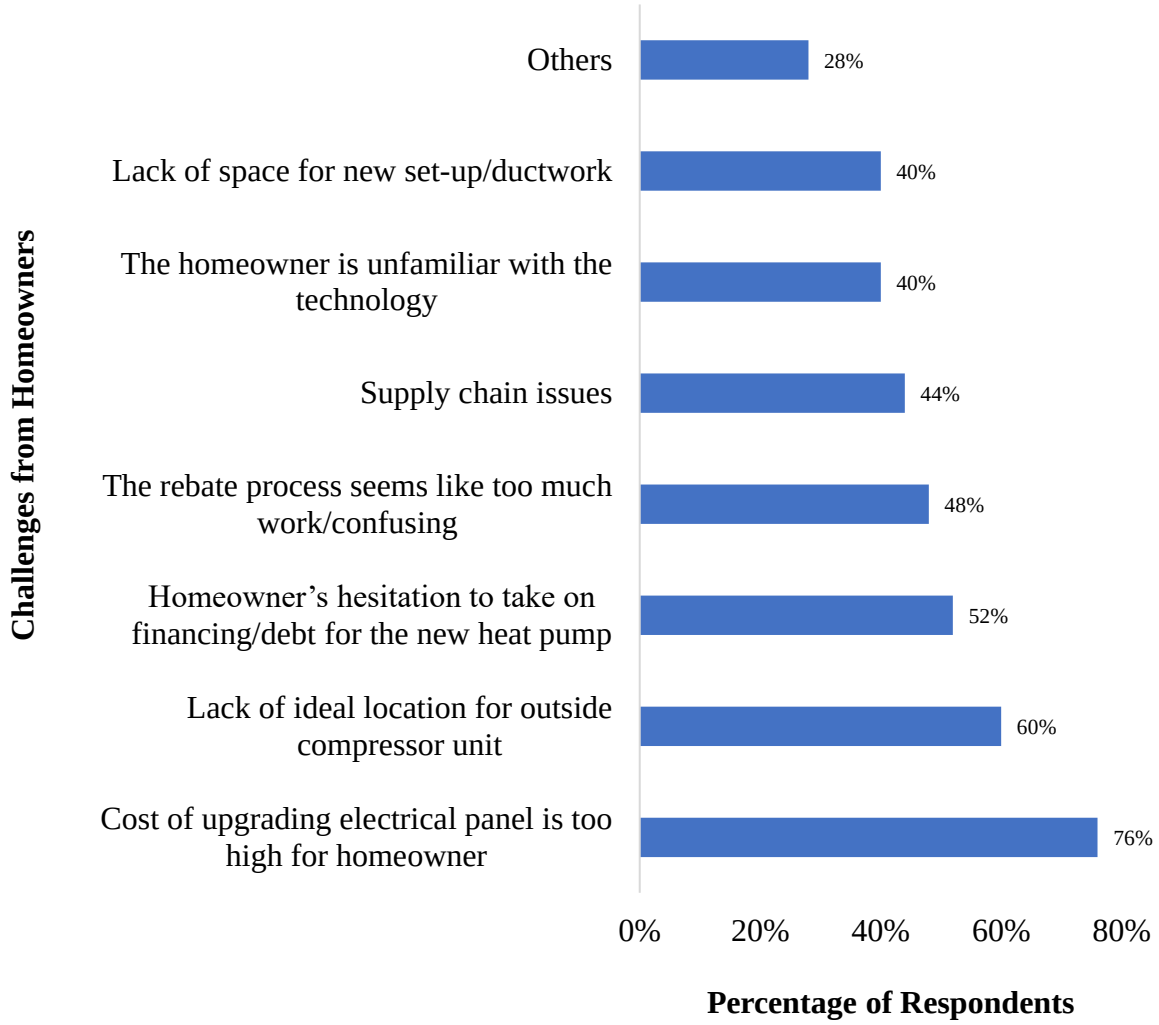

Figure 49. *Challenges homeowners discuss with HVAC contractors during the heat pump installation process*

6.3 Preparedness of HVAC Contractors for increased heat pump demand

Considering the increasing demand for heat pumps, contractors were asked how they would rate their preparedness for installing more heat pumps in the upcoming years. 44% of them stated that they are highly prepared and another 24% mentioned they are prepared. Only 8% of them mentioned being a bit prepared along with 24% being moderately prepared (Figure 50).

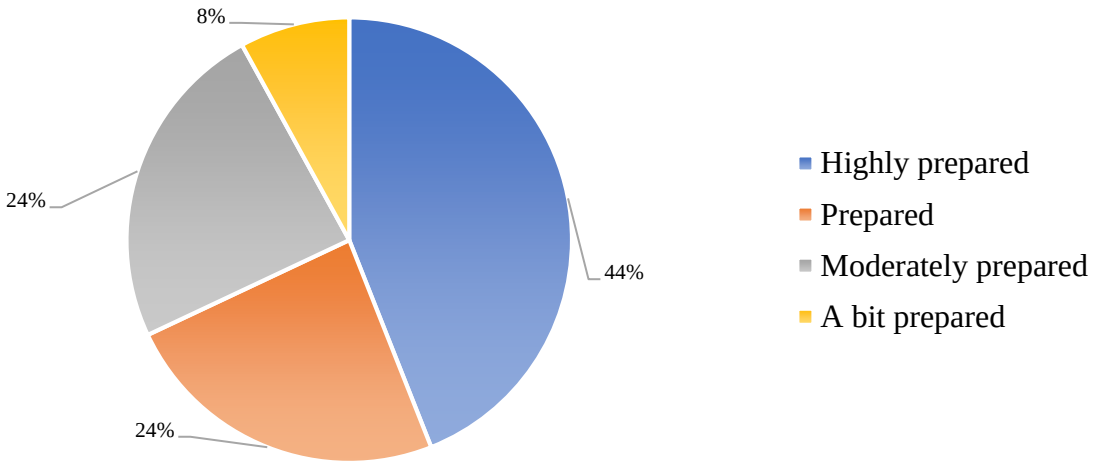

Figure 50. *Preparedness level of HVAC contractors for handling the increasing demand for heat pumps*

7. Motivating the Switch to Heat Pumps

All respondents (heat pump users, non-users, and HVAC contractors) were asked about their opinion on ways to motivate more people to install heat pumps and there was no significant difference among their opinions. For instance, heat pump users mentioned introducing more rebates (68.5%) or simplifying them (63.0%) and educating about the benefits of heat pumps (58.9%) as important pathways to motivate more people. They talked about more rebate options as most of them went through these processes. On the other hand, non-users also mentioned introducing more rebates (50.9%) or simplifying them (25.8%) and educating about the benefits of heat pumps (18.1%). Similarly, HVAC contractors also chose these options in higher percentages. Punitive or regulatory measures, like penalizing homeowners or putting GHG emissions limits, received very few responses (Figure 51).

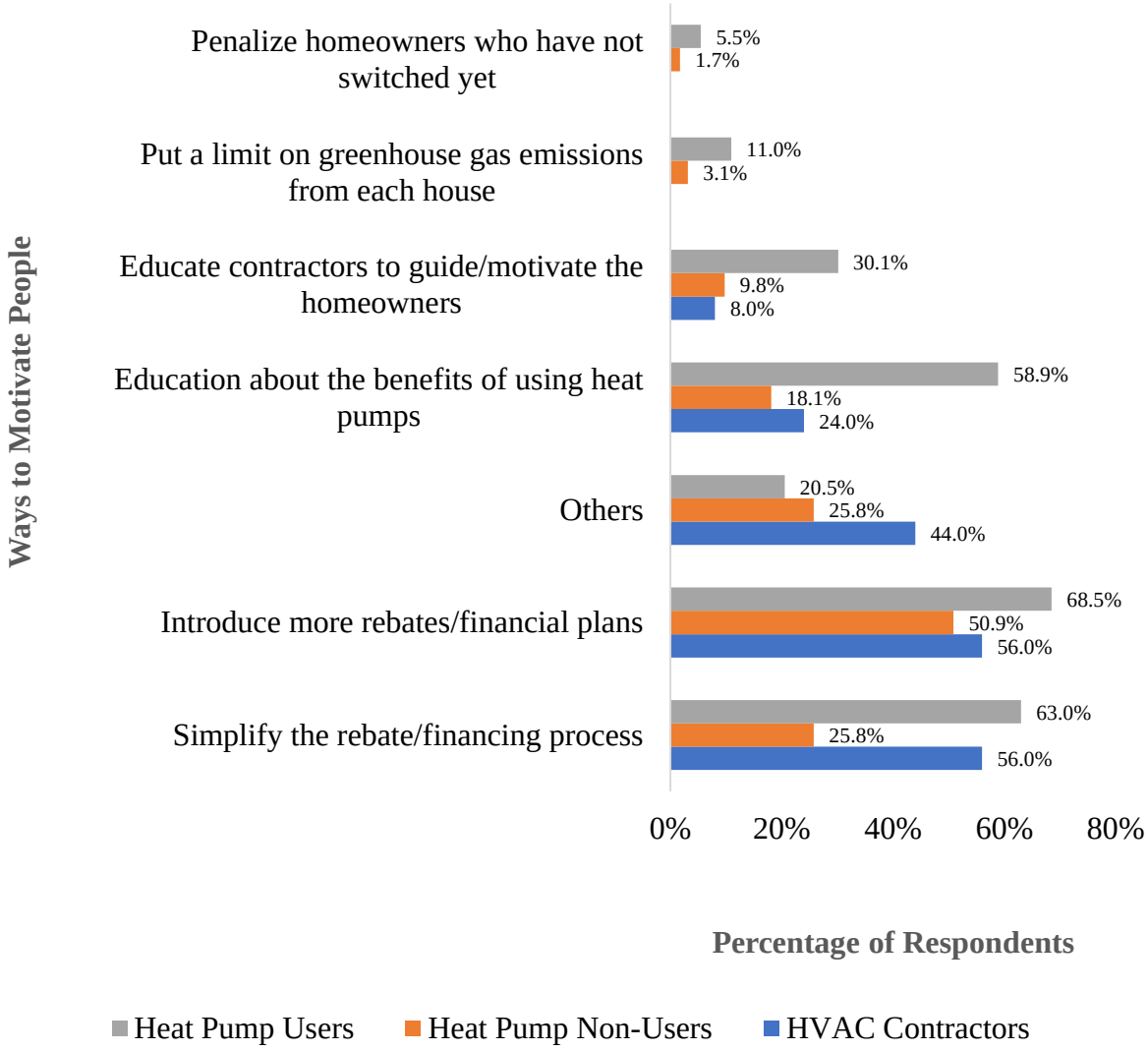

Figure 51. *Strategies to motivate more people to install a heat pump according to heat pump users, non-users, and HVAC contractors*

Among the 'Other' option, the most popular suggestion was to reduce electricity costs, so it becomes cheaper to operate a heat pump than a gas furnace. The second most suggested concern was about restrictive strata councils which do not allow them to use heat pumps. Both residents and contractors expressed their concern for the capacity of the BC Hydro electrical grid, mentioning as more people use electric systems for heating and cooling, the grid might not handle that level of demand. A few contractors mentioned they think that high-efficiency gas furnaces are cheaper, more sustainable, and emit less GHGs than heat pumps. A few homeowners and contractors mentioned that there is nothing that could motivate them to switch to a heat pump, other than utility costs becoming less for heat pumps than for natural gas furnaces.

8. DISCUSSION

8.1 Relationship between Respondent Demographics and Other Factors

In total, 382 people took part in the Township of Langley's home heating and cooling survey (3.4% of respondents do not live in the Township of Langley). Most of the homes (72.4%) are detached/single-family. Survey respondents mainly live in older homes that were built between 1970 and 1990 (40.8%) and 34.5% of the houses were built between 1990 and 2010. Unfortunately, many homeowners have the view that it is not worth it to invest in an older home (those built before 1990), therefore it is important that the benefits of retrofitting older homes are clearly communicated (City Green Solutions, 2021; City of Vancouver, 2021).

The respondents were then asked about their annual household income. 27.2% did not disclose their income, while the remaining were distributed among different income groups almost uniformly. 23.2% have an annual household income in the range of $100,000 to $150,000, followed by 21.8% making more than $150,000 per year, and the rest making less than $100,000. It is important to know about the income of the respondents because their home retrofit preferences and decisions are largely influenced by their socioeconomic profiles. City Green Solutions (2021) conducted a study to assess the Capital Regional District (CRD) Retrofit Initiative with two focus groups – groups with household incomes under $90,000 and groups with household incomes over $90,000. The two groups' responses differed noticeably from each other. For example, when considering replacing a heating system, those earning less than $90,000 mentioned that cost saving is the most important factor for them while GHG emissions reduction is the least important. On the other hand, those earning more than $90,000 mentioned that energy efficiency and GHG emissions reduction are the most important factors. This higher-income group listed the availability of zero-interest loans or financing options as the least important factor for replacing the current heating system (City Green Solutions, 2021).

8.2 Relationship between Current Heating and Cooling Systems and Other Factors

Natural gas furnaces (54.2%) are the most common primary heating system among respondents, and 68.6% of respondents have at least one type of natural gas-based system (furnace, fireplace, boiler) in their home as their primary heating system. 23.6% of respondents use a heating system that is more than 16 years old, meaning it may need a replacement soon. Notably, 23.4% of gas furnaces, 43.3% of gas boilers, and 21.1% of gas fireplaces are more than 16 years old. These households should be the focus of a higher proportion of the outreach and financial incentives, so it is ensured that they replace their natural gas-based systems with

electric options like heat pumps. If they replace their heating system with another natural gas-based system, that new system's GHG emissions would be locked in for the next 15 to 20 years as most people do not want to get rid of appliances that are still working, in turn making it difficult to meet GHG emissions reduction targets (City of Vancouver, 2021).

On the other hand, 32.7% of natural gas furnaces and 23.3% of gas boilers are very new (0 – 5 years old). Among the homes with new natural gas-based systems, 18.6% were built in or after 2010, and 12.9% were built within last 5 years; therefore, it can be deduced that most new natural gas heating systems are replacements in older homes. According to the survey, among the homes that were built in or after 2010, 42% of them have electric baseboards, 21.7% have electric heat pumps, and 18.8% have natural gas furnaces. With so many heating systems on the cusp of replacement, and many new homes still being built with natural gas heating, it is imperative that the Township promotes and encourages heat pumps for existing homes, and regulates heat pumps for new homes, as soon as possible to reach their 2030 and 2050 GHG emissions reduction goals.

Interestingly, 36.4% of respondents use both natural gas and electricity for heating. Among these respondents, 24.5% have a heat pump as their primary heating system and a natural gas fireplace or furnace as their secondary heating system. If residents still use a natural gas-based system for secondary heating, 100% GHG emission reduction is unlikely. Therefore, policies should be implemented to ensure they only use electric systems for primary heating and cooling, and secondary systems when absolutely necessary. It is important to recognize that one-quarter of respondents do not have any cooling system and considering the warming climate and increasing number of heat waves, the cooling benefit of heat pumps should continue to be highlighted as a key benefit.

8.2.1 Heating and Cooling Performance of Current Systems

When asked about the performance of their heating systems in the winter, 30.6% and 36.1% of total respondents rated their heating systems as 'Excellent' and 'Good'. Electric heat pumps had slightly better performance than natural gas furnaces (47% vs 30% 'excellent' ratings) and significantly better performance than electric baseboard heaters in the winter (4% 'excellent' ratings). Though respondents are generally satisfied with the heating performance of their systems in the winter, satisfaction numbers were noticeably lower for cooling performance in the summer. Only 23.6% and 24.4% gave 'Excellent' and 'Good' ratings for cooling performance. The lower satisfaction for home cooling is likely due to the fact that most

respondents have cooling systems that only cool part of the house (i.e., portable air conditioner, window air conditioner), or they do not have cooling at all. For cooling performance, central air conditioners and electric heat pumps received the most 'Good' and 'Excellent' responses. 46.7% and 49.3% of total users selected 'Excellent' for central air conditioner and electric heat pump, respectively. Central air conditioners need to be paired with a heating system to provide year-round heating and cooling, while electric heat pumps can provide both. Considering summer temperatures will continue rising with climate change, electric heat pumps' feature to keep the home comfortable year-round in just one system is another highlight of heat pumps that can be used to promote it more effectively.

8.2.2 GHG Emissions from Current Systems

Most respondents rated their primary heating systems 'Average' in terms of GHG emissions (50.5%). Electric systems received more 'Good' and 'Excellent' ratings (55%) than natural gas-based systems (32%), however, there is a clear pattern that indicates many respondents do not know that natural gas systems produce significant amounts of GHG emissions. Very few people believe natural-gas systems emit high GHGs (9.4% put 'poor' or 'very poor', compared to 11.8% for electric systems), which points toward this knowledge gap among the respondents. A similar study was conducted by the City of Vancouver (2021) to investigate initial reactions to their Green Home Retrofit program and found that people are not very concerned about GHG emissions from their heating systems (which were mostly natural gas-based). Additionally, misconceptions exist about natural gas-based systems being the most suitable for larger homes, humid climates, and heating water compared to other systems (City of Vancouver, 2021). Some of their respondents (and some of the respondents of this study) mentioned being told that natural gas is a clean option for home heating (City of Vancouver, 2021), which clearly indicates the spread of misinformation.

8.2.3 Utility Costs of Current Systems

Utility costs depend on the condition of the building envelope (i.e., airtightness, insulation levels) and the primary heating system, the efficiency of the heating system, and personal energy use habits. Though in general, most of the respondents (41.6%) rated their primary heating system 'Average' in terms of utility costs, electric heat pump users listed theirs as having 'Good' (47.1%) and 'Excellent' (17.7%) utility costs. Conversely, electric baseboards got the highest (34%) 'Very Poor' and higher (26%) 'Poor' responses, which matches what is known about their energy efficiency compared to heat pumps. Natural gas-

based systems mostly got ‘Average’ (50%) and ‘Good’ (26%) ratings in terms of utility costs. Therefore, along with ensuring the energy source of the main heating system is electric due to BC’s clean hydroelectricity, it is also important to ensure the system is energy efficient, so utility costs remain affordable.

8.2.3 Future Retrofit Plans

With just over two-thirds of respondents using natural gas in their homes, it is necessary to investigate residents’ home heating and cooling system retrofit plans so that the Township can fully understand and plan for the decarbonization of home heating systems. It is unfortunate that 89.8% of natural gas furnace users and 84.6% of other natural gas-based systems users are not planning to change their systems in the next year, which could have detrimental effects on achieving GHG emissions reduction targets. Interestingly, 8.5% of heat pump users mentioned that they have plans to retrofit their home heating and cooling system in the next year. It would be helpful to know why they are replacing their heat pump and what they are thinking of installing instead. Poor installation work can lead to poor performance of the heat pump. In that case, contractors need to be trained properly so that people do not have any issues with their heat pumps and do not switch to natural gas-based systems again.

8.3 Heat Pump Users

20.7% of total respondents have heat pumps in their homes either as primary or secondary heating systems, with the most common type (70.1%) being central heat pumps. Around half of these heat pumps were installed between 2016 and 2022, which indicates the growing interest in recent times. According to heat pump users, over 94% of heat pumps are performing either ‘Average’, ‘Good’, or ‘Excellent’ in heating and cooling.

8.3.1 Relationship between Installation Costs and Other Factors

Heat pump installation costs were investigated. Installation costs varied widely, and most respondents (35.2%) spent between $5,000 to $10,000; 25.9% paid in the range of $11,000 to $15,000 and 22.2% spent more than $15,000. Unfortunately, there is a slight pattern showing an increase in heat pump installation costs over time. 39.3% of heat pumps installed within the last five years had an installation cost between $11,000 to $15,000 and 39.3% costed more than $15,000. It is not a new technology so it can be assumed that it should be more affordable with time, but the recent supply chain issues during the COVID-19 pandemic may have affected prices. As the actual scenario does not reflect a decrease in costs over time, the Township should consider investigating further. Relating home age to installation cost, for older homes

built between 1950 and 1970, respondents generally spent more than $15,000 (50%) on their heat pump installation. For newer homes that were built in or after 2010, installation costs were comparatively less, with 87.5% spending less than $15,000. Another cost associated with heat pump installations is electrical service upgrades. Though 71.4% of total homes did not need an upgrade, most older homes that were built between 1970 and 1990 (54.5%) required one, compared to 18.2% of newer homes built in or after 2010. Overall, 19.6% of homes needed an electrical service upgrade and they paid between $150 to $6,000 for the upgrade.

8.3.2 Relationship between Rebates and Other Factors

35.7% of heat pump users did not access any rebates to help with the cost of heat pump purchase and installation. It is possible they had enough savings to do the retrofit, or they thought the rebate process would be time-consuming and confusing, so they preferred to avoid it. 27% of heat pump users perceived the rebate process as being too much work, and 16% said there was a lack of information regarding rebates, which both support further work to be done on simplifying and promoting rebate programs. Among the users who said the rebate process was too much work, 44.4% accessed rebates. Besides, among the users who said there was a lack of information regarding rebates, 53.3% accessed rebates. It is evident that they are reflecting on their experience while accessing rebates.

It is important to note that 58% of rebate recipients who gave details on their annual household income had an annual household income of more than $150,000, 26% had an income of $100,000 to $150,000, 5% made $50,000 to $100,000 and 11% made less than $50,000. It is clear from these results that heat pumps are generally bought by people with a higher income, which is understandable given the relatively high initial cost of heat pumps compared to other heating systems such as furnaces.

8.3.3 Relative Merits of Heat Pumps from Users

This study identified the relative merits of using heat pumps from users. Among current heat pump users, 87.3% did not have a cooling system before their heat pump and 66.7% mentioned that the addition of cooling is the main advantage of using a heat pump. Most heat pump users responded that their utility bills have decreased either significantly (16.4%) or slightly (43.6%) since installing a heat pump, which is another key benefit of heat pumps for most people who switch. Unfortunately, some of the respondents mentioned not having enough heat from heat pumps during very cold days. The City of Vancouver (2021) also reported a perception that people believe heat pumps need a back-up heating system. In some cases, where

the home has poor insulation, a leaky building envelope, or the heat pump is incorrectly sized or poorly installed, this could be true; however, in Langley and the surrounding areas, there are heat pumps available that do not need any secondary heating system as they can reach up to -15°C while still maintaining good energy efficiency (see the previous Cold Climate Heat Pump section).

8.3.4 Reasons to Install Heat Pumps from Users

According to heat pump users, cooling benefits (72.7%), improved thermal comfort (54.6%), reduced energy bills (40%), and reliability/cost-effectiveness of heat pumps (30.9%) are the main factors that motivated them to install a heat pump. Results of the City Green Solutions (2021) study also agree with these findings. On the other hand, 65.5% and 56.4% of the users responded 'Not important' for the "previous heating system broke down" and "fear of imminent breakdown of previous heating system" options, respectively. This result shows that many respondents did not upgrade just because they had to; they were convinced to switch because of the added benefits listed above. Ideally moving forward, the number of people switching because their previous system broke down would increase as that would show that the heat pump installation process is straightforward enough for an urgent replacement, and a qualified contractor is immediately available for an installation. Along with motivating people to replace their current working heating systems with heat pumps, it should also be ensured that they can quickly replace their broken systems with heat pumps.

8.4 Heat Pump Non-Users

8.4.1 Heat Pump – Not a New Word to Non-Users

Though 79.3% of total respondents are not using heat pumps, only 10.8% mentioned that they have no knowledge about heat pumps. So, limited awareness of heat pumps is not a significant issue among the Township of Langley respondents unlike the study conducted by the City of Vancouver (2021) where they found limited awareness of heat pumps among the participants. It is reported that a third of Canadian homeowners (non-users) expressed their willingness to install heat pumps (Corbett et al., 2023). Similar to heat pump users, non-users identified the addition of cooling as the most important benefit of heat pumps (72.1%). 49.5% of heat pump non-users know that heat pumps are associated with lower GHG emissions and 43.6% identified it as an energy-efficient system. Many non-users know about the efficiency and sustainability benefits associated with heat pumps, but interestingly, they are not switching to them, which reflects that other significant obstacles exist.

8.4.2 Barriers to Adopting Heat Pumps for Non-Users

Non-users state the most significant barriers for them switching to a heat pump are the high initial cost of purchasing (54.4%), the cost of the electrical panel upgrade (33.1%) and the higher cost of operating a heat pump (18.5%) compared to their current systems. The City of Vancouver (2021) reported the fear of monthly bills as a more significant obstacle than the initial investment. While motivating non-users, the focus should not be on the savings in monthly bills, rather it should be on the payback of the upfront investment through savings on energy bills (City of Vancouver, 2021). City Green Solutions (2021) reported that hesitancy to take on financing/debt and limited knowledge of rebate programs are common obstacles. The non-users have mentioned that a lack of knowledgeable contractors and/or contractors advising natural gas furnaces instead of heat pumps (also found in City Green Solutions, 2021) were also barriers for them to adopt heat pumps; this could be addressed with proper training and knowledge mobilization targeting HVAC contractors. Overall, most of the obstacles stopping people from switching to a heat pump are related to economic factors.

Unfortunately, 69% of non-users do not have any future heat pump retrofit plans, even when considering further than 10 years in the future, which makes education and advocacy of heat pumps even more important in order to achieve GHG emissions reduction targets. For the respondents who mentioned having plans of switching to a heat pump, their top two concerns were the high initial cost (73%) and the cost of upgrading the electrical panel (45%). Additionally, lack of space for the new set-up (19.1%) and lack of knowledgeable contractors (16.9%) were significant obstacles for them. As these non-users have some sort of retrofitting plan, their obstacles should be addressed as soon as possible so that they can make the switch sooner.

8.4 HVAC Contractors

This study also includes insights from 36 HVAC contractors among which 32.3% have installed more than 200 heat pumps in the last five years and central heat pumps are the most (82.1%) installed. They stated that the most common primary heating systems prior to installing a heat pump were: natural gas furnace (72.2%), electric baseboard (41.7%), and natural gas boiler (36.1%). HVAC contractors stated that the most popular reasons their clients had for installing a heat pump were the cooling benefit of heat pumps (82.1%) and the availability of rebates (60.7%). 78.6% of HVAC contractors discussed at least one rebate option with homeowners during the heat pump installation process.

While installing heat pumps, the contractors heard about the challenges homeowners are having, which are mostly related to economic factors like high initial cost and hesitation to go into debt for the retrofit. In the City of Vancouver (2021) study, they also found that HVAC contractors face challenges during heat pump installation as renovation usually costs more than quoted, which homeowners were not prepared for. Additionally, some homeowners do not want to invest the money that is required for upgrading the electrical panel (City of Vancouver, 2021).

8.5 Motivating the Switch to Heat Pumps

Near the end of the survey, all participants were asked to give their opinions on ways to motivate more people to switch to a heat pump. As expected, the introduction of more rebates or financial plans got the highest responses from heat pump users (68.5%), non-users (50.9%), and contractors (56%). Heat pump users also mentioned simplifying the rebate process (63%) and educating people about the benefits of heat pumps (58.9%) as important pathways for motivating more people. Simplifying the rebate process and educating people about the benefits of using heat pumps got high responses from non-users and contractors too. Punitive or regulatory measures, like penalizing homeowners or putting GHG emissions limits on homes, received very few responses. The City of Vancouver (2021) also reported that homeowners prefer positive measures instead of regulatory measures to encourage people to switch.

The most commonly cited motivating strategy by the respondents who selected ‘Others’ was to lower the price of electricity so that heating with electricity would consistently be cheaper than heating with natural gas. A few homeowners and contractors mentioned that nothing would motivate people to switch to a heat pump other than utility costs becoming less for heat pumps than for natural gas furnaces, which is a somewhat misinformed statement as heat pumps can often cost less or the same to run as natural gas furnaces (BC Hydro Power smart, 2022). The City of Vancouver (2021) study also found that people thought it would be more expensive to heat with an electric heat pump than a natural gas furnace. Unfortunately, 26% of heat pump non-users stated there was nothing that could persuade them to switch to a heat pump, which is an important factor when considering how to motivate this group as perhaps regulatory measures may be the only way to convince them to switch.

Another concern that was mentioned in the “Others” option is strata councils being too restrictive and not allowing heat pumps to be installed in their buildings. Finally, a common

concern among respondents (both public and HVAC contractors) was that the BC Hydro electrical grid would not be able to handle the increased demand from widespread electrification of buildings and vehicles. Respondents to the City of Vancouver's study (2021) also mentioned that they were not switching due to concerns about BC Hydro's electrical capacity.

Related to increasing education and outreach on heat pumps, Corbett et al. (2023) mentioned that aiming to increase the homeowners' technical familiarity with heat pumps is an effective way to motivate them. Additionally, connecting non-users with users through testimonial videos can be a possible way to motivate people (Corbett et al., 2023). Testimonial videos from consumers are also impactful and can increase a desire for the advertised product, affecting the behaviour of non-users (Howes and Sallot, 2013; Spillinger and Parush, 2012; Tucker and Yu, 2017). 16 heat pump users who responded to our survey volunteered to give a testimonial or participate in a case study that would highlight their retrofit journey and energy savings to help educate peers and neighbours.

9. Recommendations

Based on the findings of the public survey targeting heat pump users, non-users, and HVAC contractors, this study concludes with some recommendations for the Township of Langley and similar municipalities, to help accelerate the switch to electric heat pumps:

a. **Advocate for increased heat pump rebate amounts and give funding for top-ups:** As shown by this survey, Township of Langley residents place a lot of importance on the initial cost of their home heating and cooling systems. To address this concern, the Federal and Provincial Governments should introduce more rebate options for every income group, but especially lower incomes. Additionally, the Township should provide funding for rebates whenever possible, such as for the CleanBC Better Homes Municipal Top-up for heat pumps. The rebate amount should cover a significant amount of the initial purchase cost of heat pumps in order to make them competitive with natural gas options.
b. **Advocate for a simplified rebate process:** The rebate application process should be straightforward and quick. Both heat pump users and HVAC contractors selected "simplify the rebate/financing process" as their top or second highest option for how more people can be motivated to switch to a heat pump. Notably, 35.7% of heat pump

users did not receive a rebate for installing their heat pump. This could be a signal that the current rebate process is too onerous for residents to complete.

c. **Advocate for quick and easy financing options:** In addition to rebate options, there should be financing options like zero/very low-interest loans, installment plans, etc. so that people without any savings can easily make the decision to upgrade their current systems to heat pumps. Lack of savings can be sometimes the major obstacle in the retrofitting journey.

d. **Expand education on building decarbonization and advocate for education from all levels of government and BC Hydro:** There are still some knowledge gaps about the benefits of heat pumps and the adverse effects of using natural gas-based systems. More campaigns and webinars for Township residents would be helpful to dispel myths about heat pumps and natural gas. Interactive, in-person sessions with residents should be held to discuss these issues. Moreover, in-person campaigns such as door-knocking and distributing flyers can help attract people who are not reached by traditional marketing. As mentioned in the Discussion section, testimonial videos and case studies showcasing the retrofit experience of Township residents will further help convince residents to switch to a heat pump. Ideally, the Township would act as a trusted source of information that all residents can look to learn more about heat pumps and the installation process.

   Along with residents, HVAC contractors should also receive more education on heat pumps, electrification myths, and FAQs. Training on how to install heat pumps properly should continue to be given by trusted sources such as the Home Performance Stakeholder Council (HPSC) and certification of heat pump installers should be made public so residents can easily find qualified heat pump installers. Homeowners' complaints of their heat pumps not working in cold temperatures and other installation-related problems can be solved by the contractors suggesting buying cold-climate/highly efficient heat pumps and upgrading their home's insulation. Contractors can play a vital role in promoting heat pumps to more residents/homeowners by making a bridge between residents and local governments.

   To make the knowledge mobilization strategy more robust, scientific research and quantitative benefits should be communicated more clearly to residents and contractors. For example, it is true that heat pumps emit less GHGs than natural gas-based systems but conveying this message with some quantitative research output (i.e., 50% reduction in GHG emissions) will be more convincing. The same thing goes for reducing utility

bills. Comparison between heat pumps and high-efficiency natural gas furnaces should be carried out in terms of their performance in GHG emissions and utility costs as some residents still believe natural gas-based systems are more sustainable and cheaper than electric heat pumps. There should be studies to compare heat pumps with conventional air conditioners too. City of Vancouver (2021) reported that their respondents liked the video comparison between vehicle emissions and home emissions.

e. **Ensure enough electrical capacity and supply for building decarbonization and be transparent with this information (BC Hydro lead):** Although electrical capacity is currently not an issue, many British Columbians are understandably concerned about electricity supply and capacity as our population and electricity use grow. The province and BC Hydro should ensure there is enough electricity supply and grid capacity to support full electrification to 2050, and clearly communicate these plans to BC residents. Additionally, alternative sources to produce clean electricity (i.e., solar, wind) should be explored. They should be transparent about their plans going forward to zero emissions by 2050 so that people are confident in their heating electrification decision.

f. **Collaborate and ensure consistent messaging between all levels of government:** Electrifying our heating and cooling systems and getting to zero emissions by 2050 will not be managed solely by municipal governments. All levels of government should work together to achieve global targets. There should be balance, compatibility, and consistency among the measures taken at different levels of government.

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APPENDIX A: SURVEY QUESTIONNAIRE FOR TOL RESIDENT

Home Heating and Cooling Systems survey

Welcome and thank you for participating in the Township of Langley's Home Heating and Cooling Systems survey. This survey is designed for all Township of Langley residents to learn more about their current home heating and cooling systems, and the barriers/obstacles they may be facing during the installation of a new heat pump system (if applicable).

Your responses to the survey will inform actions connected to goals outlined in the Township of Langley Climate Action Strategy.

This survey will take around 5-10 minutes to complete. You will need the following information:
1. **Home information** such as square footage and year built (an estimate is fine).
2. **(If applicable) Heat Pump Information** such as the installation cost, electric service upgrade cost, and rebates you accessed. You can find this information on your heat pump invoice; if these documents are not available, estimate to the best of your ability.

Need Support?

If you need clarification regarding a question or want updates about the project, please contact Sarah Maleska, Environmental Sustainability Coordinator at Township of Langley at smaleska@tol.ca, or Jannatul Ferdous, UBC Sustainability Scholar at jannatul.ferdous@ubc.ca.

Part 1: Information about the current heating and cooling system

* 1. What is the primary heating system in your home?

- ◯ Natural gas fireplace
- ◯ Natural gas boiler
- ◯ Natural gas furnace
- ◯ Electric radiant
- ◯ Electric baseboard
- ◯ Electric heat pump
- ◯ Electric boiler
- ◯ Electric furnace
- ◯ Wood-burning stove or fireplace
- ◯ Propane furnace
- ◯ Oil furnace
- ◯ Other (please specify)

2. Do you have any other heating system(s)? *(Select one or more responses)*

- ☐ Not applicable
- ☐ Natural gas fireplace
- ☐ Natural gas boiler
- ☐ Natural gas furnace
- ☐ Electric radiant
- ☐ Electric baseboard
- ☐ Electric heat pump
- ☐ Electric boiler
- ☐ Electric furnace
- ☐ Wood-burning stove or fireplace
- ☐ Propane furnace
- ☐ Oil furnace
- ☐ Other (please specify)

* 3. What type of cooling system do you use in the house?

- ◯ No cooling system
- ◯ Central air conditioner
- ◯ Window air conditioner
- ◯ Portable air conditioner
- ◯ Electric heat pump
- ◯ Through-wall air conditioner
- ◯ Other (please specify)

* 4. How would you currently rate your home's performance based on the following attributes?

	Very poor	Poor	Average	Good	Excellent
Comfortable indoor temperature in heating season (winter)	◯	◯	◯	◯	◯
Comfortable indoor temperature in cooling season (summer)	◯	◯	◯	◯	◯
Greenhouse gas emissions (very poor = high emissions, excellent = low emissions)	◯	◯	◯	◯	◯
Utility costs	◯	◯	◯	◯	◯

* 5. How old is the primary heating system?

- ◯ 0 – 5 years
- ◯ 6 – 10 years
- ◯ 11 – 15 years
- ◯ 16+ years
- ◯ Unsure

* 6. Do you have any plans to replace/upgrade the heating/cooling system of the house in the next year?

- ◯ Yes
- ◯ No
- ◯ Unsure

7. How do you plan to finance your next home heating system replacement? *(Select one or more responses)*

- [ ] Payment plan
- [ ] Savings
- [ ] Line of Credit or Credit Card
- [ ] Rebates
- [ ] I don't know
- [ ] Other (please specify)

  _____

- [ ] Not applicable

* 8. Does your home currently use a heat pump for either primary or secondary heating?

- ◯ Yes
- ◯ No

Part 2: Questions for the household using heat pumps

* 9. Which type of heat pump are you using? (Central heat pumps use the existing ducting and have a centralized air handler. Mini-split heat pumps are ductless and have wall-mounted heads or small mini-ducts that run through the ceiling above rooms. Click here for other heat pump definitions.)

- [ ] Central heat pump
- [ ] Mini-split heat pump (1 head)
- [ ] Multi-split heat pump (2 or more heads)
- [ ] Air-to-water hydronic heat pump
- [ ] Combination air and hot water heat pump
- [ ] Ground-source or geothermal heat pump
- [ ] Unsure about the type

* 10. Approximately what percentage of your home is heated by a heat pump?

0% 100%

* 11. What year was the heat pump installed? *(If unsure, use an estimate)*

_____

* 12. Was the heat pump in the home when you moved in or was it installed since you moved in?

- ◯ The heat pump was in the home prior to moving in
- ◯ The heat pump was installed since/after moving in

* 13. What benefits have you experienced using a heat pump? *(Select one or more responses)*

- ☐ Reduced energy bills
- ☐ Improved thermal comfort of home
- ☐ Reduced greenhouse gas emissions/environmental considerations
- ☐ Provide cooling in addition to heating
- ☐ Air filtration and dehumidification (better indoor air quality)
- ☐ Increased home value
- ☐ Unsure

* 14. In your opinion, do you feel there are any disadvantages to heat pumps?

* 15. In your opinion, how can more people be motivated to switch to heat pumps? *(Select all that apply)*

- ☐ Education about the benefits of using heat pumps
- ☐ Introduce more rebates/financial plans
- ☐ Put a limit on greenhouse gas emissions from each house
- ☐ Penalize homeowners who have not switched yet
- ☐ Educate contractors to guide/motivate the homeowners
- ☐ Simplify the rebate/financing process
- ☐ Other (please specify)
- ☐ Unsure

* 16. Approximately how much did the purchase and installation of your heat pump cost? *(Enter number only, do not include decimal or dollar sign ($))*

* 17. Did the heat pump installation require an electrical service upgrade?

- ◯ No
- ◯ Unsure
- ◯ Yes (please specify cost)

* 18. Which rebates did you access toward the cost of your heat pump? *(Select all that apply)*

- ☐ Better Homes BC (Provincial)
- ☐ BC Hydro
- ☐ FortisBC
- ☐ Canada Greener Homes (Federal)
- ☐ I did not access rebates
- ☐ Other (please specify)
- ☐ Unsure

Part 2: Questions for the household using heat pumps (continued)

* 19. Before installing a heat pump, did you have air conditioning or any cooling system?

- ◯ Yes
- ◯ No
- ◯ Unsure

* 20. How important were the following factors/reasons for upgrading to a heat pump?

	Not important	Less important	Neutral	Important	Very important
Previous heating system broke down	○	○	○	○	○
Fear of imminent breakdown of previous heating system	○	○	○	○	○
Recommendation by the contractor/ installer	○	○	○	○	○
Available rebates	○	○	○	○	○
Reducing energy bills	○	○	○	○	○
Improve home’s thermal comfort	○	○	○	○	○
Reduce emissions; environmental/ sustainability considerations	○	○	○	○	○
Air conditioning/cooling benefits	○	○	○	○	○
Air filtration benefits	○	○	○	○	○
Making investment to increase home value	○	○	○	○	○
Reliability and cost-effectiveness of heat pumps	○	○	○	○	○

21. If there were any other important factors in choosing to install a heat pump, please mention them here.

* 22. What type of challenges did you face during the heat pump upgrade process? *(Select one or more responses)*

- [ ] Scarcity of qualified contractors
- [ ] Contractors were too busy
- [ ] Contractors not wanting to install a heat pump and suggesting another heating system
- [ ] Lack of availability of desired heat pump
- [ ] Lack of information or confusion about different types of heat pumps
- [ ] Lack of information regarding rebates
- [ ] The rebate process is too much work
- [ ] No challenges
- [ ] Other (please specify)

* 23. How much have your home heating/cooling bills changed compared to your previous home heating/cooling system?

Decreased significantly	Decreased slightly	No change	Increased slightly	Increased significantly
○	○	○	○	○

* 24. How was your whole experience from researching heating/cooling system options to the end of the process (either installation completion or receiving rebates)?

Highly unsatisfactory	Unsatisfactory	Neutral	Satisfactory	Highly satisfactory
○	○	○	○	○

* 25. Compared to the previous heating system, how is the overall performance of your heat pump?

Much worse	Worse	No change	Better	Much better
○	○	○	○	○

* 26. Have you faced any issues with the heat pump after installation?

- ○ No
- ○ Yes (please specify)

27. In your opinion, how can more people be motivated to switch to heat pumps? *(Select all that apply)*

- [ ] Education about the benefits of using heat pumps
- [ ] Introduce more rebates/financial plans
- [ ] Put a limit on greenhouse gas emissions from each house
- [ ] Penalize homeowners who have not switched yet
- [ ] Educate contractors to guide/motivate the homeowners
- [ ] Simplify the rebate/financing process
- [ ] Other (please specify)

- [ ] Unsure

* 28. We are looking for volunteers with whom we can follow up for the development of testimonials and case studies. These testimonials will highlight your retrofit journey and energy savings to help educate peers and neighbours. Participating in these initiatives helps us in our efforts to create programs that will help mitigate and adapt to climate change.

Are you willing to volunteer to provide a testimonial or participate in a case study?

- ◯ Yes, I am interested in providing a testimonial or case study. Please contact me with additional information.
- ◯ No, I am not interested in providing a testimonial or participating in a case study.

29. What is your contact information?

Name

Email Address

Part 3: Questions for the household without heat pumps

* 30. Have you heard of heat pumps?

- ◯ Yes
- ◯ No

* 31. Rate your knowledge of heat pumps. *(1= no knowledge, 5 = heat pump expert)*

1 5

* 32. What do you think the benefits are of switching to a heat pump? *(Select all you believe are a benefit)*

- [ ] Reduced greenhouse gas emissions compared to natural gas heating
- [ ] No risk of carbon monoxide poisoning compared to natural gas heating
- [ ] Air filtration and dehumidification (better indoor air quality)
- [ ] Provide cooling in addition to heating
- [ ] Very energy efficient
- [ ] Initial purchase cost subsidized by rebates
- [ ] Cheaper to operate compared to electric baseboard heating
- [ ] Cheaper to operate compared to the natural gas furnace

* 33. Do you have any plans to switch to a heat pump?

- ( ) Yes, within five years
- ( ) Yes, within ten years
- ( ) Yes, but further in the future
- ( ) No

* 34. In your opinion, how could you be motivated to switch to heat pumps? *(Select all that apply)*

- [ ] Education about the benefits of using heat pumps
- [ ] Introduce more rebates/financial plans
- [ ] Put a limit on greenhouse gas emissions from each house
- [ ] Penalize homeowners who have not switched yet
- [ ] Educate contractors to guide/motivate the homeowners
- [ ] Simplify the rebate/financing process
- [ ] I won’t be motivated
- [ ] Other (please specify)

_____

* 35. What are the barriers/obstacles for you to purchasing a heat pump? *(Select all that apply)*

- [ ] The initial purchase cost is too expensive
- [ ] Operation cost is too expensive
- [ ] Do not want to invest in the current home
- [ ] Have plans to relocate/sell the house
- [ ] Strata/not permitted
- [ ] Unfamiliar with the technology
- [ ] Satisfied with the current heating/cooling system
- [ ] Lack of space for new set-up/ductwork
- [ ] Cost of upgrading electrical panel
- [ ] Lack of ideal location for outside compressor unit
- [ ] Time constraints to retrofit/upgrade
- [ ] The contractor does not recommend heat pumps and/or prefers natural gas heating
- [ ] Lack of knowledgeable contractors
- [ ] Heat pumps make too much noise
- [ ] The outdoor unit doesn’t look good
- [ ] Heat pumps do not provide enough heat
- [ ] Other (please specify)

Part 4: Demographic information

* 36. Which community do you currently live in?

- ◯ Aldergrove
- ◯ Brookswood-Fernridge
- ◯ Fort Langley
- ◯ Murrayville
- ◯ Walnut Grove
- ◯ Willougby-Willowbrook
- ◯ Rural area
- ◯ Langley City
- ◯ I do not live in the Township of Langley

37. What type of home do you live in?

- ◯ Detached/Single-family
- ◯ Duplex
- ◯ Townhouse/Row house
- ◯ Multi-family apartments
- ◯ Secondary Suite
- ◯ Mobile home
- ◯ Other (please specify)

38. What is the approximate size of the home? (i.e., 2000 sq ft) (*Please write the number only)*

39. Approximately what year was the home built? (i.e., 1955)

40. What is your age?

- ◯ Less than 25
- ◯ 25 to 34
- ◯ 35 to 44
- ◯ 45 to 54
- ◯ 55 to 64
- ◯ 65+
- ◯ Prefer not to say

41. What is your annual household income?

- ◯ Less than CAD $50,000
- ◯ CAD $50,000 - $100,000
- ◯ CAD $100,000 - $150,000
- ◯ More than CAD $150,000
- ◯ Prefer not to say

Click '**Submit**' below to complete the survey.

Thank you for participating. Your feedback is important!

Township of Langley

Freedom of Information Statement: Any personal information collected on this survey will be managed in accordance with the Freedom of Information and Protection of Privacy Act and is stored on Canadian servers. Direct inquiries, questions, or concerns regarding the collection, use, disclosure, or safeguarding of personal information associated with this survey to Supervisor, Information, Privacy and Records Management, 20338 – 65 Avenue, Langley BC, V2Y 3J1, foi@tol.ca 604.532.7396.

APPENDIX B: SURVEY QUESTIONNAIRE FOR HVAC CONTRACTORS

Current State of Heat Pump Adoption in the Township of Langley

Welcome and thank you for participating in the Township of Langley's Current State of Heat Pump Adoption survey. This survey is designed specifically for HVAC companies and contractors who operate in the Township of Langley to find out the current state of installing heat pumps and the barriers/obstacles they are facing while installing/promoting heat pumps. Your responses to the survey will support the Township of Langley in achieving greenhouse gas reduction goals outlined in the Climate Action Strategy.

This survey will take around 5 minutes to complete. We appreciate you taking the time to fill out this important survey.

Need Support?

If you need clarification regarding a question or want updates about the project, please contact Sarah Maleska, Environmental Sustainability Coordinator at Township of Langley at smaleska@tol.ca, or Jannatul Ferdous, UBC Sustainability Scholar at jannatul.ferdous@ubc.ca.

Part 1: General information regarding the homes where you installed heat pumps in recent years

* 1. Which residential dwelling types do you install heat pumps in mostly? *(Select all that apply)*

- [ ] Detached/Single-family
- [ ] Townhouse/Row house
- [ ] Multi-family apartments
- [ ] Duplex
- [ ] Triplex
- [ ] Mobile home
- [ ] Other (please specify)

* 2. Approximately, how many existing homes have you installed heat pumps in during the last 5 years (i.e., not new construction)? Enter ‘0’ if none.

* 3. Before installing a heat pump, what were the primary heating sources in these existing homes? *(Select all that apply)*

- [ ] Electric radiant
- [ ] Electric baseboard
- [ ] Electric boiler
- [ ] Electric furnace
- [ ] Natural gas fireplace
- [ ] Natural gas boiler
- [ ] Natural gas furnace
- [ ] Wood-burning stove or fireplace
- [ ] Propane/Gas furnace
- [ ] Oil furnace
- [ ] Other (please specify)

Part 2: General information regarding heat pump installation

* 4. What reasons do your clients provide for upgrading to a heat pump? *(Select all that apply)*

- [ ] The previous system broke down
- [ ] Fear of imminent breakdown of previous heating system
- [ ] Reduce greenhouse gas emissions/environmental and climatic performance/sustainability considerations
- [ ] Air filtration benefits
- [ ] Adding cooling
- [ ] Increase home value
- [ ] Improve home’s thermal comfort
- [ ] Reduce energy bills
- [ ] Available rebates
- [ ] Other (please specify)

* 5. Which types of heat pumps have you installed most? *(Select all that apply)*

- [ ] Central heat pump
- [ ] Mini-split heat pump (1 head)
- [ ] Multi-split heat pump (2 or more heads)
- [ ] Air-to-water hydronic heat pump
- [ ] Combination air and hot water heat pump
- [ ] Ground-source or geothermal heat pump
- [ ] Other (please specify)

* 6. What percentage of heat pump installations require a home electrical service upgrade?

0% 100%

7. In your experience, approximately how much does it cost to upgrade the home's electrical service for a new heat pump?" *(Enter number only, do not include decimal or dollar sign ($))*

- ◯ Unsure

$

* 8. Before installing a heat pump, did you discuss/promote any rebates with the homeowner?

- ◯ Yes
- ◯ No

9. If yes, please select the name of the rebate program(s) and/or provider(s) you mention:

- [ ] Better Homes BC (Provincial)
- [ ] BC Hydro
- [ ] FortisBC
- [ ] Canada Greener Homes (Federal)
- [ ] Unsure
- [ ] Other (please specify)
- [ ] Not applicable

* 10. Do you receive any incentives/benefits for installing heat pumps?

- ◯ Yes
- ◯ No

11. If yes, who do you receive these incentives/benefits from?

* 12. What challenges or concerns have you faced from homeowners when discussing installing a heat pump in their home? *(Select all that apply)*

- ☐ Homeowner’s hesitation to take on financing/debt for the new heat pump
- ☐ Cost of upgrading electrical panel is too high for homeowner
- ☐ The homeowner is unfamiliar with the technology
- ☐ The rebate process seems like too much work/confusing
- ☐ Lack of ideal location for outside compressor unit
- ☐ Lack of space for new set-up/ductwork
- ☐ Supply chain issues
- ☐ No challenges/concerns
- ☐ Other (please specify)

* 13. In your opinion, how can more people be motivated to switch to heat pumps? *(Select all that apply)*

- ☐ Education about the benefits of using heat pumps
- ☐ Introduce more rebates/financial plans
- ☐ Put a limit on greenhouse gas emissions from each house
- ☐ Penalize homeowners who have not switched yet
- ☐ Educate contractors to guide/motivate the homeowners
- ☐ Simplify the rebate/financing process
- ☐ Other (please specify)

* 14. Considering the increasing demand for heat pumps, how well is your organization/company prepared to meet customer expectations?

Not prepared	A bit prepared	Moderately prepared	Prepared	Highly prepared
◯	◯	◯	◯	◯

Click '**Submit**' below to complete the survey.

Thank you for participating. Your feedback is important!

Township of Langley
Est. 1873

Freedom of Information Statement: Any personal information collected on this survey will be managed in accordance with the Freedom of Information and Protection of Privacy Act and is stored on Canadian servers. Direct inquiries, questions, or concerns regarding the collection, use, disclosure, or safeguarding of personal information associated with this survey to Supervisor, Information, Privacy and Records Management, 20338 – 65 Avenue, Langley BC, V2Y 3J1, foi@tol.ca 604.532.7396.

APPENDIX C: WAYS FOR ADMINISTERING THE SURVEYS

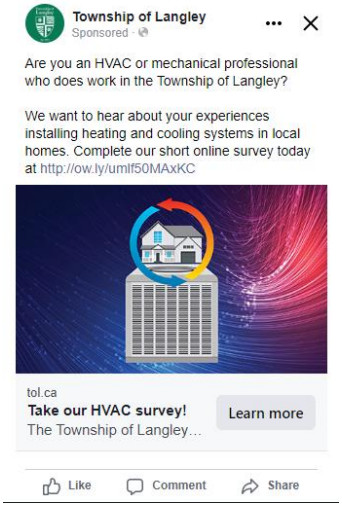
C.1 Poster/Sandwich Board Ad

C.2 Newspaper ad example (January 26, Langley Advance Times)

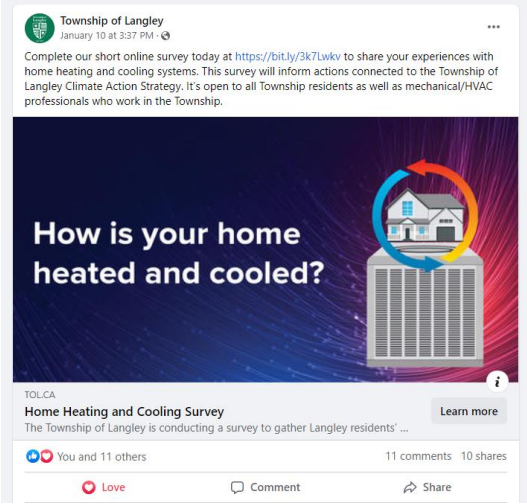
C.3 Social media ad examples

Instagram story

HVAC ad



Facebook ad



APPENDIX D: ADDITIONAL RESULTS

D.1 Performance of Primary Heating Systems based on their Ages

The relationship between the age of the primary heating system and its heating performance was investigated. In general, newer systems have better performance and it is evident from Figure D1. 37% and 35.3% of respondents rated their primary heating systems as 'Excellent' and 'Good' for their heating performance, respectively, which have been installed within the last 5 years. 35.2% and 30.8% of respondents that have systems between 6 to 10 years old said the heating performance was 'Excellent' and 'Good' respectively (Figure D1).

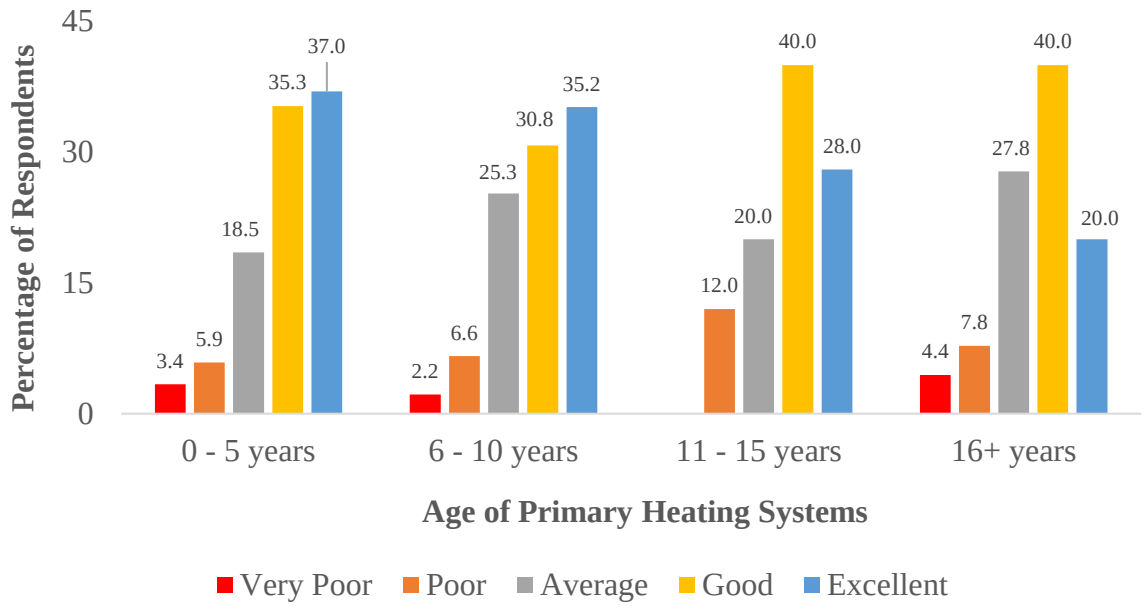


***Figure D1**. Heating performance of all primary heating systems based on their ages*

On the other hand, 4.4% of the respondents are using heating systems which are more than 16 years old, and they rated their heating performance as 'Very Poor'. Additionally, another 7.8% rated their old (16+ years) heating system as 'Poor' (Figure D1).

Analysis was carried out to determine if there is a connection between the age of the heating systems and GHG emissions. Given that, most of the respondents are using natural-gas-based heating systems, despite being installed in different time periods, most of them rated their systems 'Average' in terms of GHG emissions (Figure D2). The same scenario can be seen for the utility costs criteria. Respondents rated their systems as 'Average' mostly despite having systems from different installation periods (Figure D3).

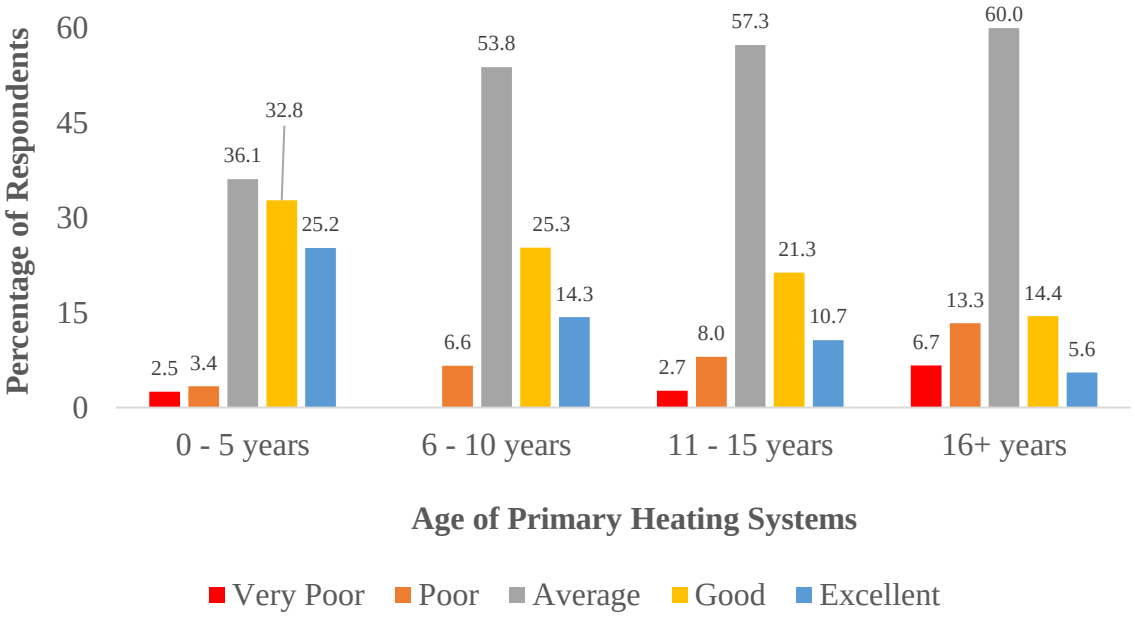


Figure D2. *GHG performance of different primary heating systems based on their ages*

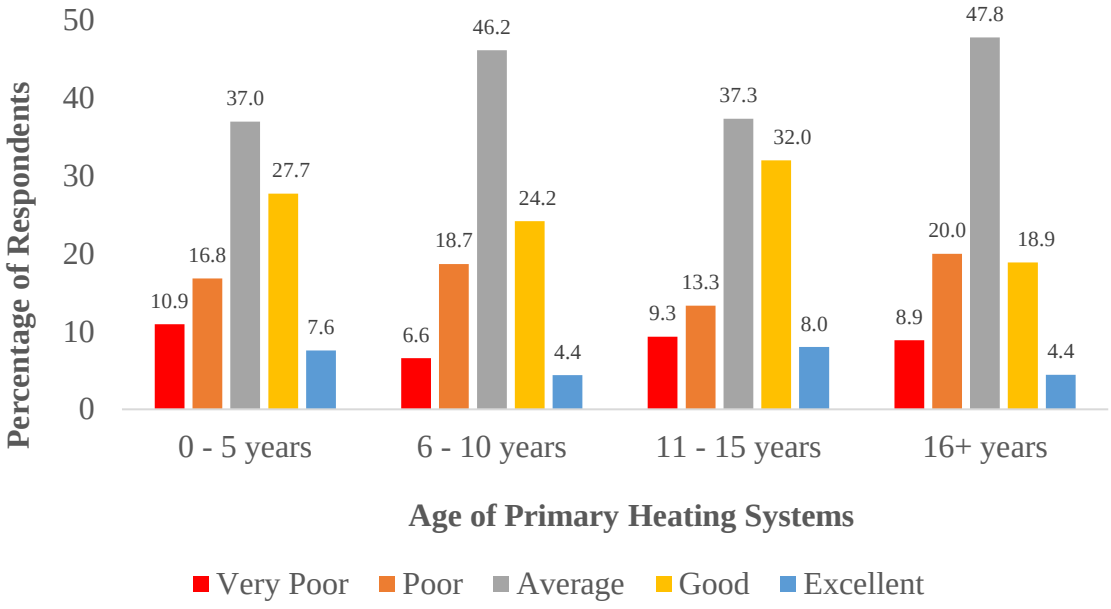


Figure D3. *Performance of different primary heating systems in terms of utility costs based on their ages*

D.2 Retrofitting Plans and Demographic Profile of Respondents

Analyses were also carried out to portray the relationship between having retrofitting plans and their demographic profile – annual household income, age, and community they are currently living. Respondents with higher income are more interested in retrofitting but there is also a higher percentage for 'No' plans in these higher income groups (Figure D4). For

example, around 32% of respondents from both the '$100,000 – $150,000' and 'More than $150,000' income groups have plans to replace/upgrade their current heating/cooling systems. On the other hand, 37.5% of the '$100,000 – $150,000' and 33.3% of the 'More than $150,000' income groups do not have plans. So, it is not very dependent solely on their income.

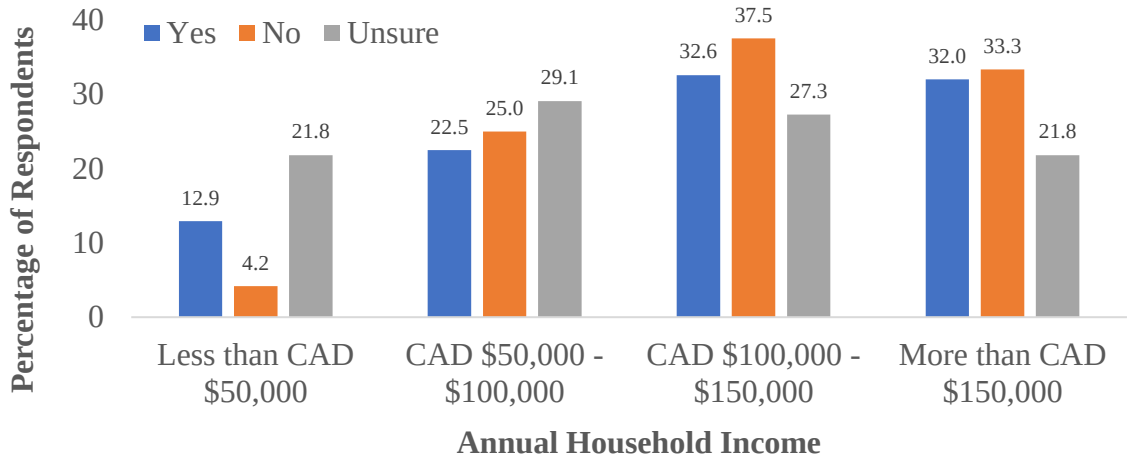


Figure D4. *Annual household income of the respondents and their responses for upgrading the systems in the next year*

There is not very significant variation in the responses for having retrofit plans based on the neighbourhood (Figure D5). But higher 'Yes' percentages are seen in the 'Walnut Grove' (23.9%) and 'Brookswood-Fernridge' (14.3%) areas. On the other hand, negative responses were higher in the 'Murrayville' (19.4%) and 'Willoughby-Willowbrook' (35.5%) areas (Figure D5).

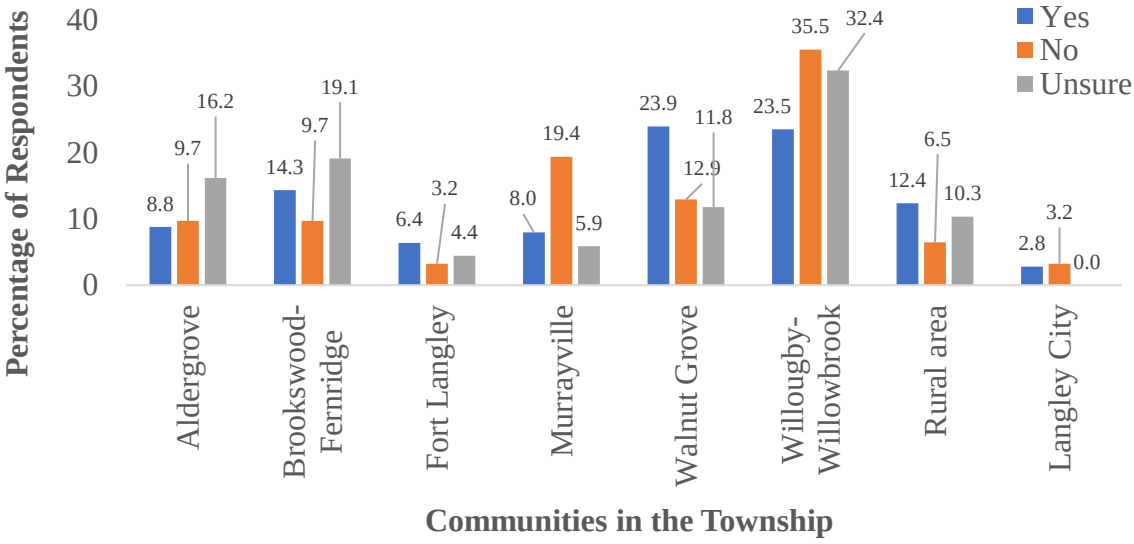


Figure D5. *Location distribution of the respondents and their responses for upgrading the systems in the next year*

D.3 Installation Period of Heat Pumps and their Performances

The performance of the heat pumps in terms of heating, cooling, GHG emissions, and utility costs according to their ages (derived from installation years) is illustrated in Figure D6. Responses for the 'Good' and 'Excellent' categories are higher in each criterion despite being in different groups of ages of the heat pumps derived from the installation years. Newer systems have slightly more 'Good' / 'Excellent' responses comparatively (Figure D6).

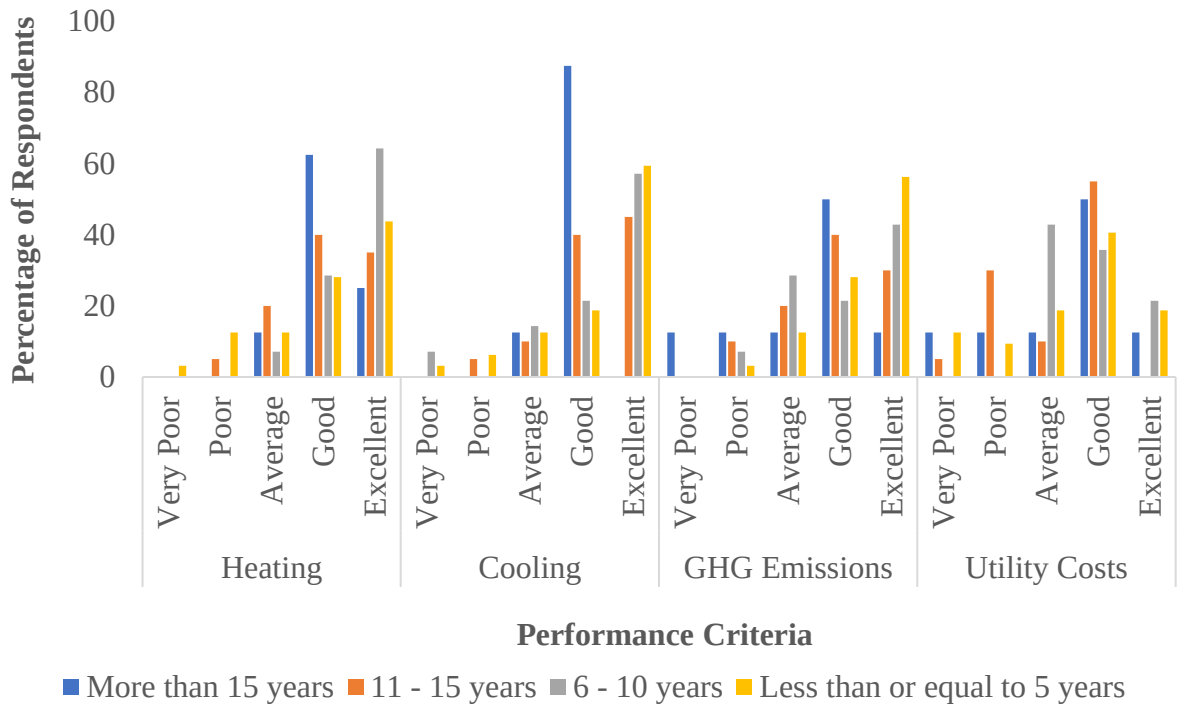


Figure D6. *Performance of heat pumps in heating, cooling, GHG emissions, and utility bills criteria based on their age*