



Assessing Renovation Industry to Deliver Energy Retrofits in City of Kamloops

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Submitted by: **Ms. Priyadharshini Krishnan Ponnammal**
M.Eng Civil Engineering – UBC

Partnering Organization: **City of Kamloops**
Mentor: **Mr. Derek de Candole**
Community Energy Specialist

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 City of Kamloops 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 City of Kamloops or the University of British Columbia.

Acknowledgment

“Be the change you wish to see in the world”, believed Mahatma Gandhi, an Indian leader, who lived in simplicity and employed non-violence throughout his life. Every small change in our way of life can have a massive impact in fighting global warming. Sustainable development is not an option, but a viable solution to the adverse effects of climate change on the planet.

I would like to acknowledge The University of British Columbia Sustainability Initiative – Point Grey campus which is located in the traditional, ancestral, unceded territory of the x^wməθk^wəy̓əm (Musqueam) First Nation. I am grateful for this opportunity to work in the Graduate Sustainability Scholar program and be a part of an innovative and supportive team.

Secondly, I would like to thank The City of Kamloops for allowing me to work with them in developing a home retrofit action plan to achieve the City’s GHG emission target. I am especially pleased to work with Mr. Derek De Candole, Community Energy Specialist, whose mentoring and guidance furthered my interest towards sustainable development.

Last but not the least, I would like to thank my family and friends for their unceasing support throughout the course of this project, and everyone who played their part by staying home and morally supporting each other amidst this stressful pandemic situation.

I plead the Almighty to equip mother earth and her people with their best potential to fight this situation and bounce back successfully.

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Introduction

The City of Kamloops (the City) is committed to meeting the emission reduction targets set by the Provincial government through CleanBC to reduce greenhouse gas emissions (GHGs) by 80% compared to 2007 levels by 2050. To meet this target a significant portion of existing buildings will need to be retrofitted to dramatically reduce GHG's. To this end, the City is developing projects and programs that will encourage the retrofit of low-density residential buildings which emit 20% of community GHG.

To successfully expand retrofit activity a better understanding of a few key topic areas is necessary. First identifying the potential measures that homeowners might take to reduce their emissions and ranking them according to their emissions reduction potential will help guide program design. Second, understanding the renovation industry and the contractors involved in it will help ensure that program design is aligned with their priorities. Third, a review of comparable jurisdictions and their existing retrofit programs will provide some ideas, and lessons learned for consideration in the City's own program.

Project Scope

Provincial initiatives and utility programs (e.g., BC Hydro, FortisBC) for residential home renovations focus on providing rebates to people when they upgrade their homes with energy-efficient technologies. This project is designed to inform the City of Kamloops' approach to encouraging participation in existing rebate programs and increasing the effectiveness of home energy retrofits. To this end a survey of businesses involved in renovations was completed in July 2020, the results of which are summarized and analyzed in this report. Retrofit programs that are currently operating in other jurisdictions in BC are analyzed as well. Discussions with the Regional District of Nanaimo, the City of New Westminster and the District of Saanich were completed to gain an understanding of how their programs are promoted, the basic structure of rebates, and the participation rates of their programs. An analysis was also completed to quantify the net annual emissions reduction possible from a list of 30 measures which were identified as having potential to reduce natural gas use. This analysis will help to prioritize messaging and promotion of these specific retrofit measures through designed programs.

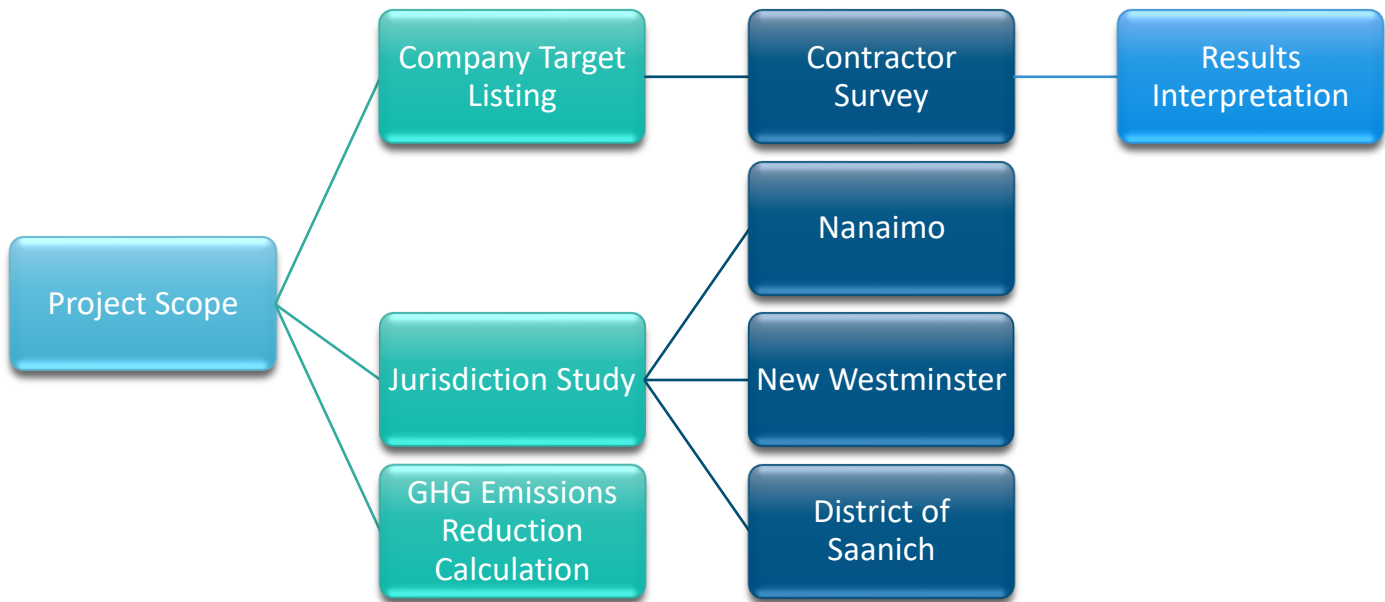


Fig 1 Chart showing the scope of the UBC Sustainability Project

Jurisdiction Overview

Municipalities in British Columbia have the opportunity to participate in Provincial efforts to encourage home energy retrofits through the CleanBC Municipal Top-up Program. The Municipal top-up program has specific incentive values that municipalities can contribute, which are administered by the Province. There are many municipalities including the City of Kamloops which are participating in this program. Several municipalities have developed programs that go above and beyond the municipal top-up opportunity, including the Regional District of Nanaimo, The City of New Westminster, and the District of Saanich, who were among those chosen for review.

Regional District of Nanaimo

The Regional District of Nanaimo (RDN) is an integrated governing body for the municipalities of Nanaimo, Lantzville, Parksville, Qualicum Beach, and seven Electoral areas. With a population of 155,000 people, the RDN has incorporated sustainable development measures and strived to demonstrate leadership by limiting their community's carbon footprint.¹

¹ About Regional District of Nanaimo - <https://www.rdn.bc.ca/about-the-rdn>

The Energy and Sustainability division of the Strategic and Community Development Department of the RDN has introduced Green Building Incentives and related programs to reduce community GHG emission in the region. The RDN has a range of rebates and incentives available which focus on making homes and buildings energy efficient. Though several of the RDN’s programs aim to reduce the carbon footprint of new buildings, the Home Energy Assessment program targets existing buildings specifically and is therefore, the focus of this analysis. Figure 3 provides a summary of the RDN’s programs.

Home Energy Assessment Program:

The program has been in place since 2011 and has seen varying levels of participation over the years. The program has two-steps of incentives:

- Initial Home Assessment Incentive
- Follow up Home Assessment Incentive with an additional performance incentive

The program has changed a few times since its inception, although the two-step structure has remained consistent.²

To participate in the program applicants must submit their initial EnerGuide Home Energy Assessment results and service receipt within 12 months of the date of testing to the RDN Sustainability Coordinator. Once the retrofit is completed, a second Home Energy Assessment must be completed and submitted to validate the performance improvement. A rebate for the assessment and the improved performance is then provided.³ Details of the participation of homeowners in this program are summarized in Table 1.

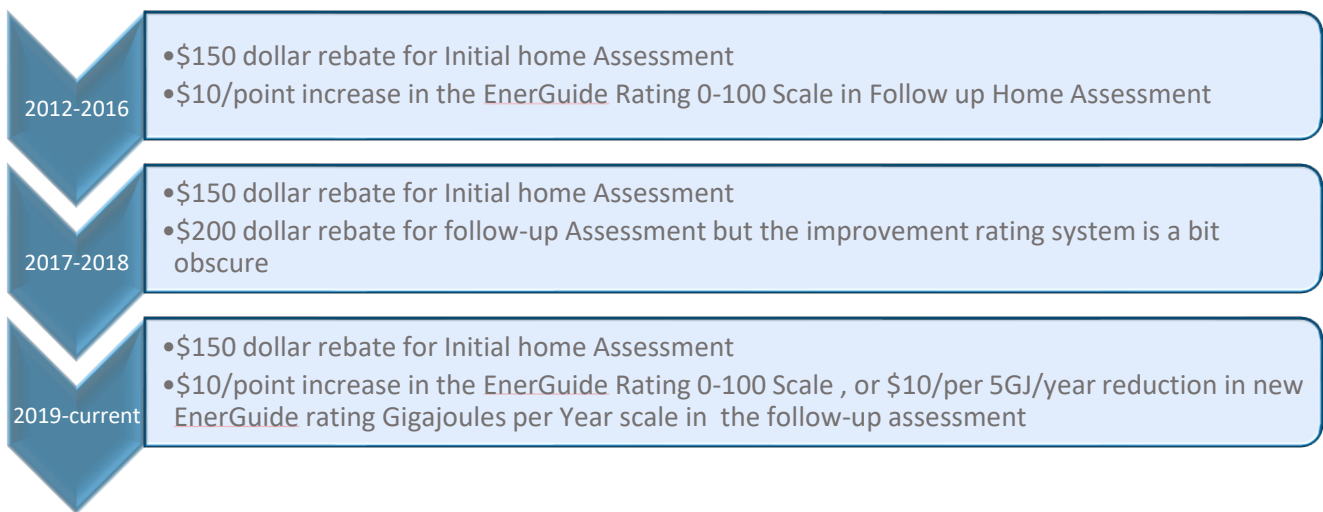


Fig 2 Summary of the format of Home Assessment Rebates over the years in RDN

² Interview with Jessica Beaubier, Climate Change Coordinator, Regional District of Nanaimo (July 2020)

³ Home Energy Assessment, Regional District of Nanaimo - <https://www.rdn.bc.ca/home-energy-assessment>

Home Energy Assessment

Provides incentives (\$150) for home owners who have conducted home energy assessments. On implementing energy efficient retrofits and conducting follow up home assessment by certified home inspectors, additional incentive up to \$200 is provided.

Renewable Energy Systems

Provides incentives of \$250 for homeowners who have upgraded to advanced energy efficient technologies like solar water heaters, photovoltaic solar panels, ground source or water-sourced geexchange and micro and small wind energy sources.

Oil to Heat Pump Rebate

Program of CleanBC which motivates homeowners to switch from oil heating to heat pumps by providing rebates from \$250 to upto \$3000.

Graded Site-Cut Timber

Home owners can receive a rebate of \$250 when they use the timber harvested in their site for home renovation or green construction considering the quality and limits of the site timber.

Residential Electric Vehicle Charging Station

To promote the electric automobile for commuting, RDN provides a rebate of up to \$500 for purchasing and installing electric vehicle charging station in homes through BC Hydro.

Sustainable Development Checklist

RDN has come up with a checklist with all the possible residential retrofits and on completing the checklist, based on the high score the home owner achieves, a rebate from \$500 - \$1000 can be obtained.

Woodstove Exchange Program

RDN provides incentives of \$250 for exchanging old wood stove (not pertaining to CSA B415) with a cleaner burning woodstove and up to \$400 for upgrading to electric, gas, propane or pellet heating to promote good air quality.

Fig 3 Energy retrofit programs in the RDN

Year	2012	2016	2019
No. of initial Assessment rebates issued	69	13	16
No. of follow up assessment rebates issued	43	4	4
Total rebate amount issued (both initial and follow up) (in dollars)	\$7,450	\$2,680	\$3,140
Highest gigajoule (GJ) of energy savings	130	115	100
Lowest GJ of energy savings	0	45	70
Average GJ savings	48	76	92.5
Total GJ saved by the program	2,020	305	370

Table 1 Performance of the RDN Home Energy Assessment Program

Participation in this program has decreased over the years, and RDN staff provided some insight into possible reasons which is summarized below along with some potential future actions to address falling participation.

Interview Insights:

- When the program was launched, there was an extensive promotion by hired marketers with the funding from the LiveSmart BC initiative. At first, the program was quite popular as the community outreach was done on a large scale. However, over time the program has not attracted as much attention as expected.
- The program depends on the pre and post home energy assessment reports to determine energy savings as there is currently no system in place to track the actual energy consumption of the homes.
- To improve the performance of the program, the RDN is working on revising the existing programs based on best practices and considering introducing more attractive rebates.

REEP – Real Estate Energy Efficiency Program is another initiative by the RDN which supports encouraging homeowners in receiving rebates. This program provides 2 hours of training to small groups of realtors on the importance of home efficiency improvements and energy assessments. This allows realtors to learn about the benefits of retrofits and the available rebates and incentives issued by the RDN, utilities, and other levels of government. To encourage their participation in this training, a complimentary home energy assessment (market value ~ \$300) is given to participants which they can pass on to their clients. RDN staff is considering expanding the role of REEP to improve participation in the Home Assessment Rebate Program

City of New Westminster

The City of New Westminster has a program known as Energy Save New West which was introduced to encourage emission reductions in residential homes and commercial buildings.⁴ This program is pivotal to

⁴ Energy Conservation and Climate Change – City of New Westminster <https://www.newwestcity.ca/services/environment-and-sustainability/energy-conservation-and-climate-change>

achieving their emission reduction targets as buildings in New Westminister contribute 41% of community-wide GHG emissions (16% from residential sources, and 25% from commercial buildings).⁵

Energy Save New West Overview:

Energy Save New West was created to provide awareness, training, service, and rebates to the residents of New Westminister for home energy retrofits. The program is applicable to existing homes, new homes, multi-residential and commercial buildings. The various home energy retrofit rebates are funded by CleanBC.

Energy Save New West has a 5-step process for homeowners to follow:⁶

1. Register for Energy Save New West
2. Complete a pre-retrofit home energy assessment with an Energy advisor which is subsidized by CleanBC and New Westminister
3. Complete recommended home improvements based on the report
4. Post-home energy assessment to verify increased home performance
5. Collect rebates for home retrofit and performing an evaluation

The City has been running the program since 2011 and has recently surveyed the participants and hired a sustainability scholar from UBC to further study the performance of the program.⁷

Participation in the program: The program has been running continuously since 2011.⁸ The survey categorized people in three ways; people who only registered for the program, people who registered and completed a pre-retrofit energy assessment, and people who did registration, pre-retrofit energy assessment, upgrades, and post-energy assessment. Table 2 summarizes total participation since 2013 and figure 4 shows the number of assessments completed every year until 2020.

Assessment recorded by	No. of Assessments
CityGreen & NRCan	386
CityGreen only	7
NRCan/Hero NewWest	5
Total	398
Evaluation type	No. of records
Pre-Evaluation only	359
Pre and Post Evaluation pairs	39
Grand total	398

Table 2 Number of home assessments completed in New Westminister 2013-2019

⁵ Official Community Plan 2017 – City of New Westminister

[https://www.newwestcity.ca/database/files/library/Official_Community_Plan_\(Consolidated_August_2018\).pdf](https://www.newwestcity.ca/database/files/library/Official_Community_Plan_(Consolidated_August_2018).pdf)

⁶ Existing homes – EnergySave – City of New Westminister - <http://www.energysavenewwest.ca/existing-homes/>

⁷ Survey for EnergySave NewWest – through mail with the participants

https://docs.google.com/forms/d/e/1FAIpQLSctmcj5h6uh_YzMPj6ovXbgTumvJqOIErth21p5y2VnrCw2nQ/viewform

⁸ Energy Save New West – 2018 Year in Review –

<http://www.energysavenewwest.ca/news/energy-save-new-west-2018-year-in-review/>

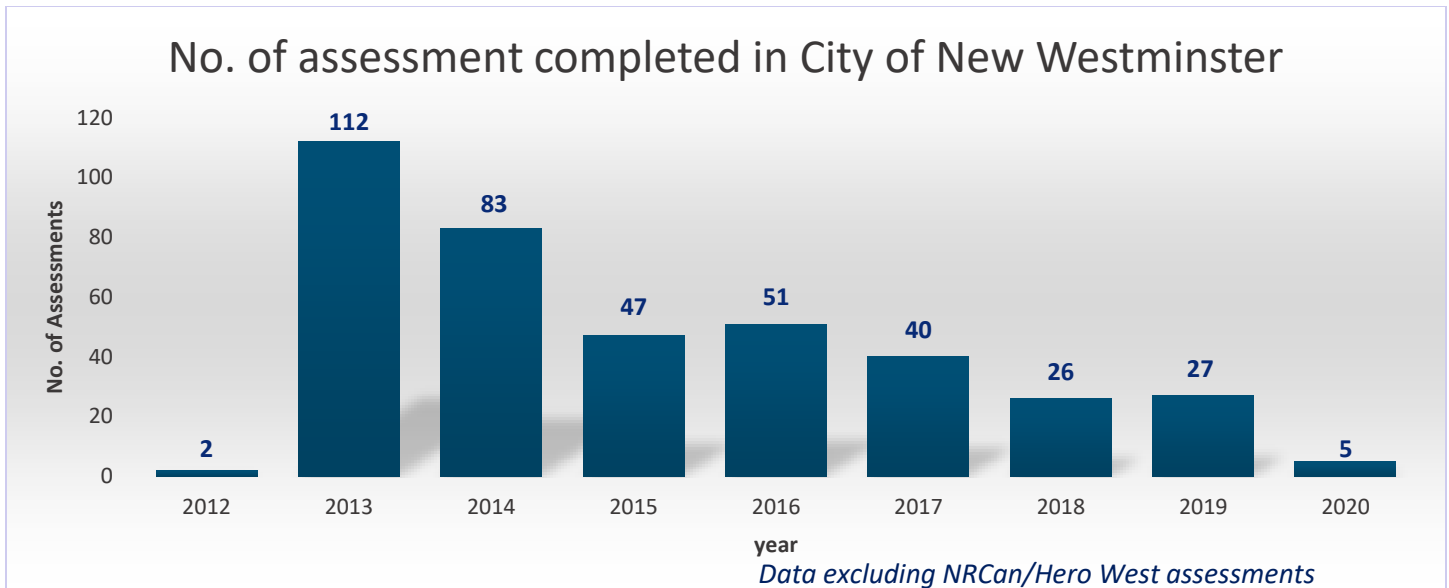


Fig 4 number of assessments over the year in Energy Save New West program

Energy use reduction: The survey was completed by 39 respondents, the average GHG emissions level based on pre-retrofit home energy assessment reports was modeled at 11.86 tonnes/year/household, the average modeled emissions in the post-retrofit assessment was 9 tonnes/year/household resulting in a 2.86 tonnes/year/household average reduction.⁹

Program Marketing: The City of New Westminster has its own electric and gas utility which enables them to market their program and incentives by including the information with their utility bills. They also use electronic billboards, print advertising, case study profiles in news and social media to advertise the program. Every fall and spring the City updates its communication strategy to enhance the program participation.

District of Saanich

In January 2020, the District of Saanich adopted the “2020 Climate Plan – 100% Renewable & Resilient Saanich” with goals to:

- Reduce GHG emissions by 50% by 2030 and net-zero by 2050 (over 2007 baseline year)
- Adopting 100% renewable energy by 2050

The Climate Action Plan was developed with substantial public participation which included three phases of public engagement, 55 events, which resulted in about 3,000 people being engaged.¹⁰ The District of Saanich encourages residents to set their personal GHG emission target by adopting the “Global Fair Share” approach. The District developed a GHG emission calculator with which people can determine the emissions they are responsible for, and set a target with a climate commitment sheet provided by the District.¹¹

⁹ Based on survey results – provided by the UBC sustainability scholar working on project EnergySave NewWest program

¹⁰ 2020 Climate Action Plan -January 2020 – District of Saanich

<https://www.saanich.ca/assets/Community/Documents/Planning/sustainability/2020-Climate-Plan-intro.pdf>

¹¹ Resident’s Climate Action Guidebook – District of Saanich

The District of Saanich participates in the Municipal Top-up Program as summarized in Table 3.¹² The homeowners can apply for standard CleanBC rebates for energy upgrades and registered participants are automatically eligible to receive these additional top-ups from the District.

Program	Rebates - Top-ups over CleanBC rebates
Fossil fuel space heating to heat pumps	\$350 by District of Saanich & \$350 by Central Regional District
Electric Panel Upgrade during fossil fuel to heat pump transition	\$500 by District of Saanich
Electric heat pump water heaters	\$350 by District of Saanich
Pre-retrofit EnerGuide Home Evaluation	\$150 by District of Saanich

Table 3 municipale ‘top-up’ rebates provided by District of Saanich

Program Initiation: For the past 10 years, the District had been providing incentives through their Green Homes program which provides oil tank to heat pump incentives and more recently through the CleanBC top-ups program.¹³

Background Study: The District conducted a thorough background review using census data, energy efficiency data from NRCAN, and BC Assessment Data to gain a quantitative understanding of their community. They also collected qualitative data through public engagement activities including focus groups that explored topics such as climate literacy and resident interest in energy efficiency upgrades.¹⁴

Program Promotion: The program was advertised using the District of Saanich website, social media, E-newsletters, brochures, and posters/displays at community festivals, public presentations, community recreational centres, and through earned media.

Rebate Program Performance: The data on the number of assessments completed and rebates provided are yet to be collected. While past programs such as the oil to heat pump incentive program have seen excellent participation, the current number of rebates do not appear to be achieving the levels required to meet the City’s current GHG reduction targets.

<https://www.saanich.ca/assets/Community/Documents/Planning/sustainability/Climate-Guidebook.pdf>

¹² Climate – Friendly Home Incentives – District of Saanich

<https://www.saanich.ca/EN/main/community/sustainable-saanich/climate-change/programs-rebates/climate-friendly-home-incentives.html>

¹³Conversation with Glenys Verhulst – Sustainability Planner – District of Saanich

¹⁴ Climate Action Plan Newsletter and Reports – District of Saanich <https://www.saanich.ca/EN/main/community/sustainable-saanich/climate-change/climate-videos-enewsletters-other-resources.html>

Fostering Behavioural Changes

Residents and their daily activities play a large role in community-wide GHG emissions in a city. Small differences like reducing shower time by only 2 minutes can save up to 5 gallons of water and its associated heating energy which could make a big impact if adopted broadly.¹⁵ To help the City of Kamloops prioritize the promotion of different behaviour changes and energy retrofits that households might take, a list of energy efficiency measures were shortlisted to those that would reduce natural gas use and then ordered from highest potential emissions reduction to lowest. This complete analysis can be found in Appendix A. These behaviours can be broadly categorized by those which affect space heating, domestic water heating and home insulation. This analysis represents a component of the first step of Community Based Social Marketing, an approach to behaviour change pioneered by Dr. McKenzie-Mohr.¹⁶

This initial step is to figure out the energy upgrade with the highest potential GHG emissions reductions by studying all the possible behavioral changes. To determine the most promising behavioral changes, there are three factors to consider:¹⁶

- **Impact:** The level of GHG emissions reduction expected from the behavioral change
- **Probability:** The chances of the public accepting the behaviour change. These can be identified by conducting surveys and focus groups to create awareness and determine public opinion.
- **Penetration :** The extent to which the measure has already been implemented by the target group.

This analysis helps to determine the likely impact [of...].

Data Collection:

Table 4 summarizes key statistics according to NRCAN in British Columbia in 2017¹⁷. This data was used to calculate the emissions reduction potential of various behavioural changes in kgCO₂e/household/year.

Category	Data
Number of households	1923000
Energy Use for Space heating	83.4 PJ
Energy Use for water heating	44 PJ
GHG emission by space heating	2.6 Mt of CO ₂ e (excluding electricity)
GHG emission by water heating	1.8 Mt of CO ₂ e (excluding electricity)
GHG emission due to 1 GJ of NG	49.87 kg CO ₂ e

Table 4 showing the energy use and emission of BC household calculated by NRCAN

¹⁵ Climate and Environment – The Washington Post

<https://www.washingtonpost.com/news/energy-environment/wp/2015/03/04/your-shower-is-wasting-huge-amounts-of-energy-and-water-heres-what-to-do-about-it/>

¹⁶ McKenzie-Mohr, Doug, 1959- Fostering sustainable behavior : an introduction to community- based social marketing – 3rd ed.

¹⁷ Residential Sector BC Energy end use and emission – NRCAN Database (2017) -

<https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP§or=res&juris=bc&rn=2&page=0>

According to Energy Star, a ductless mini-split heat pump HVAC system saves 60 % of the energy used by a normal resistance-based heating system.¹⁸ When it replaces a natural gas system, the GHG reduction would be nearly 100%. 60% in energy savings corresponds to a 60% reduction in emissions from space heating and therefore, we can estimate a minimum reduction of 1,500 kg/year/household of CO₂e emissions. For a change in domestic hot water heating such as installing an on-demand system, NRCAN suggests that 30% less energy is used when compared to conventional tank-type water heaters.¹⁹ This means we can expect a GHG emissions reduction of 322 kg/year/household when a household switches to a tankless hot water system. The U.S Department of Energy says home insulation methods such as installing window covers can potentially reduce heat loss by 40% or more, which equates to about 20% heating energy savings and approximately 202 kg/year/household of CO₂e reduction.²⁰ These are a few examples of the estimated emissions impact; more details on the 30 selected behaviors are outlined in Appendix A. This information will be used to select the best practices to be encouraged in the City’s new home renovation program.

Target Company Listing:

The City of Kamloops categorizes building industry contractors by general contracting, renovation contracting, HVAC, and insulation contracting. Of the more than 5,000 businesses in the City, over 600 were targeted with a direct mail-out advertising the survey. Those contractors fit into the following categories as shown in table 5:

Type of Business	Findings
General Contracting	<ul style="list-style-type: none"> • 219 General Contractors • 12 of them are industrial or infrastructure contractors • 5 of them are Green Building contractors • 21 of them do only engineering designs and drafting contracts
Renovation Contracting	<ul style="list-style-type: none"> • 84 General Renovation Contractors • 3 of them do water or fire damage restoration exclusively • 14 interior design contractors • 19 Home inspection service companies • 17 exclusively kitchen and Bathroom renovation contracting services

¹⁸ Ductless cooling and heating – Energy Star https://www.energystar.gov/products/heating_cooling/ductless_heating_cooling

¹⁹ Tankless water heater – NRCAN - <https://www.nrcan.gc.ca/energy/products/categories/water-heaters/14541>

²⁰ Energy efficient window attachments – U.S Department of Energy <https://www.energy.gov/energysaver/energy-efficient-window-attachments>

HVAC Technician	<ul style="list-style-type: none"> • 105 HVAC contracting companies • This includes companies that do all kinds of electrical services and plumbing service providers
Insulators	<ul style="list-style-type: none"> • 60 Insulation contractors • Includes 8 exclusive drywall contractors and 28 exclusive roofing contractors

Table 5 listing the number of various businesses targeted for the study

Renovation Industry Survey Results

To reduce GHGs from residential buildings, the City intends to promote energy retrofits to homeowners who are planning a renovation. General contractors, renovation contractors, HVAC technicians, and insulators are key businesses that can help influence the decisions of their clients during home renovations. For this reason, the City surveyed these businesses to better understand the following:

- What market segments make up significant portions of their businesses
- How they interact with existing incentive programs
- Their business outlook given the pandemic

The survey was posted on the City of Kamloops' website and business owners were encouraged to respond to the survey. A letter was sent to all the targeted businesses and the Canadian Home Builders Association – Central Interior promoted it through their newsletter. Survey results were collected between June 26th and July 19th, 2020. Over that period 40 companies responded. Complete results can be seen in Appendix B.

A key objective of the survey was to validate different market segments. Contractors were asked to estimate the percentage of their clients who would fit into the following categories:

Home Buyers:

As it is common for people who have recently purchased a home to conduct extensive renovations, this market segment was identified as a good target to encourage energy efficient upgrades with planned renovations. The businesses being surveyed were asked what portion of their clients had (to their knowledge) recently acquired the home being renovated. Of the businesses who responded (shown in figure 5) an average of 31% of their clients were recent home buyers making up a sizeable portion of their business.

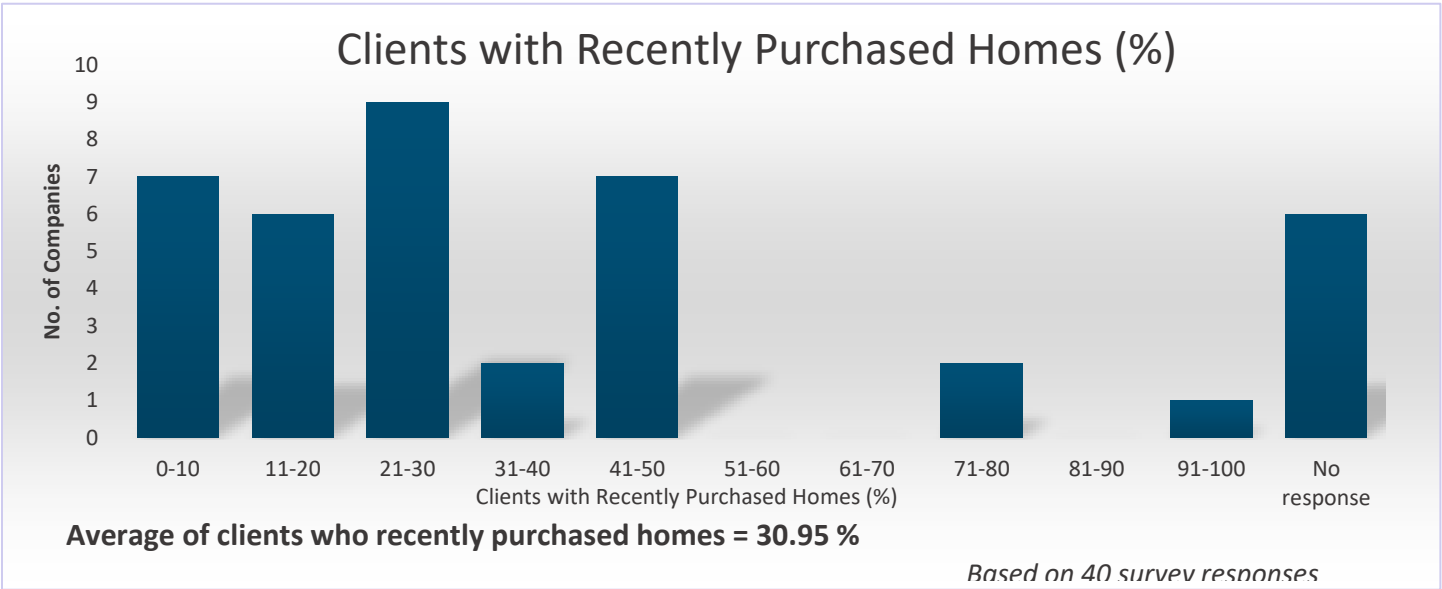


Fig 5 chart showing ownership details of the clients

Renovation due to damage:

Homes are prone to natural disasters like floods, hurricanes, or other kinds of damage like fire will require immediate renovation. The survey data shown in figure 6 explains that only about 10% of the clients of the participating businesses are repairing damage caused by natural disaster. This can be partially explained by the make-up of businesses who responded to the survey (i.e., none identified restoration as their primary business).

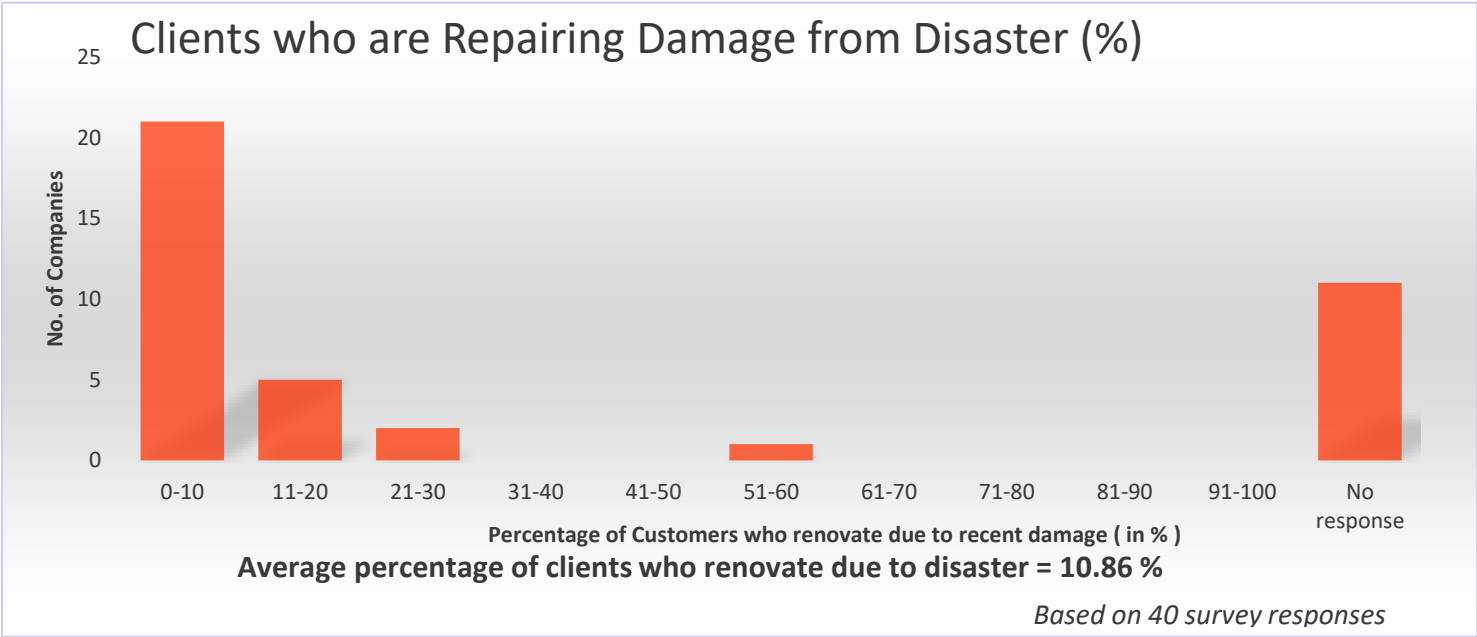


Fig 6 Chart showing clients percentage who renovate due to damage

Large Scale Renovation:

Large scale renovations seem to represent the biggest market segment with 26 businesses reporting it as comprising more than 20% of their business, while 8 responded that it was more than 50%, shown in figure 7.

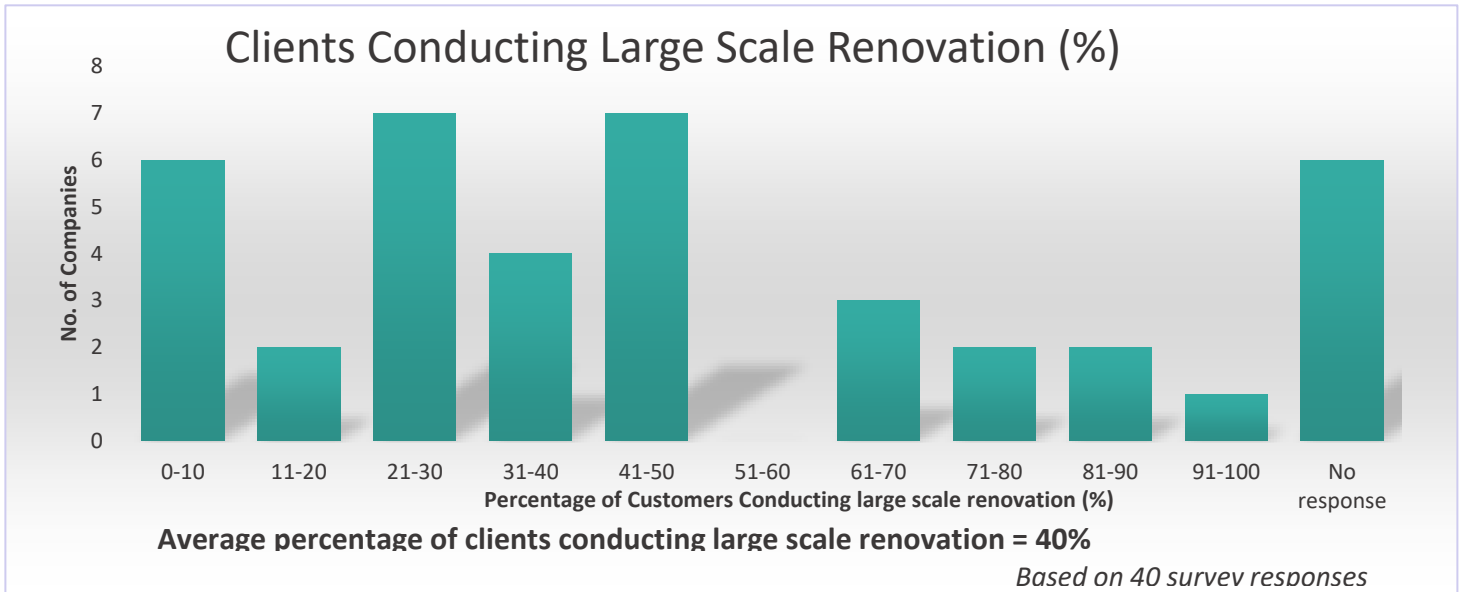


Fig 5 chart showing clients who do large renovations

Regular Home Repair:

Figure 8 shows that 14 companies claim less than 20 % of their customers are doing necessary repair or ongoing maintenance of their homes. Few contractors surveyed linked their clients with doing regular home repair/maintenance. 11 companies skipped this question. While perhaps not the most common motivation for homeowners to conduct a renovation, it is clearly work performed by most of the companies surveyed.

Replacing Failed Equipment:

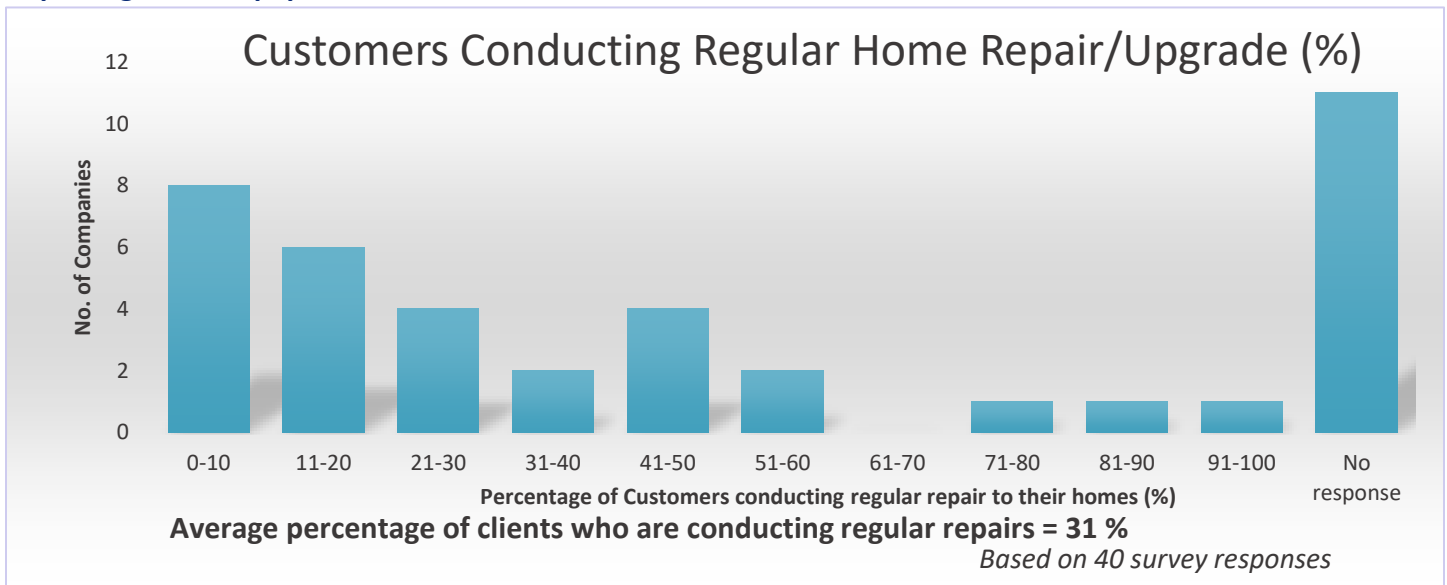


Fig 8 chart showing clients who do repair works in their homes

Replacing failed equipment was the most skipped of the market segment questions, with almost half (17) companies choosing not to respond. Of those who did respond, most (9) said it represented less than 10% of their clients as seen in figure 9.

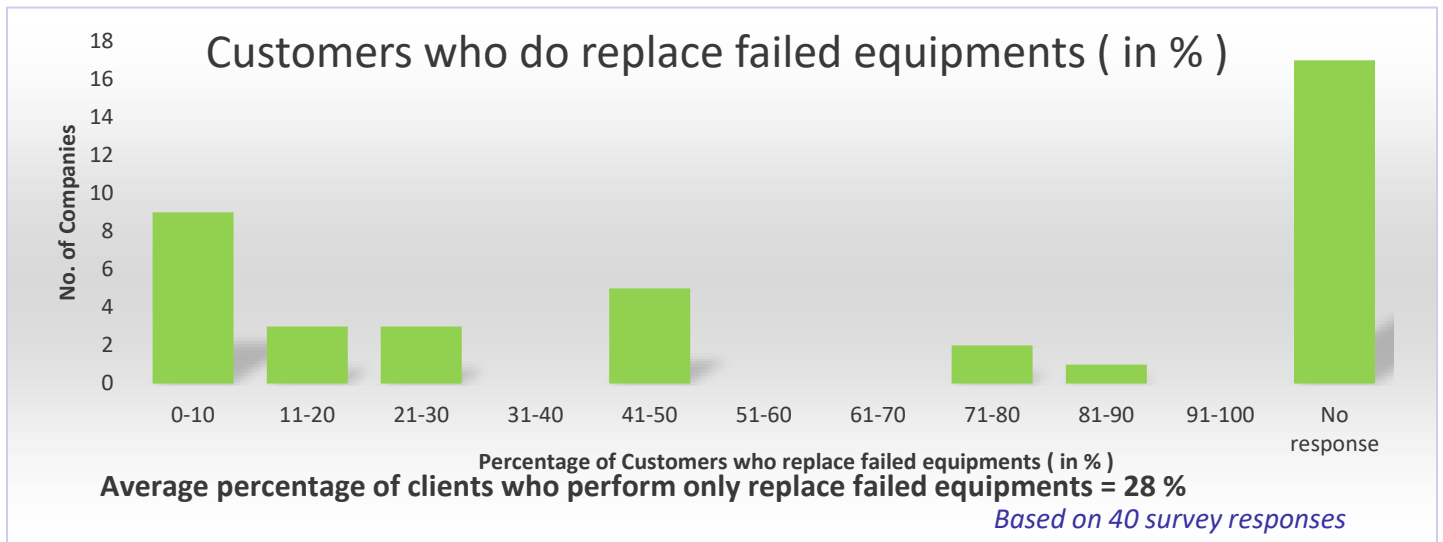


Fig 9 chart showing clients who replace failed equipment

Survey respondents provided comments on the other reasons their clients conduct renovations such as;

- Customers upgrade homes to increase their aesthetic appearance and/or add a new home feature (e.g., a basement suite).
- To increase the value of the property with energy-efficient changes in their homes.
- Since purchasing a new home is not affordable for some, clients consider home renovation to make their existing home more modern.
- The personal interest of people to choose environmentally sound technologies.
- To add modern equipment or features such as hot tubs and heat pumps

Conclusion

This UBC sustainability project examined the potential of industries to deliver energy retrofits in existing homes through a contractor survey with the objective to better understand the existing state in the City. The project scope included researching existing home retrofit programs in comparable cities and estimating the GHG reduction potential of select energy conservation measures. The project deliverables are intended to provide meaningful insights that will help inform the development of a home energy retrofit program in the City of Kamloops.

Appendix A – Impact of Behavioural Changes

Behaviour	Insight	Emission reduction (kg/household/year)
1. Insulating basement	A study by the department of energy of the US shows that in Seattle people save up to 280 USD per year for insulating the basement of 1500 sqft where the cost of 1 therm = 0.72 \$ for HVAC fueled by natural gas. ¹	2,045
2. Installing ductless mini-split heat pump	Energy star suggests that the ductless minisplit HVAC system saves 60 % of the energy used by a normal resistance-based heating system. ² In the case of replacing a natural gas system the GHG reduction would be nearly 100% from space heating (upto 2782 kg/year/household).	1,502
3. Installing Heat Pump Water Heater (HPWH)	NRCAN suggests that using EnergyStar HPWH can use up to 50% less energy compared to the standard electric water heater. ³ In the case of replacing a natural gas system the GHG reduction would be nearly 100% from water heating.	1,076
4. Installing a solar water heater	NRCAN suggests that a solar water heater can meet 60 % of hot water demand in a normal household. ⁴	560
5. Electric fireplace instead of NG fireplace	NG powered fireplace has only an efficiency of 70% whereas electric fireplace is 99% efficient and produces much less GHG emissions. ⁵	498

¹ Basement Insulation – Technology fact sheet – U.S Department of Energy

<https://web.ornl.gov/sci/buildings/docs/factSheets/basement%20Insulation%20Technology%20fact.pdf>

² Ductless cooling and heating – Energy Star

https://www.energystar.gov/products/heating_cooling/ductless_heating_cooling

³ Heat Pump Water Heater – NRCAN <https://www.nrcan.gc.ca/energy/products/categories/water-heaters/14556>

⁴ Solar Water Heaters – NRCAN - <https://www.nrcan.gc.ca/energy/products/categories/water-heaters/14562>

⁵ Determining how a gas fireplace affect your heating bill – NRCAN - <https://www.nrcan.gc.ca/energy-efficiency/about-energy-star-canada/energy-star-announcements/publications/all-about-gas-fireplaces/contents/appendix-determining-how-gas-fireplace-will-affect-your-heating-bill/6799>

Behaviour	Insight	Emission reduction (kg/household/year)
6. Installing HRV	Based on few research papers, on the average there will be 35% saving in GHG emission. ^{6 7}	473
7. Purchasing RNG	Renewable Natural Gas is carbon neutral gases and it reduces GHG emission by replacing the natural gas usage. Consumers can have a 10%, 25%, 50% or 100% mix of RNG with their regular NG supply. ⁸	436 (adding 10% RNG with NG supply)
8. Installing external air barriers	With external air barriers, the leaks and gaps are filled and save up to 36% of space heating energy. ⁹	405
9. Upgrade to a central heating system	Energy star says, on an average, based on various models of central heatpump systems there is a 30% reduction on federal minimum usage for space heating. ¹⁰	405
10. Shut internal doors to rooms not being used	Calculated with FortisBC home energy calculator by providing the area of rooms as; Living room = 700 sqft Living room + bedroom = 900 sqft. ¹¹	350
11. Plugging unused chimney	By using chimney balloons to plug the chimney makes the building 27% energy efficient in terms of space heating. ¹²	338

⁶ El Fouih, Y., Stabat, P., Rivière, P., Hoang, P., & Archambault, V. (2012). Adequacy of air-to-air heat recovery ventilation system applied in low energy buildings. *Energy and Buildings*, 54, 29–39. doi:10.1016/j.enbuild.2012.08.008

⁷ Li, B., Wild, P., & Rowe, A. (2019). Performance of a heat recovery ventilator coupled with an air-to-air heat pump for residential suites in Canadian cities. *Journal of Building Engineering*, 21, 343–354. doi:10.1016/j.job.2018.10.025

⁸ Reducing GHG emission with RNG – FortisBC - <https://www.fortisbc.com/services/sustainable-energy-options/renewable-natural-gas/public-sector-organizations-reducing-ghg-emissions-with-rng>

⁹ Air dealing fro new home construction – U.S Dept of Energy <https://www.energy.gov/energysaver/air-sealing-your-home/air-sealing-new-home-construction>

¹⁰ ENERGY STAR most efficient 2020 – Central heating system - https://www.energystar.gov/products/most_efficient/central_air_conditioners_and_air_source_heat_pumps

¹¹ Home enrgy calculator – FortisBC - <https://www.fortisbc.com/rebates-and-energy-savings/saving-energy-in-your-home/home-energy-calculator>

¹² Cimney Ballon field test – The Chimney Ballon - <https://www.chimneyballoon.us/fireplacedampertest.html>

Behaviour	Insight	Emission reduction (kg/household/year)
12. Installing an on-demand water heating system	NRCAN suggests that tankless water heaters use 30 % less energy than conventional tank-type water heaters. ¹³	322
13. Using shower timer to reduce shower length to 4 minutes	If an average Canadian shower time is 8 minutes, a study by McGill University suggests that a showerhead which let 2.5 Gallons/min, reducing 4 mins in shower length will save 10 Gallon of hot water. ¹⁴	298
14. Replacing windows with EnerGuide windows	Energy star suggests that there is 12% saving in energy bill national wide by installing energy-efficient windows. ¹⁵	274
15. Upgrading to an energy-efficient furnace	Energy Star says, most of the energy-efficient furnace models save 20 % of energy when compared with standard furnace models. ¹⁶	270
16. Installing right-sized water heaters	Calculated by comparing the performance of 40 Gallon and 60 Gallon capacity water heater	220
17. Operating window covers	U.S Department of Energy says In heating seasons, installed cellular shades can reduce heat loss through windows by 40% or more, which equates to about 20% heating energy savings. In cooling seasons, cellular shades can reduce solar heat through windows by up to 80%, reducing the total solar gain to 15% or less when installed with a tight fit. ¹⁷	202
18. Installing Smart thermostat	NRCAN suggests that 8 % energy is saved by using an EnergyStar efficient programmable thermostat. ¹⁸	200

¹³ Tankless water heater – NRCAN - <https://www.nrcan.gc.ca/energy/products/categories/water-heaters/14541>

¹⁴ This is how much water Canadians waste – Global News – <https://globalnews.ca/news/3016754/this-is-how-much-water-canadians-waste/>

¹⁵ Residential windows, doors and skylights – Energy Star - https://www.energystar.gov/products/building_products/residential_windows_doors_and_skylights

¹⁶ Energy Star most efficient furnace 2020 - https://www.energystar.gov/products/most_efficient/furnaces

¹⁷ Energy efficient window attachments – U.S Department of Energy <https://www.energy.gov/energysaver/energy-efficient-window-attachments>

¹⁸ Connected/Smart Thermostat – NRCAN <https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-products/product-information/heating-equipment-residential-us/connected-or-smart-thermostats/15781>

Behaviour	Insight	Emission reduction (kg/household/year)
19. Using low flow aerators in the sink	Calculated by comparing 1gpm faucet and 2.2gpm faucet water flow	147
20. Installing Programmable Thermostat	U.S Department of Energy suggests, 10% a year saving on heating and cooling by simply turning the thermostat back 7°-10°F for 8 hours a day from its normal setting. ¹⁹	135
21. Insulating hot water tanks	U.S Department of Energy suggests Insulating water tanks can save energy by 7-16%. ²⁰	129
22. Electric cooktop over gas stoves	Calculated using FortisBC calculator by comparing electric cooktop and NG stove. ³²	125
23. Decreasing water heater temperature	U.S Department of Energy suggests, there will be 4-22% saving on energy based on temperature decrease. ²¹ Considering other studies also, an average saving of 12% is considered.	112
24. Repairing leaking hot water pipes	BC Hydro says that every year 11350 lit of water by leaky faucets per household per year. ²²	102
25. Caulking windows	Caulking windows saves 5-10% energy in heating the homes. ²³	101
26. Changing HVAC filter regularly	The study by the scientists in the National Renewable energy laboratory in the USA and the University of Colorado states that for more extreme fouling cooling source energy savings can be up to 5% in cooling-dominated climates and heating source energy savings can be 7% - 9% in heating dominated climates.	94

¹⁹ Thermostats – U.S Department of Energy - <https://www.energy.gov/energysaver/thermostats>

²⁰ Saving Project: Insulated heater - U.S Department of Energy - <https://www.energy.gov/energysaver/services/do-it-yourself-energy-savings-projects/savings-project-insulate-your-water>

²¹ Saving Project: water heater temperature-U.S Dept of Energy - <https://www.energy.gov/energysaver/services/do-it-yourself-energy-savings-projects/savings-project-lower-water-heating>

²² Fix a water leak – BC Hydro - <https://www.bchydro.com/powersmart/residential/savings-and-rebates/do-it-yourself-and-save/fix-hot-water-leak.html>

²³ Weatherstripping windows - U.S Dept of Energy - <https://www.energy.gov/energysaver/services/do-it-yourself-energy-savings-projects/savings-project-how-weatherstrip-double>

Behaviour	Insight	Emission reduction (kg/household/year)
27. Caulking windows	caulking of windows saves up to 5-10% energy in space heating the homes. ²⁴	101
28. Insulating hot water pipes	According to the U.S Department of energy, there will be 2-4% saving by insulating hot water pipes. ²⁵	32
29. Draining settlement in DHW tanks	Based on various studies, on an average for 1 mm of scale, there will be a 2% increase in fuel consumption. ²⁶	21
30. Insulating interior and exterior walls*	R22 residential wall advised in BC has both interior and exterior insulations with R= 13.4 and R= 6 respectively ²⁷ . The heat loss reduction by adding this insulation is calculated	Heat loss reduction/hour by adding Interior insulation = 7923 Btu Exterior Insulation = 6455 Btu

*Insulating interior and exterior walls can have a dramatic affect on a home's energy performance, however, given the wide variation in existing conditions, heating technologies and options for improvement it was too difficult to assign a value for comparison with confidence.

²⁴ Weatherstripping windows - U.S Dept of Energy - <https://www.energy.gov/energysaver/services/do-it-yourself-energy-savings-projects/savings-project-how-weatherstrip-double>

²⁵ Saving Projects: Insulate Hot water pipes – U.S Dept of Energy - <https://www.energy.gov/energysaver/services/do-it-yourself-energy-savings-projects/savings-project-insulate-hot-water-pipes>

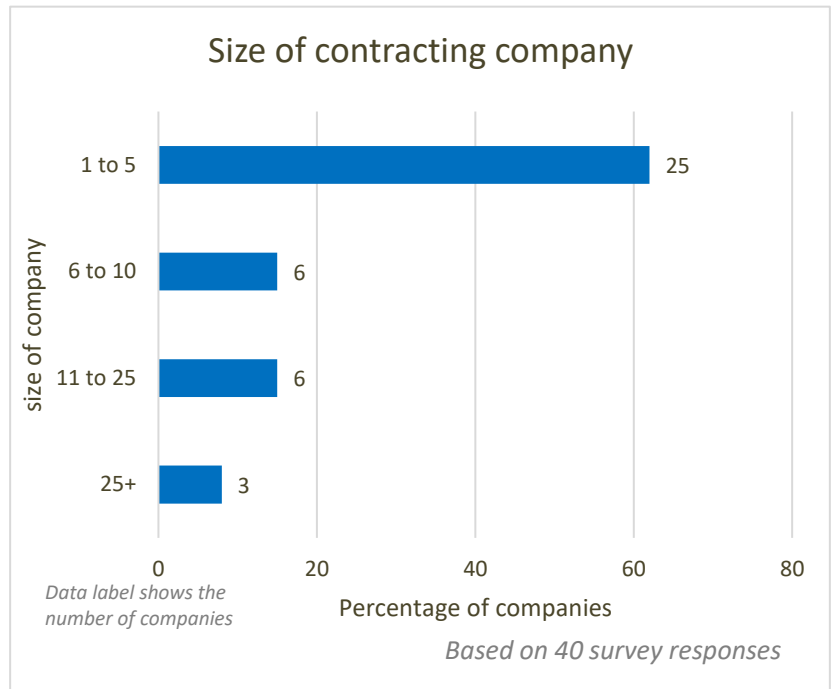
²⁶ Improving energy efficiency of boiler systems - CED Engineering - <https://www.cedengineering.com/userfiles/Energy%20Efficiency%20Boilers.pdf>

²⁷ R22+ Effective walls in residential construction in B.C. – B.C Housing- <https://www.bchousing.org/research-centre/library/residential-design-construction/ig-R22-effective-walls-residential-construction>

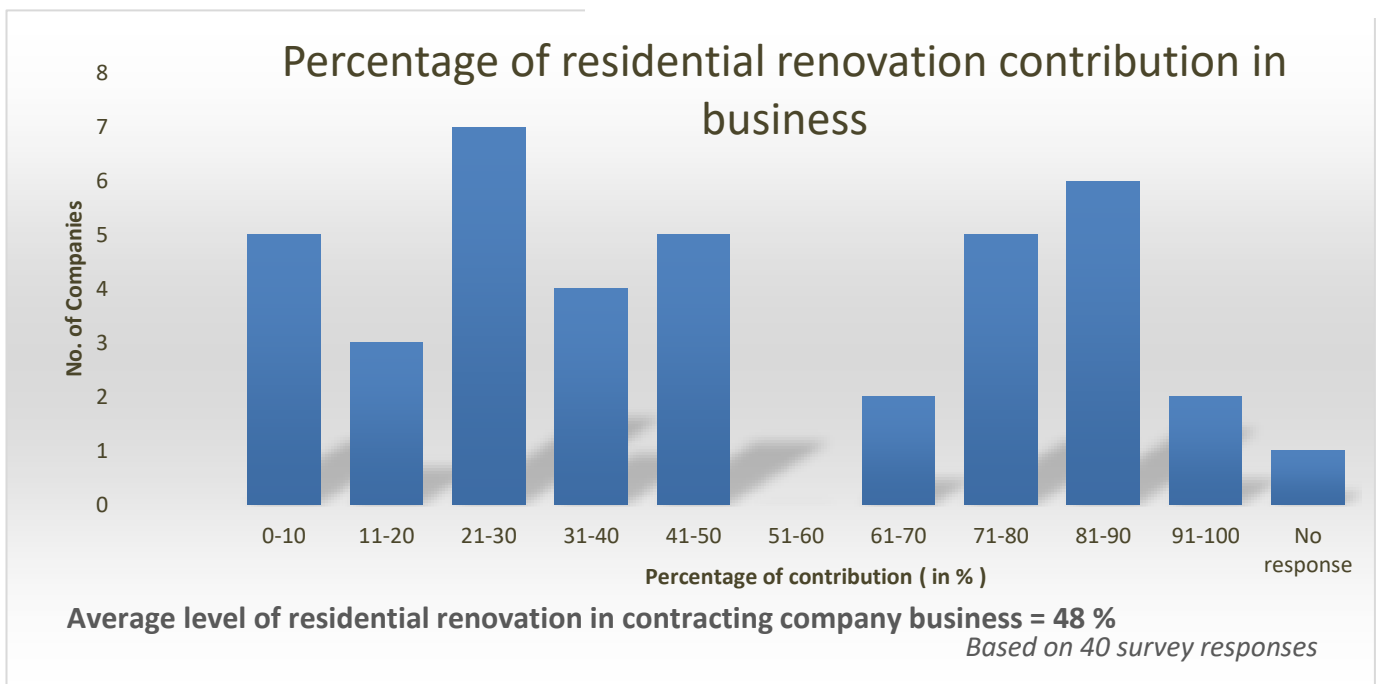
Appendix – B Survey Result

Average size of the company:

Based on the 40 survey responses acquired, we find that 62% of the companies had a manpower of 1-5 employees, about 15% of them had 6-10 and 11-25 employees each and less than 10% of companies had more than 25 employees.



Contribution of Renovation Business:

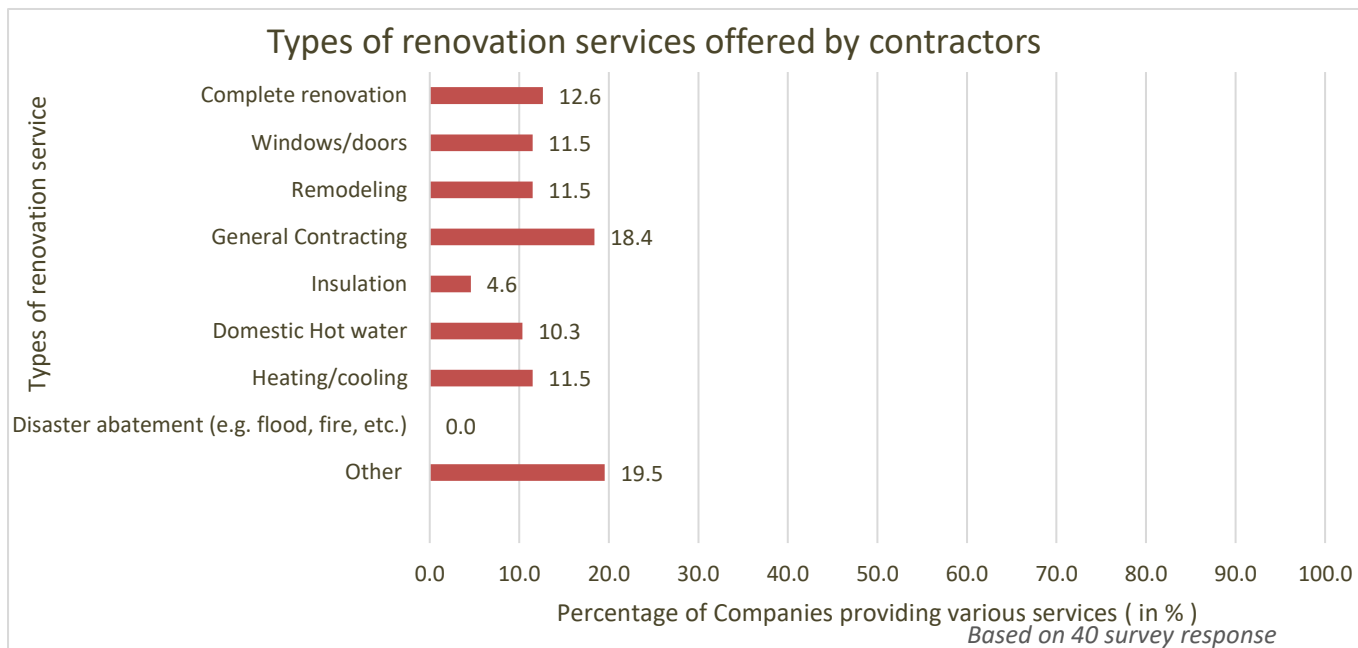


A lot of companies that have responded to the survey do more than renovation contracting. The survey questionnaire had a slider responder which the attendees used to denote the participation of residential renovation in their business services. It can be seen from the plot that, some companies have around 30% of their business as residential renovation whereas a good number of contractors do mostly (about 90%) renovation. On average we can conclude that based on data contractors in the city have about 50% (48.6% precisely) part of their business as residential renovation.

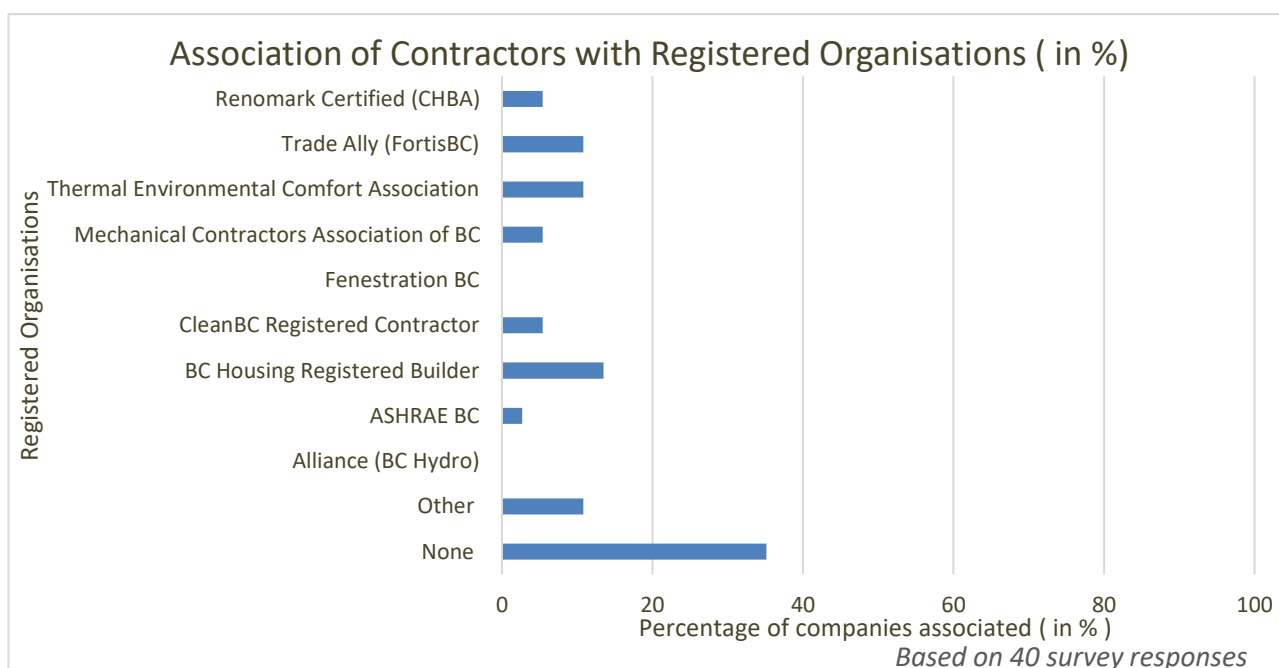
Type of Residential Renovation:

The plot below shows that most of the companies deliver all types of renovations like HVAC, Remodelling, Insulation, Domestic water heating, and similar kinds with an exemption on disaster rehabilitation. It is to be noted that the same company offers more than one type of renovation in the city. The respondents also have mentioned about other types of services (not in the questionnaire) provided by them such as;

- Masonry
- Painting
- Flooring
- Fireplace renovation
- Renovation Design
- Other plumbing
- Property Development
- Electrical upgrades
- Excavation

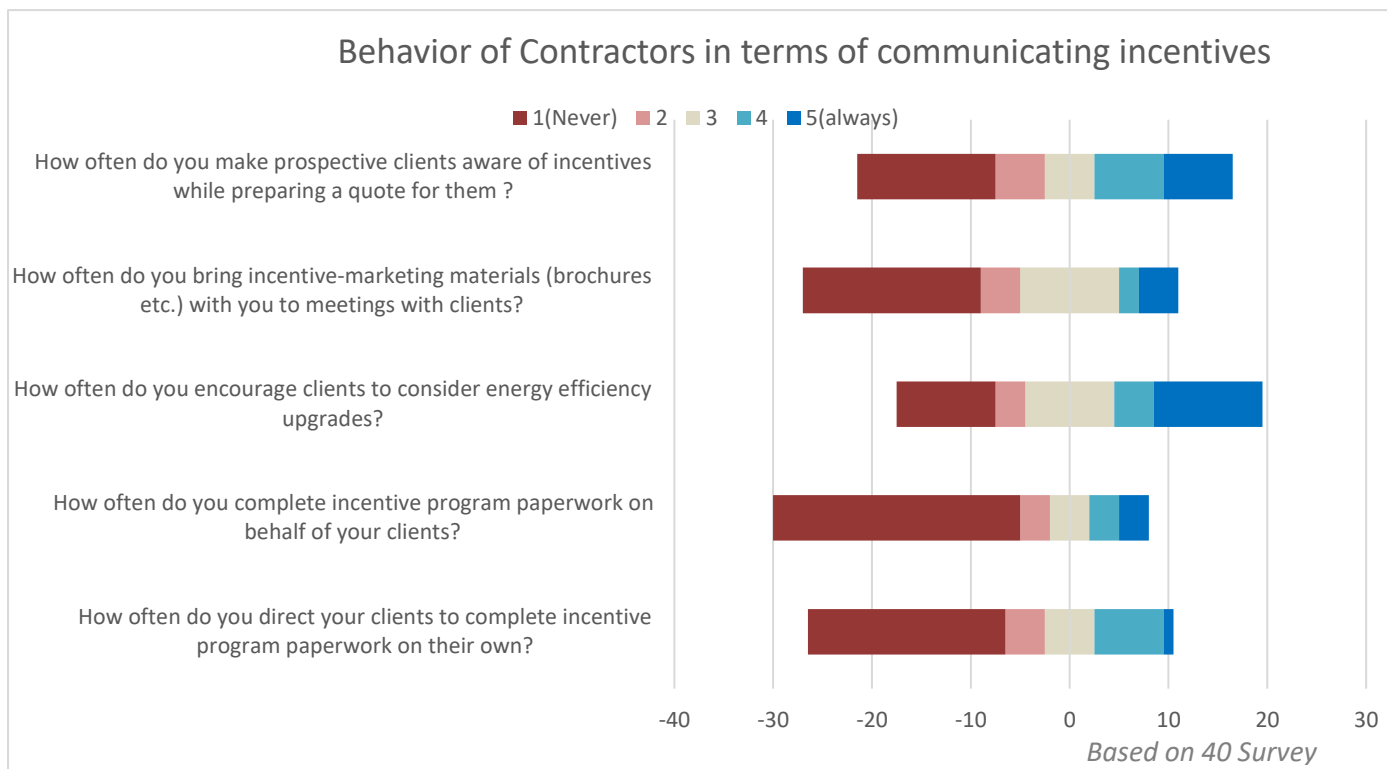


Affiliation with Organizations:



The federal and other registered organizations have got a decent number of participation among the contracting companies as shown in the chart. But a good number of companies have no association with any of the mentioned network of companies. The respondents also have pointed out the other BC registered organization they are affiliated to such as SICA and BCCSA.

Contractors Behaviour – Communicating Incentives:



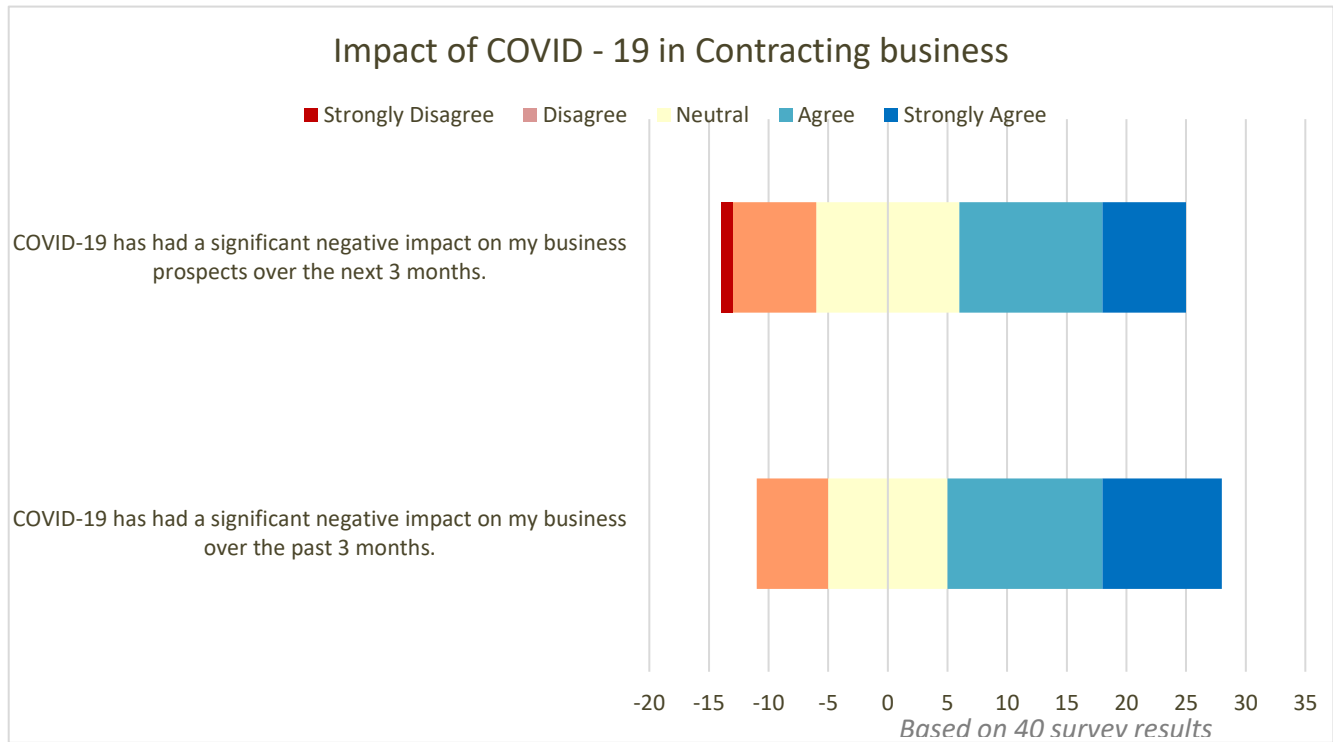
Contractors are considered one of the critical media to deliver information about the latest initiatives and energy efficiency moto of federal and local utilities to the homeowners. Ideally, contractors should encourage the homeowners towards energy retrofits by introducing new eco-friendly and affordable technologies to their clients and enable them to receive rebates from government or utilities for the retrofit performed.

Inferences from the plot are:

- About half the respondents have told that they would not propagate about available incentives to the homeowners while they make quotations for the renovation project, 12.5% of the respondents gave a neutral opinion and 35% of the contractors would communicate rebate programs to clients.
- Most of the survey respondents disagreed or were neutral when asked about taking incentive advertising media like a brochure to clients while talks on the renovation.
- On the contrary, an equal level of the positive and negative response was obtained when asked about how often contractors do motivate the homeowners towards energy retrofit opportunities available.
- The majority of respondents indicated that they would not prepare the incentive paperwork for the clients when they are eligible for the rebates.
- Similar to the previous question, more than half the contractors disagreed when asked about how often do they, direct homeowners, to complete paperwork on their own to obtain rebates from authorized bodies. But a decent number of contractors have either been neutral or were positive about instructing proper filing procedure for receiving rebates.

Though the sample size was less (40 responses), we can infer that most of the contractors are showing minimum interest in promoting the federal and other utilities incentive programs among the homeowners. The new energy retrofit program to be developed in the city should importantly focus on educating the contractors about programs and make them aware of their key role in implementing the energy retrofit initiatives.

Impact of COVID – 19 in the contractor business:



The current pandemic situation around the globe has impaired business progress for a lot of major to budding businesses and created some serious losses in the regular profits of many companies. The contractors were asked to respond to some questions to realize their current business scenario.

- Though there were some neutral opinions and disagreements, the Majority of the contractors answered to agree when asked if there was any negative impact in their business due to COVID – 19 in the past 3 months.
- In the same way, most contractors predict that there will be an unfavourable market condition in the upcoming 3 months as well.

When contractors were asked to point of reasons to why they foresee such market situation, the responses were:

- People would cut back on expenses and so home renovation would be something of interest.
- A significant impact can be seen, if complete regional quarantine is announced.
- Loss of revenue would lead small businesses to shut down.
- Some contractors were optimistic about their business growth as long as there is no recession or second wave of disease spread.
- Projects are slowed down or paused considering the health and safety of clients and their employees.
- Usual low business in fall and winter climate.