# Make the Switch Study
# Draft - Final Report

UPDATED

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***Submitted To***
***District of Saanich***

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# Executive Summary

**The purpose of the project was to** help provide concrete, real world, quantitative data from homeowners who have already switched from a natural gas furnace or boiler to an all-electric heat pump. By surveying before and after energy costs for homes that have undertaken a natural gas to heat pump conversion, as well as seeking some of the contextual details of this shift, the study intended to:

1. Provide real world operating cost comparisons between natural gas furnaces and electric heat pumps used for space heating.
2. Identify home characteristics or retrofit considerations that can optimize a heat pump installation and minimize operating costs (or by contrast those characteristics that do not lead to cost-effective heating and cooling with a heat pump).
3. Develop key messaging to educate homeowners on how to maximize efficiency, comfort, and cost savings when switching to a heat pump.

**Results**

Participant data provided valuable insights into the experience of real-world heat pump users. Data restrictions - including participant location (almost all from Climate Zone 4), scale of participation (n=32), and unknowns regarding what other upgrades were completed outside the sampling window (January 2018 – October 2021) – limit the broad conclusions that may be drawn from the results. Using the data provided, some of the conclusions that may be drawn are:

- Most participating homes experienced reduced or similar overall utility costs after upgrading to a heat pump, regardless of whether they completed additional upgrades to their home. Cost savings with a heat pump were projected for 83% of homes with an increase in carbon taxes to $170/tCO2e, and for 88% of homes when compared to the cost of purchasing 100% renewable natural gas.
    - Higher utility costs in 33% of participating homes may be attributed to improper heat pump sizing, use of less efficient secondary heating equipment, and/or unaddressed inefficiencies in the home's building envelope. Other contributing factors may include user habits (e.g. using cooling feature frequently, or user error (e.g. setting secondary heating system temperatures above that of the heat pump).
- Homes that experienced cost savings varied widely in size and age, with no clear relationships noted between cost savings and upgrades or homeowner activities. This suggests the best way to determine if a home is saving energy with a heat pump upgrade is to analyze a home's utility data directly. It also suggests that any home could achieve cost savings from a heat pump installation, provided the home's unique attributes are taken into account during system sizing/selection and the upgrade itself.
- The cost of heat pump installations appears to have increased by around 25% in the past 4 years. Possibly attributable to a combination of enhanced incentive programs, inflation and supply line issues.
- Survey responses suggest that modern heat pumps installed in Climate Zone 4 commonly do not use a separate back-up (electric baseboards, gas or electric fireplace) and that those systems are performing well as a primary heating system throughout the winter months.
- Completing an EnerGuide evaluation does appear to inform and motivate homeowners to complete deeper retrofits of their building envelope in addition to their heat pump upgrade.
    - This may reinforce the common understanding that promoting and making home efficiency education and tailored recommendations more accessible to homeowners is key to accelerating deep retrofits and achieving climate action targets.

- At least 79% of participants represent highly-educated, affluent households. All but two participants resided in Climate Zone 4.

**Recommendations**

- Customized support with tailored upgrade options (like those provided by an EnerGuide home evaluation) appears to promote deeper retrofits. Consider requiring some form of home energy evaluation to provide customized support and awareness for residents considering retrofits.
- Future investigation focusing on low to mid-income households and colder climates may provide beneficial insights to supplement the findings of this research. Understanding the motivations and barriers for low and mid-income households in completing deep retrofits could assist in the development of more equitable education and incentive programs going forward.
- Further investigation of heat pump operation in colder climates (i.e. interior and northern BC) may provide beneficial insights to supplement the findings of this research.
- Further investigation with participants who achieved notable utility costs savings in the form of a case study or testimonial could prove valuable as a communications piece and for better understanding their home's history of upgrades overall beyond the scope of this study.
- For future study design, we recommend the following:
    - Focus on more in-depth investigations of homes that have information on historical upgrades and/or EnerGuide Evaluations (the Canada Greener Homes Grant may now make the likelihood of an EnerGuide evaluation being completed much higher)
    - Investigation of the prevalence of electric resistance back-ups integrated into heat pumps on Vancouver Island and the Lower Mainland may prove useful for messaging.
    - Increased budget for outreach and participant incentives, as well as collaboration with other programs that may have data and contact information necessary to target the intended study group (e.g. CleanBC, Canada Greener Homes Grant, etc.) may help to improve participation numbers.

# Introduction

Heat pumps are a relatively new and unfamiliar technology for many households in BC. There is a general perception that it is much cheaper to heat a home with natural gas than with a heat pump, and that electricity is too expensive a fuel source to use for home heating. However, concern about the rising cost of natural gas is also growing. A recent survey by BC Hydro found that 59% of homes heated with natural gas are more concerned this year than last regarding their home heating costs, and 77% expect their heating costs to go up this winter. The same study found that despite rising gas costs and low electricity costs, 45% of respondents still think it is more expensive to heat with a heat pump and 44% would not consider switching[1]. This speaks to a deficiency in public understanding that the efficiency of a heat pump can mean operational costs can be the same or even lower than operational costs of a natural gas furnace.

While in some cases electrification may not present a cost-effective option compared to heating with gas, well-installed heat pumps with a high coefficient of performance (COP) can help minimize home energy bill costs while offering a number of other benefits, including air conditioning and improved air quality. A lack of awareness of these benefits, and even misconceptions, around the ability of heat pumps to provide year-round heating and cooling represents a major barrier to the electrification of the building sector necessary to meet the emissions reduction goals of both the Province of BC and local governments.

The Make the Switch Study was undertaken to help provide concrete, real world, quantitative data from homeowners who have already switched from natural gas to a heat pump. By surveying the before and after energy costs of homes that have undertaken a natural gas to heat pump conversion, as well as seeking some of the contextual details of this shift (e.g. size/type of house, complementary upgrades, user settings, quality of equipment and installation, etc.), this project intends to better understand the most important factors that contribute to competitive operating costs for heat pumps. This information will assist in the development of effective and honest communications materials to help homeowners set themselves – and their homes – up for success and dispel common myths about electrical heating as a prohibitively expensive option.

**Project Objectives:**

1. Provide real world operating cost comparisons between natural gas furnaces and electric heat pumps used for space heating.
2. Identify home characteristics or retrofit considerations that can optimize a heat pump installation and minimize operating costs (or by contrast those characteristics that do not lead to cost-effective heating and cooling with a heat pump).
3. Develop key messaging to educate homeowners on how to maximize efficiency, comfort, and cost savings when switching to a heat pump.

**Secondary Objectives**

1. Compare current utility costs for participants with potential future energy bill cost scenarios.
    a. Operational costs of using a heat pump compared to continuing to use natural gas with projected carbon tax increase to $170/tCO2e (2030).
    b. Operational costs of using a heat pump compared to using renewable natural gas with existing heating system.
    c. Electricity utility cost savings achieved with elimination of BC Hydro Tier 2 price.

[1] BC Hydro Bringing The Heat Report. 2022.

**Project Phases:**

- **Phase 1: Literature review and summary report**
  - Research similar studies to develop best practices for data collection and outreach methodology.
  - Research similar studies to determine existing estimates for heat pump operational costs vs. natural gas.
- **Phase 2: Survey development and delivery**
  - Develop survey using online platform (SimpleSurvey chosen)
  - Coordinate outreach to British Columbians to secure appropriate participants willing to complete the survey and provide utility data.
- **Phase 3: Data analysis and findings report**
  - Organize and analyze utility data (performed by RDH building science)
  - Organize and analyze survey data

Determine and present key findings to achieve program objectives.

# Methodology

## Survey design

The participant survey was designed to capture a very wide range of participant information laid out in Appendix A.

Participants were also instructed to upload their utility data to the survey, and were given the alternative option to email utility data. To submit via email, participants had to agree they understood the privacy and security considerations inherent in email file transfer.

## Outreach and communications

Given the expected difficulties in reaching such a niche group with little in the way of known shared characteristics to target, a broad range of online outreach tactics were employed. Quantitative results and outreach graphic and text examples can be found in Appendix A.

### Email outreach to known interested parties

Emails were sent out to interested parties and organizations encouraging them to register and/or share the information with others in their networks. These included:

- Members of local government working groups
- Organizations of interest (e.g. Building 2 Electrification, Home Performance Stakeholders Council)

### Mass email outreach

The mass email service Constant Contact was employed to send emails to publicly available lists of homeowners and industry stakeholders (i.e. Energy Advisors and Heat Pump Contractors)

### Social media outreach

#### Facebook/Instagram

Static image and video paid ads and boosted posts were utilized for outreach on Facebook and Instagram.

*Targeting:*

Initial campaigns were targeted towards the entirety of British Columbia, with subsequent campaigns focusing closer on regions and municipalities who had provided larger top-ups to the provincial rebates (e.g. Vancouver, Langley, Victoria, the North Shore). People who had showed an interest in heat pumps in the past were loosely targeted (algorithm favours them, but does not restrict advertisements to them).

Various other interests were tested, including but not limited to

- Environmentalism
- Sustainable products
- Sustainable living
- Efficient energy use
- Energy conservation

#### Reddit

Outreach on Reddit was completed through outreach to moderators of relevant groups to request to post about the study on their thread. The moderators on the r/heatpumps thread proved helpful in recruitment, as this group was already actively interested and a significant portion of the following was BC-based. Outreach to moderators of other threads (eg. r/britishcolumbia, r/victoria, r/vancouver) were not receptive to our requests to perform outreach to their groups, only r/kelowna allowed it.

Paid outreach was also tested, and while the ad reached a decent number of users, we observed little to no impact on recruitment.

## Data Analysis and Reporting

### Utility bill data analysis

Analysis of the utility bill data was sub-contracted to RDH Building Science. RDH provided analyses to compare the cost of utility bills before and after the heat pump upgrade, as well as weather normalization of energy use data, employing the methodology described in Appendix B.

An analysis of each participant's data has been completed and the results can be found in Appendix B. The first page of Appendix B offers a detailed explanation of the data. This information is typical across all participant data. Additional comments have been made to provide context for unusual findings. Where costing data was unavailable, RDH calculated costing using provided usage rates with current rates. Heat pump installation year was determined by analyzing data trends and using invoices where available.

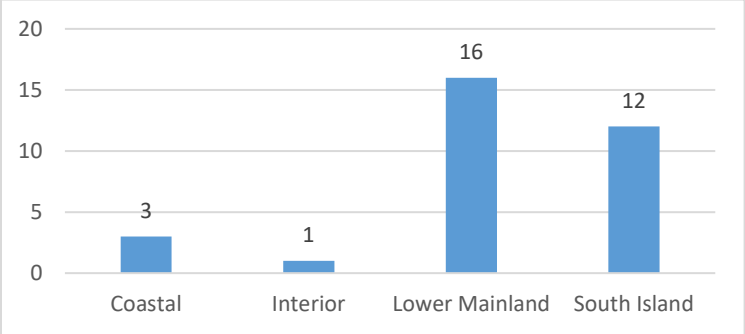
### Survey data organization and analysis

Results from the survey were organized from Simple Survey. Survey responses were analyzed next to utility bill results to determine significant correlations.

# Survey Results

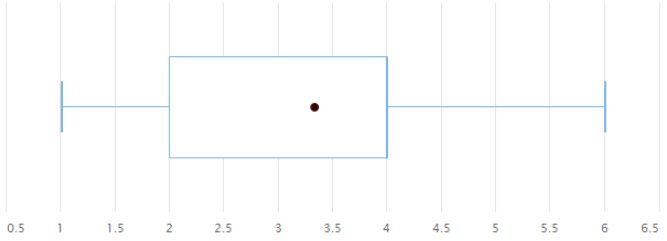
## Participant Summary

51 eligible homes registered for the program of which 32 completed both the survey and provided utility data. Of those 32 participants, 16 were from the Lower Mainland and 12 were from Southern Vancouver Island. Minimal participation was garnered from other parts of the province.

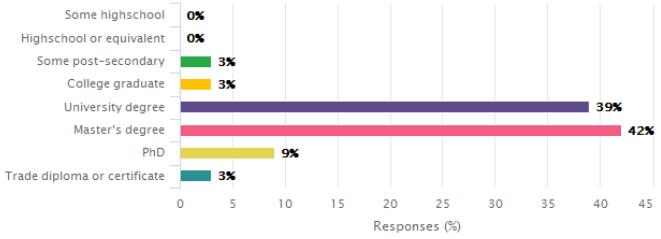



## Participant Summary Continued

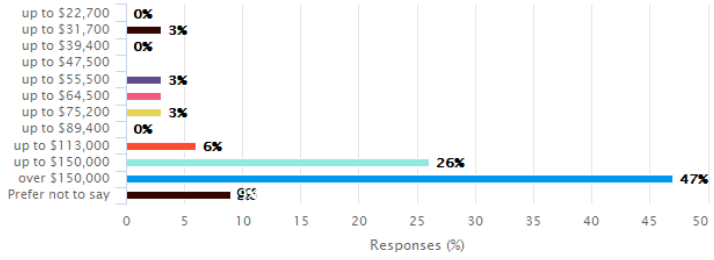
### What is the number of occupants in the household?




### What is the highest level of education you have completed so far?




### What is the household income for 2019?

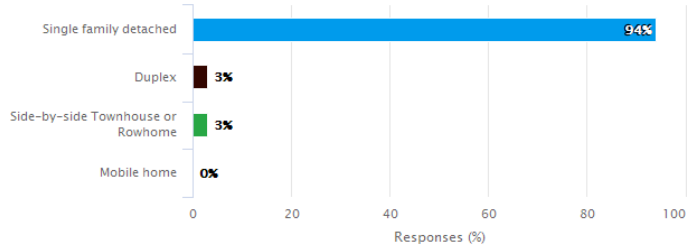



The majority of homes contained between 2-4 occupants. Occupant age responses shows the participants themselves ranged between 30 and 80 years old, with the majority being between 38 and 58. Of the respondents for the household themselves, 68% identified as male, 26% identified as female.

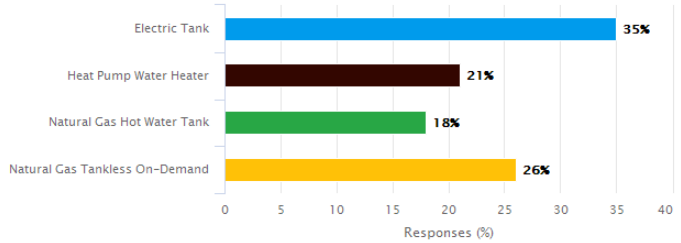
Participants skewed heavily towards highly educated, high-income households, with 73% of participating households making $113,000 or more. This tendency towards highly educated, affluent, and older households is a consistent trend noted across multiple programs; this indicates that those homes most actively installing heat pumps are from a very specific demographic. All participants had some form of post-secondary education, with the majority (51%) holding a graduate degree.

## Home Summary

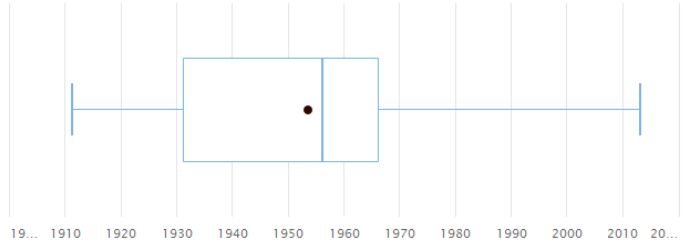
### What is the home type?



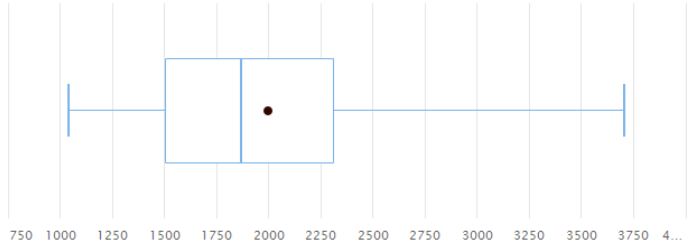

### What type of hot water heating system do you currently have?




### What year was the home built?




### What is the home's square footage?

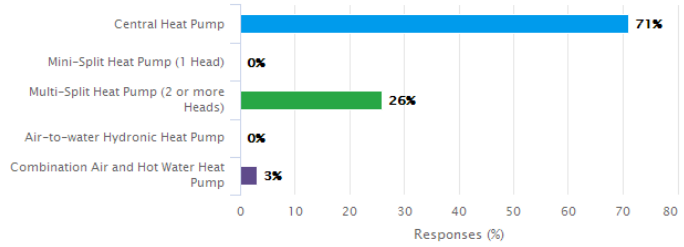



The vast majority of participating homes were single-family detached homes, with less than 10% represented by other home types (duplex, rowhome). The majority of participating homes were built between 1930 and 1970, with the oldest house built in 1911 and the newest home built in 2013. Home sizes ranged between 1,030 square feet and 3,700 square feet, with most falling between approximately 1,500 and 2,500 square feet. Again, this snapshot of typical house characteristics remains consistent with findings from other programs City Green has administered, including virtual check-ups, energy coaching, or similar.

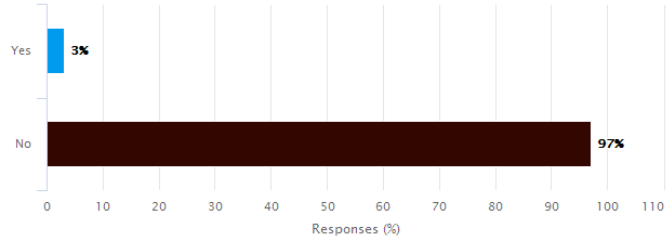
Only one participant stated they had two electrical meters, all others had a single electrical meter. Six participating homes stated they have a secondary suite with 1-2 occupants. Homes were split on water heating fuel, with 56% using electric or heat pump water heaters, and 44% using standard or tankless gas water heaters.

## Heat Pump Upgrade Details

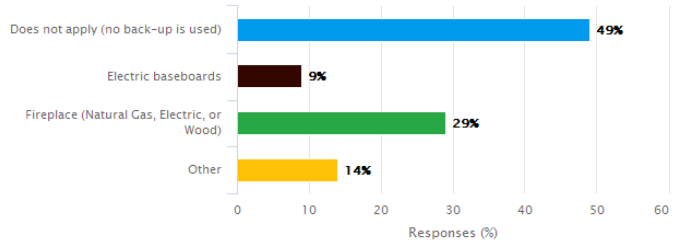
The type of heat pump we installed is




Prior to installing a heat pump, did your home have air conditioning?




The heat pump back-up is




Compared to the previous heating system

Overall, how does your heat pump compare to your previous natural gas system?

| | | |
|---|---|---|
| **Much worse** | **0.00%** | |
| **Worse** | 2.94% | |
| **Better** | 47.06% | |
| **Much Better** | 50.00% | |

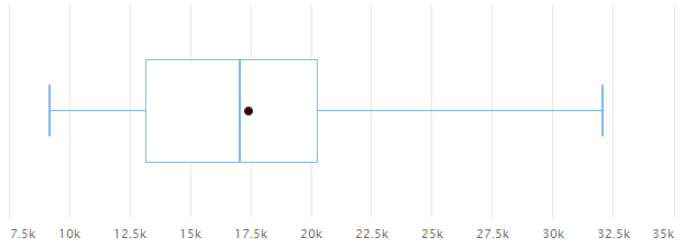
Central heat pump systems made up the vast majority of installed systems, and all but one participating household did not have air conditioning before their heat pump. Almost half of installations required no back-up system. Note participants who selected the “other” category exclusively did so to mention an integrated electric resistance coil back-up. Additional participants who selected “no back-up” may not have considered their integrated coil a back-up. The installations  where participants indicated no back-up is used were exclusively located in the Lower Mainland and Southern Vancouver Island.

This trend is interesting given that anecdotal sentiment from homeowners in the Lower Mainland and Southern Vancouver Island often includes feedback centered on concern regarding back-ups or contractors insisting that a back-up is required in those regions.

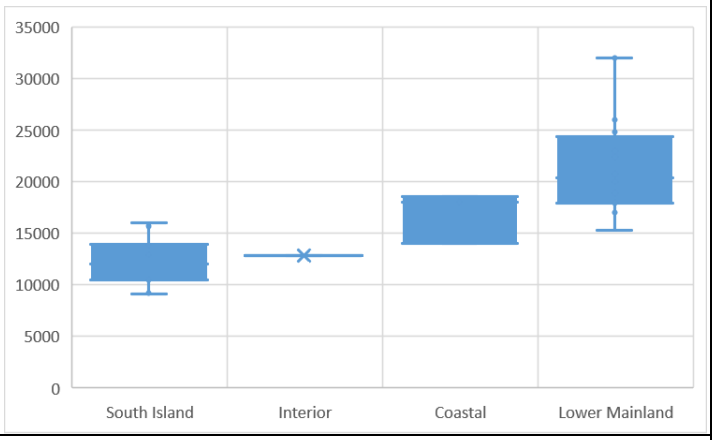
Almost all participants responded that their heat pump system was overall a better or much better heating system than their previous natural gas furnace or boiler. This further reinforces that those heat pumps installed without a back-up are performing well throughout the heating season in the Lower Mainland and Vancouver Island.

## Heat Pump Upgrade Details Continued

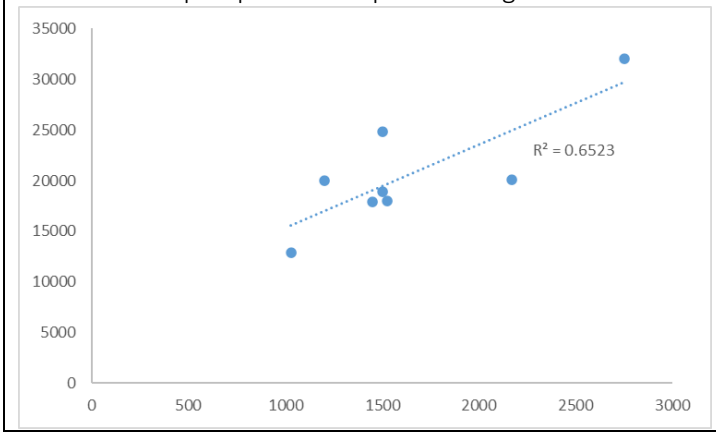
Approximately how much did the installation of your heat pump cost?



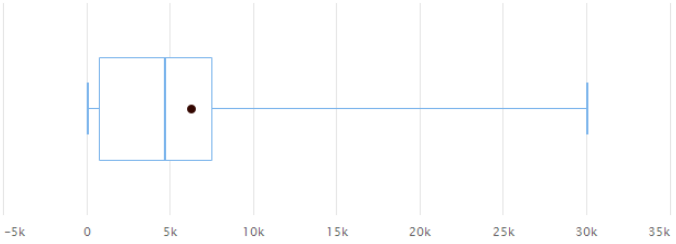

Cost distribution based on location




Ductless heat pump cost vs. square footage




Approximately how much did it cost to upgrade your home's Electrical Service?




Heat pump installation costs shows a wide variation. The majority of systems cost between approximately $13,000 and $20,000 to install, with the most expensive system costing $32,000 and the cheapest system costing $9,100. Higher installation costs were found in the Lower Mainland (averaging $21,637.56) with lower costs found in Southern Vancouver Island (averaging $12,243.33). The average heat pump installation cost on Vancouver island as a whole was $12,378.46, suggesting a 25% increase from previous cost investigation in the 2018 Oil to Heat Pump Report ($9,905.00)[2].

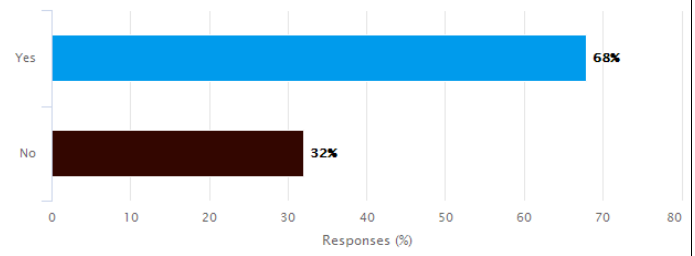
Cost of heat pump installation was also not affected by the completion of building envelope upgrades. When corrected for location, ductless and ducted heat pumps showed nearly identical installation cost. Cost of central heat pump installation showed little to no relationship with age or size of home. Cost of ductless heat pump installations did show a moderate relationship with size of the home ($R^2$=0.65)[3].

13 of 32 participants completed an electric service upgrade in conjunction with their heat pump. The median cost for the electrical service upgrade alone was $4,700, but 3 of the households reported costs reaching $12,000, $20,000, up to $30,000. Variation in cost may be related to what components of the home's electric service require upgrading. For example, homes that in addition to panel amperage upgrades require the wiring from the street to be upgraded can expect to pay more, and upgrading of underground wiring tends to be even more expensive.

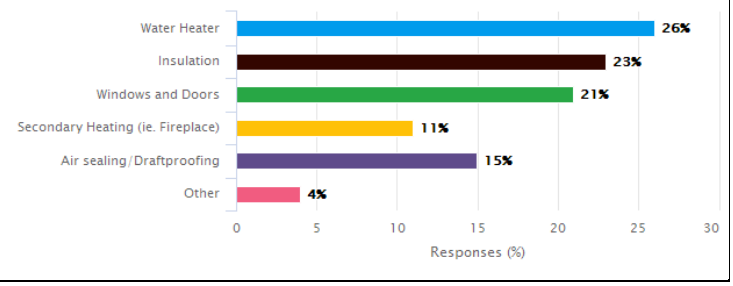
[2] City Green Solutions Program Performance Report: Oil to Heat Pump Incentive Program. 2018
[3] Limited sample size of ductless heat pump systems, n=8.

## Other Upgrade Details

Have you completed any other upgrades besides your heat pump between January 01 2018 and 2022?




Which upgrades?




Of the participating households, 68% completed additional upgrades beside the heat pump. Water heaters were the most common secondary upgrade, with building envelope upgrades being common as well. Of the 12 homes that upgraded water heaters, 4 installed natural gas systems (1 standard, 3 tankless) and 8 installed electric systems (3 standard, 5 heat pump water heaters). Of the 11 homes that completed insulation upgrades, 9 upgraded insulation in their attics, 5 upgraded exterior walls, and 6 upgraded basement or crawlspace walls.

Participants who completed an EnerGuide evaluation were more likely to have completed an additional upgrade (76%) than those who did not complete an evaluation (44%). Participants who had completed an EnerGuide evaluation were also more likely to have completed one or more building envelope upgrades (60% vs. 11% of homes that did not complete an evaluation).

## Utility Data Analysis

Participant charts depicting energy consumption, greenhouse gas emissions, and utility costs can be found in appendix C of this report.

**Greenhouse Gas Reductions**

All but one home either nearly eliminated or highly reduced their greenhouse gas emissions. One home that did not achieve high reduction in greenhouse gas emissions noted they always have their natural gas fireplace operating to supplement heat during the heating season. This participant was also one of the few that appeared to have a noticeable increase in utility costs after installation.

All other homes achieved greater than 50% GHG reductions, with homes that fully-electrified (no gas fireplaces or water heating) achieving greater than 90% GHG reductions.

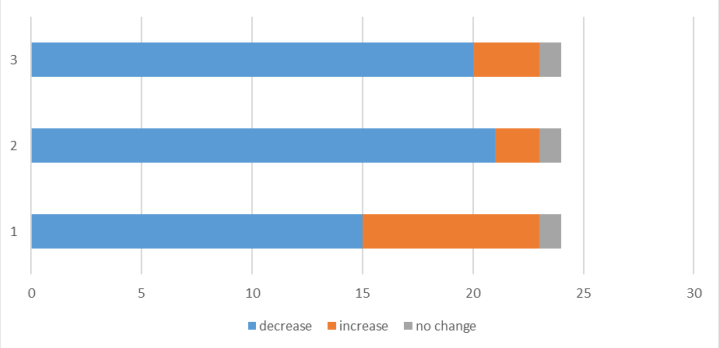
**Utility Bill Impacts**

The following table summarizes the average results from all participants in the study. The utility data analysis was provided by **RDH Building Science**. Comparison of renewable natural gas cost vs. heat pump operation cost completed by City Green Solutions. Note that these scenarios do not include recently observed natural gas commodity price increases or future commodity price projections.

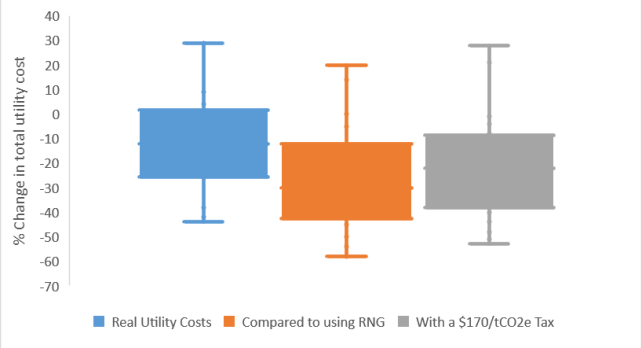
| SUMMARY OF ALL AVERAGED PARTICIPANT DATA | | | | | |
|---|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** | **Change (Units)** |
| **Utility Bill Data** | | | | | |
| **Electricity** | **Monthly kWh** | 659.91 | 1,019.55 | +54% | +359.64 |
| | **Monthly $** | $81.26 | $129.56 | +59% | +$48.30 |
| | **Monthly GHG (t $CO_{2e}$)** | 0.01 | 0.01 | +54% | 0.00 |
| **Natural Gas** | **Monthly kWh** | 1,445.67 | 333.90 | -77% | -1,111.77 |
| | **Monthly $** | $97.77 | $30.39 | -69% | -$67.38 |
| | **Monthly GHG ($tCO_{2e}$)** | 0.27 | 0.06 | -77% | -0.21 |
| **Total** | **Monthly kWh** | 2,100.65 | 1,352.11 | -36% | -748.54 |
| | **Monthly $** | $178.47 | $159.89 | -10% | -$18.58 |
| | **Monthly GHG (t $CO_{2e}$)** | 0.27 | 0.07 | -73% | -0.20 |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | | |
| **Renewable Natural Gas** | **Monthly $** | $130.92 | $37.14 | -72% | -$93.78 |
| | **Monthly $ Compared to Regular Natural Gas** | +34% | +22% | | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach*** | **Monthly $ Using RNG vs. Monthly $ using Heat Pump** | $212.18 | $159.89 | -25% | -$52.29 |
| **BC Hydro Step 1 Billing Rate Only (i.e If Step 2 Billing Rate Was Eliminated)** | | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | $112.80 | | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -12.42% | | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | | |
| **Electricity** | **Monthly $** | $82.07 | $131.03 | +60% | +$48.96 |
| **Natural Gas** | **Monthly $** | $130.01 | $38.20 | -71% | -$91.81 |
| **Total** | **Monthly $** | $211.62 | $169.07 | -20% | -$42.55 |

* Pre-heat pump column combines electricity costs with RNG cost, post-heat pump column combines standard electricity and natural gas costs from the Utility Bill Data section (no RNG)

How many participants experienced utility cost changes after switching from a natural gas furnace or boiler to an all-electric heat pump (n=24)?




Distribution of the % monthly change in utility costs for all participants.[4]




| Participant change in operational heating costs (n=24) | | | |
|---|---|---|---|
| | **Real Utility Costs** | **Compared to using RNG** | **With a $170/tCO2e Tax** |
| **Large Decrease (>10%)** | 11 | 18 | 17 |
| **Slight Decrease (10% or less)** | 4 | 3 | 3 |
| **No Change** | 1 | 1 | 1 |
| **Slight Increase (10% or less)** | 5 | 0 | 1 |
| **Large Increase (>10%)** | 3 | 2 | 2 |

**Utility Bill Data**

This section analyzes the data taken directly from participant's submitted utility bills. Average monthly electricity, natural gas, and combined energy use, greenhouse gas emissions, and utility costs were calculated for each participant. As noted in Appendix B, greenhouse gas (GHG) emissions were calculated based on actual energy consumption and the emissions factors outlined in the City of Vancouver Energy Modelling Guidelines (v 2.0). As per the guidelines, 0.185 kg CO2e were calculated per kWh of natural gas consumed. 0.011 kg CO2e were calculated per kWh of electricity consumed.

Participants experienced an average decrease in total utility costs (electricity $ + natural gas $) of 10%. This decrease is similar to the estimated 12% decrease reported by BC Hydro's Bringing The Heat report[5], and much lower than the estimations provided by FortisBC's Home Energy Calculator which suggested a cost increase of 19%-34% annually[6].

When considering real-world total utility costs, 15 of the 31 homes that submitted utility data experienced utility cost decreases, 1 had no change, and 8 experienced increases. 7 participating homes provided insufficient data to compare before and after costs[7]. Of the 15 homes that experienced a cost decrease, 4 experienced a slight decrease (10% or less),

[4] This chart is a direct visualization of the results from the RDH utility bill analysis (see appendix B).
[5] BC Hydro, 2022. Report – Bringing the heat: British Columbians concerned over energy costs, unaware that going all in on gas does not make dollars or sense. Accessed October 2022.
[6] 19% increase showing when comparing a smaller, older home with old gas equipment switching to a new heat pump, 34% increased showing when comparing a larger, newer home with new gas equipment switching to a heat pump.
[7] RDH required at least a year before and after in utility costs to complete utility bill analysis. A minimum coefficient of multiple determination ($R^2$) > 0.8 was set, but in most cases > 0.95 was achieved.

while 11 experienced larger decreases. Monthly cost changes ranged from savings of $96.00 to additional costs of $69.09, with the median participant saving $12.95 per month[8].

Interestingly, of those 15 participants that experienced cost decreases in all cases, 7 responded that they agree or strongly agree that their system costs too much to heat in the winter. Of the 7 participants, 3 experienced a slight decrease in costs (10% or less), while 4 experienced larger decreases in cost. This may speak to the disconnect some homeowners have between their electricity and gas utility bills, looking at them separately rather than as a whole. Participants may also forget that their electricity bills cover the span of two months (where BC Hydro is the electricity provider), so may seem considerably higher than the monthly natural gas bill they are accustomed to. There could be an opportunity to provide more messaging and education around how to compare utility bills.

Out of those 8 participants that experienced increases, 6 reported using their heat pump's cooling feature "frequently" (3-5 times a week) or "always" (every day). 5 also reported they make use of a secondary heating system, which may be less efficient or result in user error, increasing heating costs (e.g. setting secondary heating system temperature higher than heat pump so the secondary system takes a bigger portion of the heating load, or heating with a secondary system while the heat pump is set to cooling mode). Overall, results showed no correlation between change in utility costs and the level of either air conditioning use ($R^2$=0.001) or secondary heating system use ($R^2$=0.11). However, the sample size may limit the broad conclusions that can be drawn from these correlations.

**Renewable Natural Gas Scenario**

Analysis was completed to compare the utility costs if the participants had chosen to purchase renewable natural gas, instead of electrifying, as a means to reduce their emissions. The utility cost for renewable natural gas was calculated based on current Fortis BC rates. Regular and renewable natural gas both share the same basic charge of $0.4216 per day, delivery charge of $5.526 per GJ, storage and transport charge of $1.351 per GJ, assumed municipal tax of 3.09%, Innovative Clean Energy (ICE) Fund levy of 0.4%, and 5% provincial GST. The fee for renewable natural gas is $13.808 per GJ compared to the regular natural gas fee of $5.907 (more than double the gas cost per GJ).

This section also includes comparison of the total utility costs if the participants had chosen to purchase renewable natural gas, instead of electrifying with a heat pump as a means to decarbonize space heating. This comparison combines the pre-heat pump electricity and renewable natural gas monthly costs in the first column, while the post-heat pump electricity and standard natural gas monthly costs are combined in the second column. In all but two cases, the decarbonization approach of switching to a heat pump was less expensive than heating with renewable natural gas. The monthly cost difference of using a heat pump rather than RNG ranged from savings of $115.63 to additional costs of $37.53, with the median participant saving $37.16 per month.

**BC Hydro Step 1 Billing Rate Scenario**

BC Hydro costing was calculated using a basic charge of $0.209 per day, energy usage charges, a 5% rate rider fee, a regional transit levy of $0.0624 per day, and 5% provincial GST. Actual energy usage charges for BC Hydro are divided into Step 1 and Step 2. Step 1 charges $0.095 per kWh for the first 1,350 kWh consumed in the average two-month billing cycle. Beyond 1,350 kWh of electricity use, BC Hydro charges Step 2 rates of $0.1408 per kWh.

Calculated electricity costing was compared to actual electricity costing data and factored if required to ensure consistency between datasets. Then, the Step 2 charge was removed from the calculation and all electricity consumption was charged at the same Step 1 rate. Actual post-heat pump installation costing data using Step 1 and Step 2 rates was compared to the reduced rates calculated using only Step 1.

[8] For the 24 participants with sufficient data

**Increasing Carbon Tax Scenario**

Cost calculations were performed to show the effect on utility costs from the planned 2030 carbon tax rate of $170 per tonne CO2e compared to the current $50 per tonne CO2e that was already incorporated in the actual utility bill costs. The carbon tax of $170 per tonne CO2e is based on the future 2030 federal minimum carbon tax required in the Pan-Canadian Framework on Clean Growth and Climate Change.

Similarly to the RNG analysis, in this scenario all but two homes will achieve cost reductions under a $170/tCO2e carbon tax scenario. The monthly cost difference of using a heat pump when accounting for the future increase in carbon tax ranged from savings of $113.00 to additional costs of $54.94, with the median participant saving $33.16 per month.

**What makes a home more likely to save money by switching to a heat pump?**

6 of the 15 homes that achieved cost saving completed some kind of building envelope upgrade such as windows, doors, insulation, or draft proofing. 8 of 15 completed a secondary upgrade of any kind such as a building envelope, water heater, or secondary space heating system upgrade.

Of the 16 participating homes over 70 years old, the majority (10) noted completing additional upgrades.

Completing additional upgrades to a home's building envelope is commonly known to be a factor in improving heat pump performance, and analysis completed on the homes that saw increased energy costs (discussed below) showed that in particular, insulation and air sealing should be considered in older homes to ensure a cost-effective upgrade. However, for those homes that did see energy cost reductions, there were no specific home attributes or household behavior that stood out as clearly correlating with cost savings, which may indicate that most, if not all homes have an opportunity to save money when switching to a heat pump.

**What makes a home less likely to save money by switching to a heat pump?**

Of the homes analyzed, only two consistently experienced increased utility costs across all analyzed scenarios when switching to a heat pump. The participant that experienced the largest increase was the largest house in the group (3,700 square feet) and also noted that they felt that they had little knowledge of heat pumps when making the purchase. The participant now believes their contractor under-sized their system and has been using portable electric space heaters to make up for the shortfall, adding to utility costs.

The other participant with higher utility costs noted a home age of 80 years and has continued to use their natural gas fireplace as a heating system. This is likely contributing to a higher utility cost, as natural gas fireplaces are generally less efficient than primary gas heating equipment, with modern direct-vent systems being around 72% efficient, and older fireplaces being around 30% efficient[9].

Neither of these participants completed insulation or air sealing work before installing their heat pump.

When considering all 8 households that experienced increases in their real-world operational costs, 6 (75%) of them indicated they used their heat pump for cooling frequently (3-5 times a week) or always (every day). However, this ratio only slightly decreases when considering all participants with utility costing analysis (16 out of 24 frequently or always use cooling, 67%), suggesting this may not be the reason for higher utility bills. All homes that experienced cost increases – apart from the home mentioned above with the undersized system – were over 50 years old, with the average age being 87, compared to an average age of 65 years for homes that experienced decreases. While 6 of the

[9] Natural Resources Canada. 2016. Appendix - Determining How a Gas Fireplace Will Affect Your Heating Bill.

homes completed building envelope upgrades, only two completed upgrades to insulation or air sealing work during the time period studied.

These homeowner's separate experiences may speak to the importance of the combined impact of the following factors:

- Ensuring homeowners feel knowledgeable and confident when researching and choosing a contractor/system.
- Choosing a reputable contractor who will complete a quality installation
- Choosing a heat pump sized properly to heat your entire home without the need for auxiliary systems like gas fireplaces.
- Completing insulation and air sealing upgrades for older homes before installing their heat pump.

## Confounding factors

The data provided by these participants provides valuable insights into the experience of real-world heat pump users and how home properties impact heat pump efficiency and experience. However, there are some factors of the participating group that may impact the data's applicability to the province as a whole.

- Income and education: The demographics skewed heavily to highly educated, high-income households. These are the households that are more likely to have the means to upkeep and upgrade their homes overtime to maintain efficiency and suitability for heat pumps.
- Participant location: Participants were almost exclusively located in the Lower Mainland and southern Vancouver Island regions, both falling mostly in climate zone 4. This limits the capacity of the study to draw conclusions and compare costs for operating a heat pump in colder climate regions and the real-world efficiency of cold-climate heat pumps.
- Scale: Despite dedicated outreach efforts, participant registrations were limited to 51, with 32 fully completing the process. Recruitment was limited by time, budget, and ability to target the very specific group being sought for the study. Sample size may limit the statistical significance of some correlations, and limits any broad, general conclusions that can be drawn from the results of this study.
- Survey questions:
    - Participants were asked if they completed additional upgrades between the January 2018 and October 2021. However, a number of participants realized cost reductions on older homes without indicating they completed any additional building envelope upgrades. This may suggest that some of these older homes had completed building envelope upgrades prior to January 2018, but this information was not captured in the survey.
    - Survey responses were not clear about whether their heat pumps built-in back-up electrical coil was defined as a "back-up" system.

## Recommendations for further research

- Future investigation focusing on lower income households and colder climates may provide beneficial insights to supplement the findings of this research.
- Further investigation with participants who achieved notable utility costs savings in the form of a case study or testimonial could prove valuable as a communications piece and for better understanding their home's history of upgrades overall beyond the scope of this study.
- For future study design, we recommend the following:

- Focus on more in-depth investigations of homes that have information on historical upgrades and/or EnerGuide Evaluations (the Canada Greener Homes Grant may now make the likelihood of an EnerGuide evaluation being completed much higher)
- Investigation of the prevalence of electric resistance back-ups integrated into heat pumps on Vancouver Island and the Lower Mainland may prove useful for messaging.
- Increased budget for outreach and participant incentives, as well as collaboration with other programs that may have data and contact information necessary to target the intended study group (e.g. CleanBC, Canada Greener Homes Grant, etc.) may help to improve participation numbers.

# Conclusions

Participant data provided valuable insights into the experience of real-world heat pump users. Data restrictions - including participant location (almost all from Climate Zone 4), scale of participation (n=32), and unknowns regarding what other upgrades were completed outside the sampling window (January 2018 – October 2021) – limit the broad conclusions that may be drawn from the results. Using the data provided, some of the conclusions that may be drawn are:

Using the data provided, the conclusions that may be drawn in relation to the project objectives are as follows:

1) Comparative energy costs for natural gas versus a heat pump (Climate Zone 4):

- At current utility costs and carbon tax rates, heat pumps resulted in the same or lower costs in the majority (70%) of participating homes. With only 12% of homes experiencing a utility cost increase of more than 10%.
- In comparison to choosing RNG to achieve carbon reductions, a heat pump tends to be a more cost-effective approach in almost all cases (88% of cases).
- In comparison to the costs of natural gas once the planned $170/tCO2e carbon tax is enacted, a heat pump tends to be a more cost-effective approach in almost all cases (83% of cases).

2) The characteristics of homes and retrofits that lead to cost-effective heating and cooling with heat pumps, or conversely, may lead to increased costs:

- Completing additional upgrades to a home's building envelope is commonly known to be a factor in improving heat pump performance, and analysis completed on the homes that saw increased energy costs showed that in particular, insulation and air sealing should be considered in older homes to ensure a cost-effective upgrade. However, for those homes that did see energy cost reductions, there were no specific home attributes or household behavior that stood out as clearly correlating with cost savings, which may indicate that most, if not all homes have an opportunity to save money when switching to a heat pump.
- While confounding factors listed above limit the broad conclusions that can be drawn in this study, the two homes that experienced large increases in utility costs highlighted some important factors:
  - Sizing of a heat pump system is important to ensuring efficient and cost effective operation of the home's heating and cooling.
  - Utilizing secondary heating systems (fireplaces, portable electric heaters, etc.) may lead to higher utility costs due to the lower efficiency of these systems.
  - Completing additional building envelope upgrades (insulation, air sealing, windows) may improve likelihood that a home experiences cost savings with a heat pump.

3) Determine and develop key messages and communications materials

- Motivating and creating awareness for home efficiency upgrades appears to promote deeper retrofits. However, deep retrofits tend to be completed mostly by educated, affluent households. Future investigation focusing on low to mid-income households and colder climates may provide beneficial insights to supplement the findings of this research.
    - Understanding the motivations and barriers for low- and mid-income households in completing deep retrofits could assist in the development of more equitable education and incentive programs going forward.
- Develop materials and messaging focussed on the following points:
    - Communicate that heat pumps are a cost-effective way to heat your home in comparison with natural gas and often leads to energy savings.
    - Outline how heat pumps can be a more cost-effective approach for reducing a home's carbon footprint as compared to purchasing renewable natural gas.
    - Explain to fairly compare utility bills - for example ensuring they consider their total energy costs (natural gas plus electricity before and after upgrades) and accounting for the different bill cycles for electricity (two months) vs. natural gas (one month)
    - Emphasize the steps a resident should take to ensure a cost-effective switch from natural gas to a heat pump, such as building envelope upgrades and proper sizing and operation of the new heat pump.
    - Communicate that properly sized and installed heat pumps in climate zone 4 do not need a separate backup energy system, that heat pumps generally come with an integrated back up electric coil to address extreme cold days, and that use of an auxiliary heat system (e.g. a gas fireplace) in combination with a heat pump can actually increase energy costs
- Develop materials and support programs to help residents access available incentives and financing to help defray the upfront cost of heat pumps.
- Develop case studies or testimonials for participants that saw similar or reduced energy costs to showcase cost-effective gas to heat pump replacements and highlight some of the considerations that ensure a successful retrofit.

4) Other conclusions

- Customized support with tailored upgrade options (like those provided by an EnerGuide home evaluation) appears to promote deeper retrofits. Consider requiring some form of home energy evaluation to provide customized support and awareness for residents considering retrofits.
- The cost of heat pump installations appears to have increased by around 25% in the past 4 years, at least on Vancouver Island. This increase may be attributed to one or a combination of the following factors:
    - Expansion of rebate and incentive programs for heat pumps allowing contractors to increase their quotes. This theory is reinforced by the significantly higher installation costs seen in the Lower Mainland, where Vancouver rebate top-ups dwarf those offered elsewhere (14 of 16 lower mainland participants resided in Vancouver (11) or North Vancouver (3)).
    - Inflation and supply line issues resulting in part from the Coronavirus pandemic as well as other global and domestic factors.
    - With the income and education levels of participating households, participants may have had the means and understanding to avoid the “lowest bid” contractor quotes to get a quality system and installation. This has the possibility of skewing average cost upwards.

- Survey responses suggest that modern heat pumps installed in Climate Zone 4 commonly do not use a separate back-up (electric baseboards, gas or electric fireplace) and that those systems are performing well as a primary heating system throughout the winter months.
- Survey responses suggest that completing an EnerGuide evaluation does inform and motivate homeowners to complete deeper retrofits of their building envelope in addition to their heat pump upgrade.
    - This may reinforce the common understanding that promoting and providing accessible home efficiency education to homeowners, and in particular customized retrofit information, is key to accelerating deep retrofits and achieving climate action targets.
- Most participating homes appear to have experienced reduced or similar overall utility costs after upgrading to a heat pump, regardless of whether they completed additional upgrades to their home. Cost savings with a heat pump were projected for 83% of homes with an increase in carbon taxes to $170/tCO2e, and for 92% of homes when compared to the cost of purchasing 100% renewable natural gas.
    - Higher utility costs in a minority of participating homes (33%) may be attributed to improper heat pump sizing, use of less efficient secondary heating equipment, and/or unaddressed inefficiencies in the home's building envelope. Other contributing factors may include user habits (e.g. using cooling feature frequently), or user error (e.g. setting secondary heating system temperatures above that of the heat pump).
- Homes that experienced cost savings varied widely in size and age, with no clear relationships noted between cost savings and upgrades or homeowner activities. This suggests the best way to determine if a home is saving energy with a heat pump upgrade is to analyze a home's utility data directly. It also suggests that any home could achieve cost savings from a heat pump installation, provided the home's unique attributes are taken into account during system sizing/selection and the upgrade itself.

# Appendix A – Outreach

## Survey design

The participant survey was designed to capture a very wide range of participant information including:

- Building details including but not limited to
  - Age
  - Size
  - Number of occupants
  - Location
  - EnerGuide rating if applicable
- Household demographics including but not limited to
  - Age
  - Income
  - Education level
  - Gender
  - Minority status
- Details on energy use including by not limited to
  - Hot water type
  - Hot water usage habits
  - Other natural gas system use
  - Auxiliary electrical systems (e.g. hot tubs, etc)
  - Other efficiency upgrades completed on the home
- Home upgrade details including but not limited to
  - Heat pump upgrade – type, cost, date of installation
  - Other upgrades completed – windows, insulation, etc.
- Heat pump experience including but not limited to
  - Contractor experience
  - Comfort and operational experiences
  - Operational cost experience

## Outreach and communications

### Mass email outreach

Mass email outreach via Constant Contact resulted in:

**To homeowners (past CityGreen clients)** – 925 reached (opened email)

**To homeowners (Bring It Home Participants)** – 227 reached

**To HVAC contractors** – 231 reached

**To energy advisors** – 96 reached

CityGreen

The **Make the Switch Study** is actively recruiting participants until June 15th. Make The Switch is a research initiative to better understand homeowners' motivations and real-world experiences when switching from natural gas to an electric air source heat pump for their home heating.

If you or anyone in your organization/network has **switched from a gas heating system to a heat pump between January 2018 and October 2021**, you can register or pass along this information to your networks! Participants will be provided a $100 honorarium for completing the study. Registration is open until May 31st, and participants will be supported in completing a short survey and submitting their utility data.

If you would like to help spread the word about **Make the Switch** through your networks please feel free to use this email or the linked social media posts below. If you have any questions, please do not hesitate to contact us at demo@citygreen.ca.

**Facebook**
https://www.facebook.com/citygreensolutions/videos/1320890945099682/

**LinkedIn**
https://www.linkedin.com/feed/update/urn:li:activity:6909583607812517888

You can **register for Make the Switch through this link** and learn more below!

**Interested in Switching?** If you currently heat with natural gas and are interested in switching to a heat pump, you may be able to access over $11,000 in rebates. See the rebate search tool on www.betterhomesbc.ca for details.

**Who is eligible?**

1. Homeowners who are full-time residents of British Columbia.
2. Have converted their primary heating system from natural gas furnace or boiler to an electric air source heat pump between January 2018 to October 2021.
3. The heat pump must not have a natural gas, oil, or propane furnace or boiler as a back-up system.
4. Live in a single family detached home, townhome, duplex, row home or mobile home.
5. Participants must be willing to provide utility billing data for their natural gas and electricity utilities from between 2016 and 2022, or for as far back as they are able to access, and to complete a program survey.

**What are the benefits of participating?**

- All selected participants will receive $100 CAD for providing their utility data and completing the Make the Switch Survey.
- Support research that improves understanding of the costs and homeowner motivations for switching to an electric air source heat pump.
- Contribute to the future development of home energy improvement, and climate action programs in your community.

The Make the Switch Study is a project of the District of Saanich, administered by City Green Solutions.

Thank-you for supporting this project! **You can register for the Make the Switch Study through this link**.

## Social media outreach

### Facebook/Instagram

Static image and video posts were utilized for outreach on Facebook and Instagram.

*Campaign results:*

| Campaign | Result Metric | Reach | Cost Per Click/Engagement | Spend |
|---|---|---|---|---|
| **July 2021 (Traffic – Clicks)** | 287 (link clicks) | 10,343 | $0.35 | $100.00 |
| **August 2021 (Traffic – Clicks)** | 39 (link clicks) | 2,810 | $2.46 | $95.96 |
| **August 2021 (2) (Traffic – Clicks)** | 392 (link clicks) | 13,872 | $0.51 | $199.99 |
| **Sept 2021 (Awareness – Reach)** | 23 (link clicks) | 26,369 | $3.74 | $86.06 |
| **April 2022 (Engagement)** | 12,549 (post engagements) | 16,592 | $0.01 | $119.49 |

*Text example:*

Have you upgraded your home from gas to a heat pump? Want to receive $100 and help inform future climate action programs? Sign up for the Make the Switch Study to tell us about your experience switching! We are looking for participants who have switched between Oct 2018 and Oct 2021. Visit www.citygreen.ca/make-the-switch for more details and to sign-up. #heatpump #community #research #naturalgas


[Video ad examples attached to PDF]

### Reddit

*Campaign results:*

| Campaign | Result Metric | Impressions | Cost Per Click | Spend |
|---|---|---|---|---|
| **June 2022 (Traffic – Clicks)** | 101 (link clicks) | 28,737 | $1.24 | $125.61 |

*Text example:*

We need your help! - Switched from gas heating to a heat pump? Participate in Make the Switch Study.

Make The Switch is a research initiative to better understand homeowners' motivations and real-world experiences when switching from natural gas to an electric air source heat pump for their home heating. **Research will help inform future climate action in BC**. We are recruiting participants until **June 30th** and need your help to sign up or spread the word!

If you or anyone you know has switched from a gas heating system to a heat pump between **January 2018 and October 2021**, you can register or pass along this information to your networks! Participants will be provided a **$100 honorarium** for completing the study and will be supported in completing a short survey and submitting their utility data.

You can learn more and register for Make the Switch through this link!

# Appendix B – Utility Data Analysis

The contents of this appendix was provided by RDH Building Science. Comparison of Renewable Natural Gas cost vs. heat pump operation cost completed and added by City Green Solutions.

RDH Building Science Inc.
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Making Buildings Better™

TO **City Green Solutions**
C/O **Grant Stott**
EMAIL **grant.stott@citygreen.ca**
City Green Solutions
214 - 620 View Street
Victoria BC V8W 1J6

**R-25184.000**
**City Green Solutions | Utility Bill Analysis**

DATE December 8, 2022

REGARDING **Utility Bill Analysis**

Dear Mr. Stott,

As requested by City Green Solutions (City Green), RDH Building Science Inc. (RDH) is pleased to provide you with this report for a utility bill analysis for 32 single-family dwellings (SFDs) that have recently switched to heat pumps in British Columbia.

# 1 Background

RDH was contracted by City Green to investigate the energy savings, operating costs, and emission reductions achieved by switching fuel-fired heating systems to heat pump systems and alternative energy options for 32 SFDs in BC. The scope of services included the following:

- **Task 1:** Process participant utility bill data and calculate missing data as required
- **Task 2:** Obtain and process Heating Degree Day (HDD) data for each climate location for weather normalization
- **Task 3:** Weather-normalize the utility data for 32 homes
- **Task 4:** Compare the energy consumption and greenhouse gas (GHG) emissions before and after heat pump installation
- **Task 5:** Compare the utility cost before and after heat pump installation at actual rates
- **Task 6:** Compare the utility cost assuming a switch to 100% renewable natural gas rates instead of a switch to heat pumps
- **Task 7:** Compare the utility cost before and after heat pump installation assuming electricity at BC Hydro's Step 1 rate only
- **Task 8:** Compare current 2022 carbon tax of $50 per tonne $CO_{2e}$ with the planned carbon tax of $170 per tonne $CO_{2e}$ in 2030.

# 2 Methodology

**Task 1:** Utility bills were processed using RETScreen Expert (v 9.0.0.0). Natural gas data received from participants was downloaded from Fortis BC. Electricity data was also provided by participants from BC Hydro. Where utility costing was not available in the provided documents, RDH calculated costing based on billing cycle duration (calculated or estimated based on the provided data) and current rates for Fortis BC and BC Hydro.

Heat pump installation dates were taken from the participant survey provided by City Green Solutions. Inflation rates and increased costs of utilities were not accounted for in this analysis. Provided utility bill data varies per participant, so not all participants have a large enough dataset to create a representative sample. For example, some participants only provided post-heat pump installation data for the winter season, which skews their post-heat pump installation analysis to show more energy consumption than would actually be average over a full year.

**Task 2:** The Heating Degree Day (HDD) data was pulled from the NASA database in RETScreen for the appropriate climate location weather station of each participant. The HDD data was used to form a regression analysis for each participant's natural gas and electricity consumption. The reference temperature in each regression model was optimized within the range of 11°C to 21°C to find the best fit for the data, using HDD reference temperatures from the NASA climate location database.

**Task 3:** The natural gas model optimization was time-constrained to pre-heat pump installation energy consumption, and the electricity model's HDD reference temperature optimization was limited to post-heat pump installation energy consumption. The date boundaries ensured accuracy for weather normalization to predict natural gas consumption for space heating based on HDD of a given month and the building's historical data, and to model reduced space heating energy consumption based on HDD and historical space heating electricity consumption. When applying the regression model factors to normalized data calculations, any negative baseline factors were manually overwritten with the data sample's minimum baseload consumption.

Weather normalization shows the energy consumption trends over a small sample size (only a few years as per this study's dataset) without interference from abnormal weather trends. For example, a very cold winter requiring more space heating after a heat pump is installed may not reflect the decreased energy consumption. Weather normalization regulates the effects of weather on energy consumption.

**Task 4:** Greenhouse gas (GHG) emissions were calculated based on actual energy consumption and the emissions factors outlined in the City of Vancouver Energy Modelling Guidelines (v 2.0). As per the guidelines, 0.185 kg $CO_{2e}$ were calculated per kWh of natural gas consumed. 0.011 kg $CO_{2e}$ were calculated per kWh of electricity consumed.

**Task 5:** Utility data provided by participants was processed in RETScreen as described in Task 1. The utility billing data was broken down by month and graphed to show natural gas and electricity consumption compared to GHG emissions and utility costs. The data was also averaged pre- and post-heat pump installation to calculate average changes in consumption, cost, and GHG emissions.

**Task 6:** The utility cost for renewable natural gas was calculated based on current Fortis BC rates. Regular and renewable natural gas both share the same basic charge of $0.4216 per day, delivery charge of $5.526 per GJ, storage and transport charge of $1.351 per GJ,

assumed municipal tax of 3.09%, carbon tax of $2.5588 per GJ, Innovative Clean Energy (ICE) Fund levy of 0.4%, and 5% provincial GST. The fee for renewable natural gas is $13.808 per GJ compared to the regular natural gas fee of $5.907 (more than double the gas cost per GJ).

The utility cost was calculated for a pre-heat pump comparison of renewable and regular natural gas to show the difference in cost while using natural gas for space heating. A post-heat pump comparison was calculated for properties using natural gas outside of space heating (e.g. natural gas domestic hot water, appliances, etc). A comparison for the whole dataset (both pre- and post-heat pump) was calculated to average the cost increase of switching to renewable natural gas throughout their full provided billing data.

**Task 7:** BC Hydro costing was calculated using a basic charge of $0.209 per day, energy usage charges, a 5% rate rider fee, a regional transit levy of $0.0624 per day, and 5% provincial GST. Actual energy usage charges for BC Hydro are divided into Step 1 and Step 2. Step 1 charges $0.095 per kWh for the first 1,350 kWh consumed in the average two-month billing cycle. Beyond 1,350 kWh of electricity use, BC Hydro charges Step 2 rates of $0.1408 per kWh.

For this task, calculated electricity costing was compared to actual electricity costing data and factored if required to ensure consistency between datasets. Then, the Step 2 charge was removed from the calculation and all electricity consumption was charged at the same Step 1 rate. Actual post-heat pump installation costing data using Step 1 and Step 2 rates was compared to the reduced rates calculated using only Step 1.

**Task 8:** Cost calculations were performed to show the effect of the planned 2030 carbon tax rate of $170 per tonne $CO_{2e}$ compared to the current $50 per tonne $CO_{2e}$ that was already incorporated in the actual utility bill costs. The carbon tax of $170 per tonne $CO_{2e}$ is based on the future 2030 federal minimum carbon tax required in the Pan-Canadian Framework on Clean Growth and Climate Change.

# 3 Results

An analysis of each participant's data can be found in Appendix A. Additional comments have been made in Appendix A to explain inconsistencies or irregularities in the datasets where applicable. The ID number and the corresponding participant information is available in Appendix B. All participants originally used natural gas to heat their homes before converting to an electric heat pump for space heating.

The following three graphs and data show the analysis completed for participant #018. This analysis was chosen as an example since the participant was able to provide approximately 6 years of overlapping natural gas and electricity utility bills to show trends over time. This analysis shows the standard trends observed by all participants unless otherwise noted in Appendix A.

Figure 1 below shows the total energy consumption (blue bars) compared to the total GHG emissions (orange line) by month. The red arrow indicates when the heat pump was installed. Spikes in energy consumption occur in the winter when more energy is required to heat the home. Energy consumption is lower in the summer when only baseloads (domestic hot water, lighting, and domestic appliances) are required to power the home.

A heat pump is more efficient than natural gas heating equipment, so total energy consumption over a year is generally lower after installing a heat pump. Because natural gas is more carbon intensive than electricity in BC, the GHG emissions are higher in the winter months when more natural gas is used to heat the home and lower in the summer months when less natural gas is used. After the heat pump installation, the GHG emissions drop significantly compared to the energy consumption. Further details are available in Appendix A.

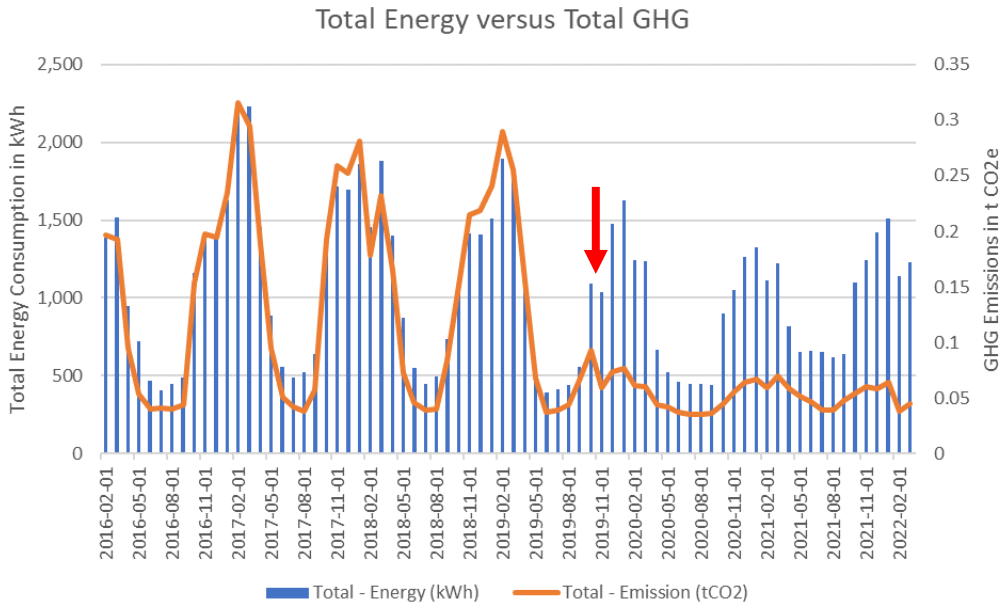


*Figure 1: Total energy consumption (blue) and greenhouse gas (GHG) emissions (orange) for ID #018. The red arrow indicates when the heat pump was installed.*

Figure 2 illustrates the monthly GHG trend. The orange bars show GHG emissions due to natural gas consumption, and the blue bars show GHG emissions due to electricity consumption. Similar to total energy consumption, GHG emission spikes occur in the winter when more energy consumption is required to heat the home.

Natural gas generates more GHG emissions per unit of energy (0.185 kg $CO_{2e}$ per kWh) than electricity (0.011 kg $CO_{2e}$ per kWh), so heating with natural gas causes larger GHG spikes than heating with an electric heat pump. After the heat pump is installed, there is a slight increase in electricity-generated GHGs in the winter, but the overall spikes are significantly lower. The natural gas GHGs are relatively uniform after the heat pump installation, since the natural-gas powered baseloads do not change with the weather.

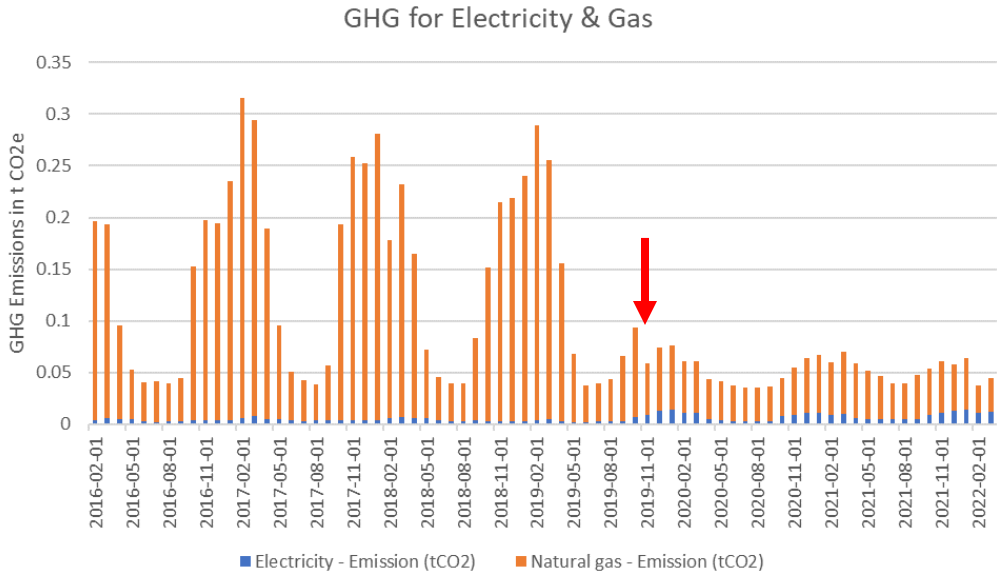


*Figure 2: Greenhouse gas (GHG) emissions for natural gas (orange) and electricity (blue) for ID #018. The red arrow indicates when the heat pump was installed.*

Figure 3 shows the monthly utility cost of natural gas (orange) and electricity (blue). The unit cost of electricity is higher than the unit cost of natural gas. Despite lower total energy consumption after installing a heat pump, the increase in electricity consumption causes the electricity bill to rise significantly in winter months when heating is required. The increase in winter electricity consumption often enacts BC Hydro Step 2 billing rates ($0.1408 per kWh after 1,350 kWh in a 2-month billing cycle instead of Step 1 at $0.095 per kWh), which further increases the electricity cost. In summer months, heat pumps that provide cooling also increase electricity consumption and costs compared to pre-heat pump costing where cooling was not provided (outside of electric air conditioners, which would be included in electricity consumption pre-heat pump).

The natural gas cost post-heat pump installation is relatively uniform since the natural gas is being used for baseloads such as domestic hot water heating and natural gas-fired appliances. These natural gas baseloads are not temperature dependent, so they stay uniform throughout the year.

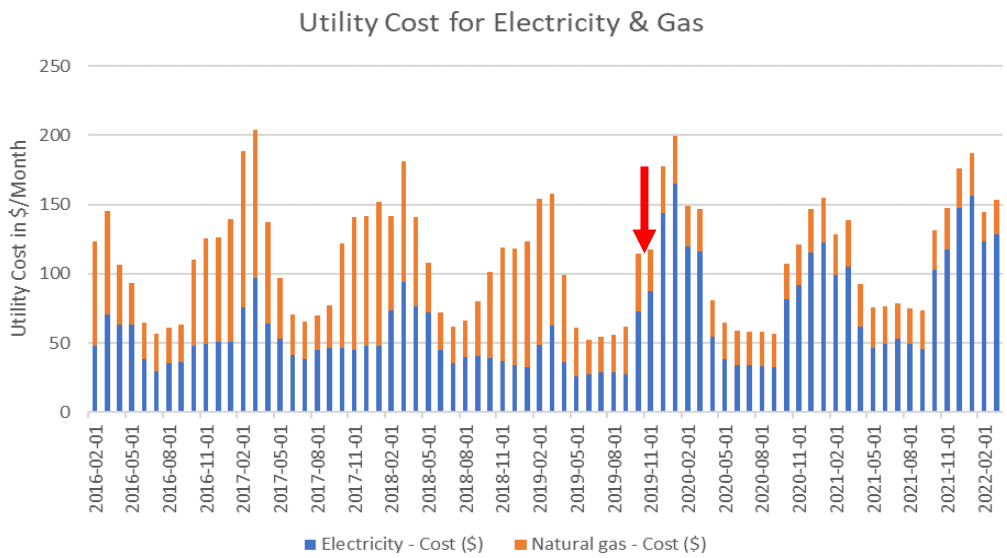


*Figure 3: Utility costs for natural gas (orange) and electricity (blue) for ID #018. The red arrow indicates when the heat pump was installed.*

# 4 Closure

We trust that this report meets the needs of your project. Please contact the undersigned should you have any questions regarding this report.

Yours truly,

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encl. Appendix A – Participant Analysis Results

Appendix B – Participant ID Numbers

# Appendix A

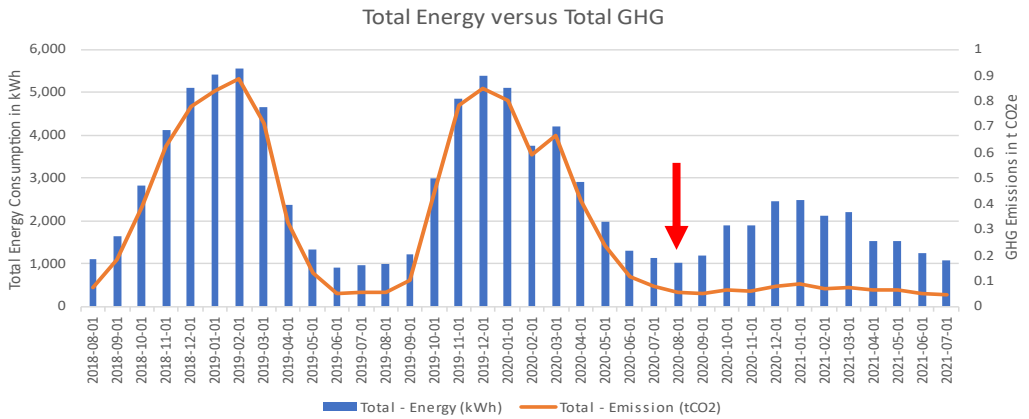
## Participant Analysis Results

# Appendix B

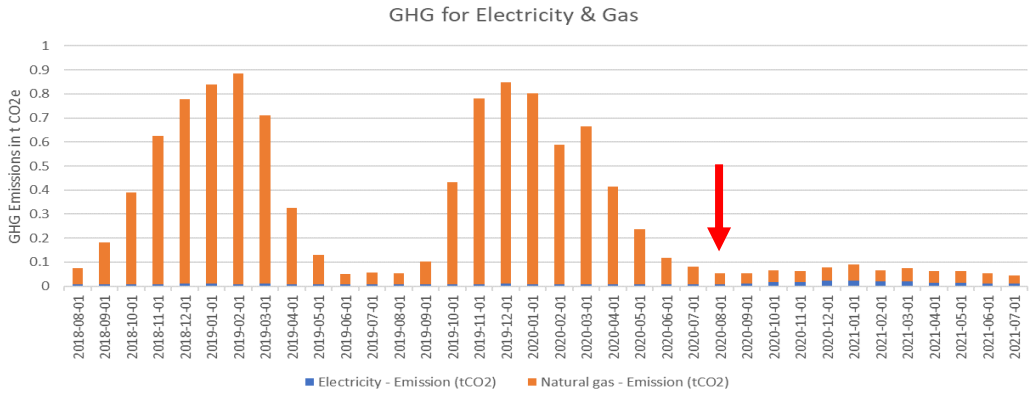
## Participant ID Numbers

# ID #001

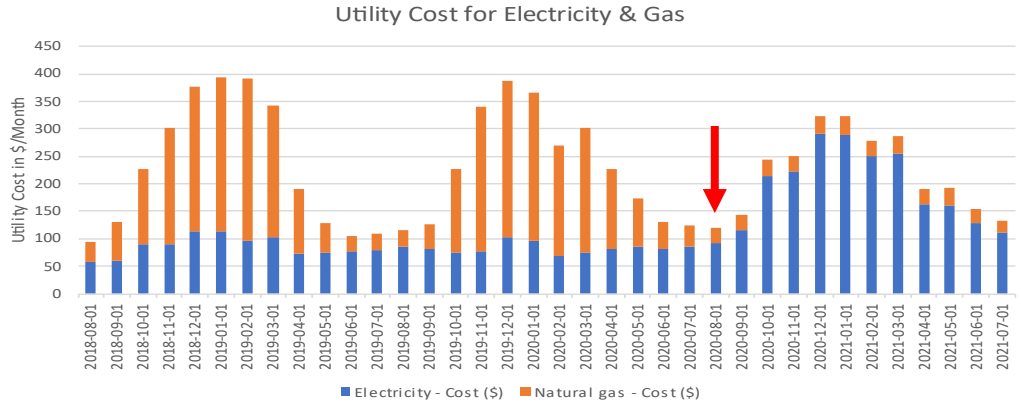
Heat pump installation date: August 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #001. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #001. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #001. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #001 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 748.17 | 1,461.41 | +95% |
| | **Monthly $** | 84.42 | 190.85 | +126% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.008 | 0.016 | +95% |
| **Natural Gas** | **Monthly kWh** | 2,247.03 | 259.18 | -88% |
| | **Monthly $** | 148.05 | 29.10 | -80% |
| | **GHG ($tCO_{2e}$)** | 0.416 | 0.048 | -88% |
| **Total** | **Monthly kWh** | 2,995.20 | 1,720.59 | -43% |
| | **Monthly $** | 232.47 | 219.94 | -5% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.424 | 0.064 | -85% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,354.66 | 1,639.01 | -30% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Renewable Natural Gas** | **Monthly $** | 195.76 | 34.71 | -82% |
| | **Monthly $ Compared to Regular Natural Gas** | +32% | +19% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 280.18 | 219.94 | -22% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 154.32 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -19% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 85.46 | 192.87 | +126% |
| **Natural Gas** | **Monthly $** | 200.43 | 35.14 | -82% |
| **Total** | **Monthly $** | 285.89 | 228.01 | -20% |

Observations:

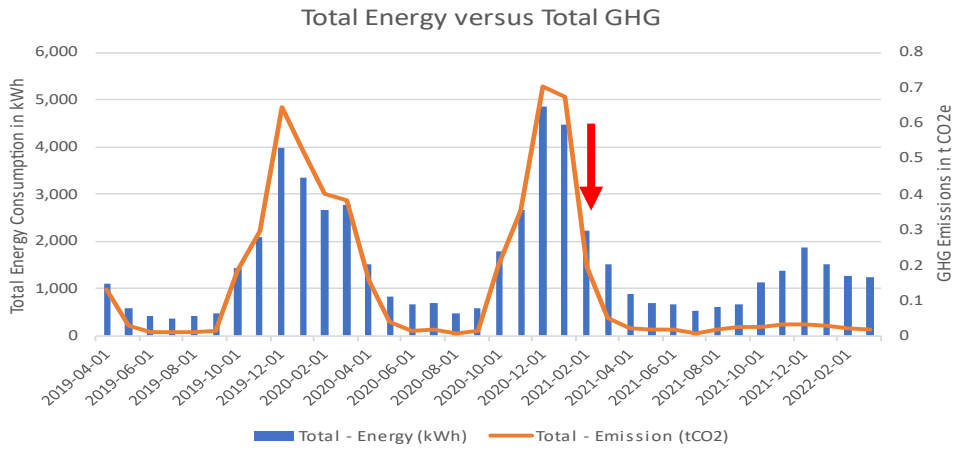
- **Utility Bill Data:** Overall decrease in post-heat pump energy consumption due to increased heating efficiency of electric heat pump, slight decrease in total cost,

and large decrease in GHG emissions despite the high relative increases of electricity values.

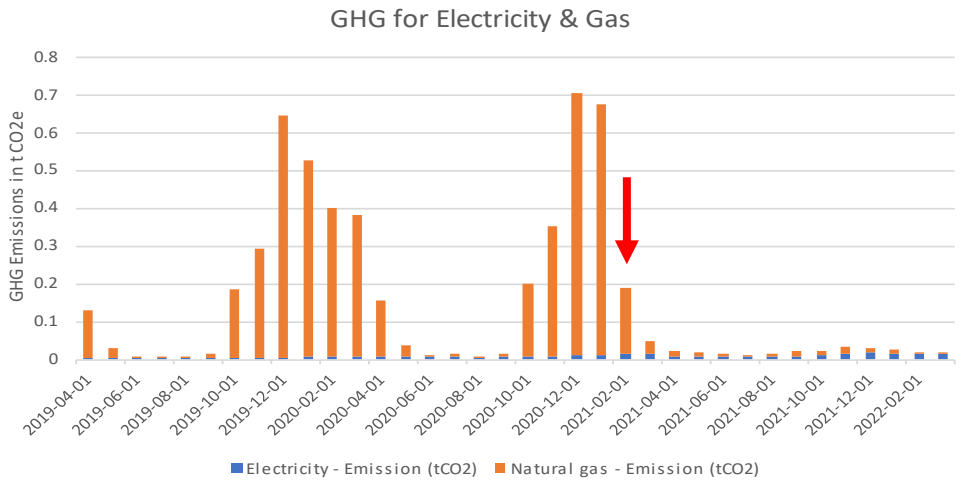
- **Carbon Tax at $170 per tonne $CO_{2e}$:** Despite increased costs projected for the higher electricity use with a heat pump, the lower carbon emissions associated with BC Hydro electricity will yield a lower total utility bill than if the natural gas furnace were to remain (see actual utility bill data for pre-heat pump cost comparison).

## ID #002

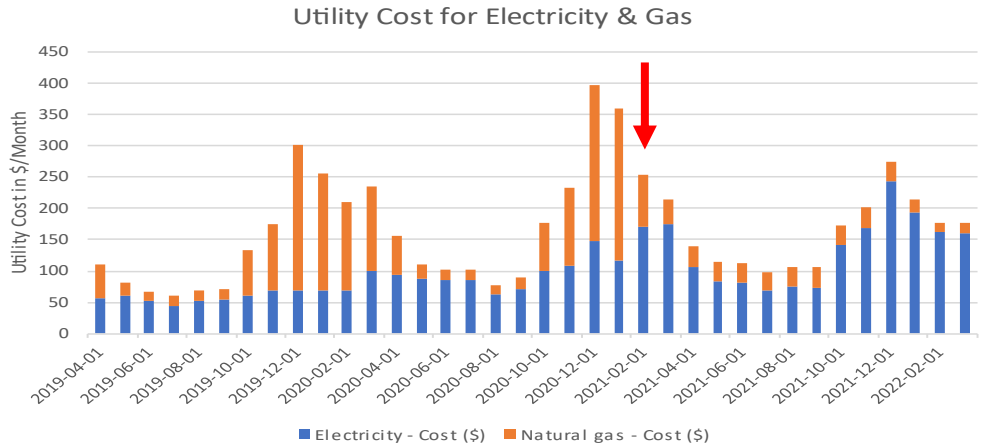
Heat pump installation date: February 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #002. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #002. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #002. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #002 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 587.24 | 1,003.29 | +71% |
| | **Monthly $** | 78.14 | 133.51 | +71% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.006 | 0.011 | +71% |
| **Natural Gas** | **Monthly kWh** | 1,149.71 | 67.66 | -94% |
| | **Monthly $** | 84.52 | 29.02 | -66% |
| | **GHG ($tCO_{2e}$)** | 0.213 | 0.013 | -94% |
| **Total** | **Monthly kWh** | 1,736.95 | 1,070.95 | -38% |
| | **Monthly $** | 162.67 | 162.53 | 0% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.219 | 0.024 | -89% |
| **Weather Normalization** | | | | |
| **Total** | **Monthly kWh** | 1,462.17 | 1,083.97 | -26% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 107.02 | 19.43 | -82% |
| | **Monthly $ Compared to Regular Natural Gas** | +27% | -33% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 185.16 | 162.53 | -12% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 132.57 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -1% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 78.96 | 134.90 | +71% |
| **Natural Gas** | **Monthly $** | 111.32 | 30.60 | -73% |
| **Total** | **Monthly $** | 190.28 | 165.50 | -13% |

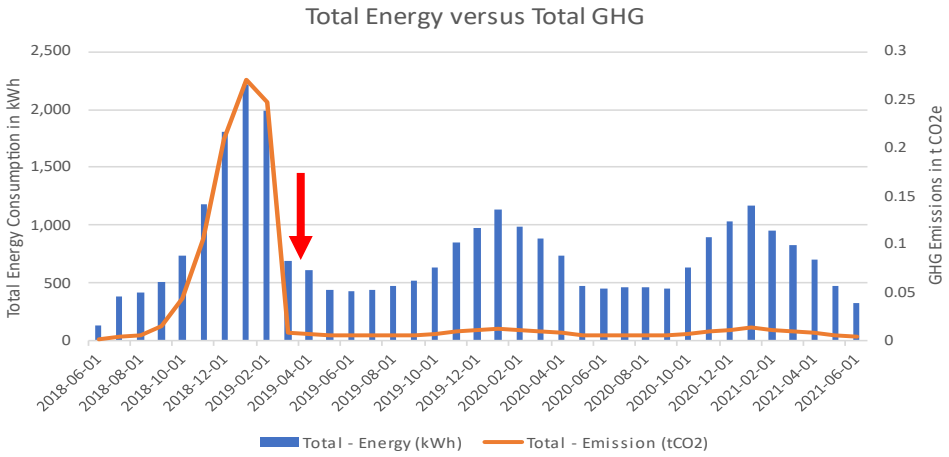
Observations:

- **Renewable Natural Gas:** The change between monthly averages for regular and renewable natural gas in the post-heat pump category is negative. Generally,

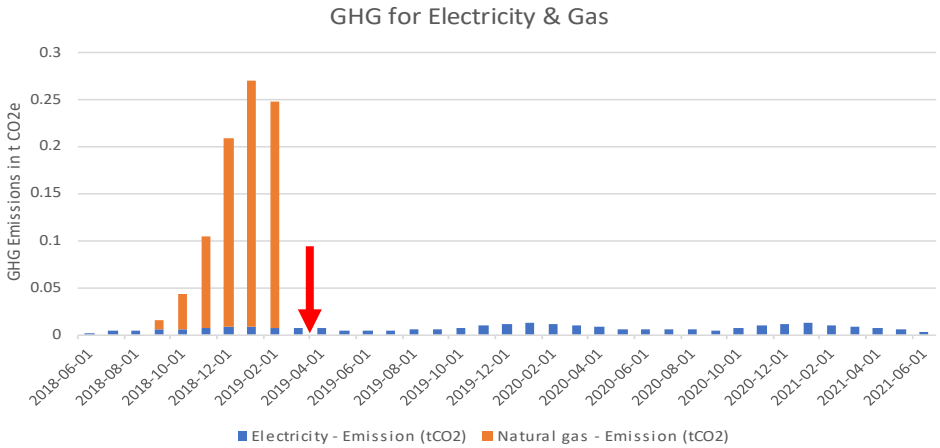
renewable natural gas is expected to cause an increase in cost for the given gas consumption. In the post-heat pump category, the natural gas is composed largely of base and supplementary charges, so a small error in the natural gas costing model compared to the actual billing data or an unforeseen Fortis BC charge likely changed the expected resulted from a cost increase to a cost decrease.

# ID #003

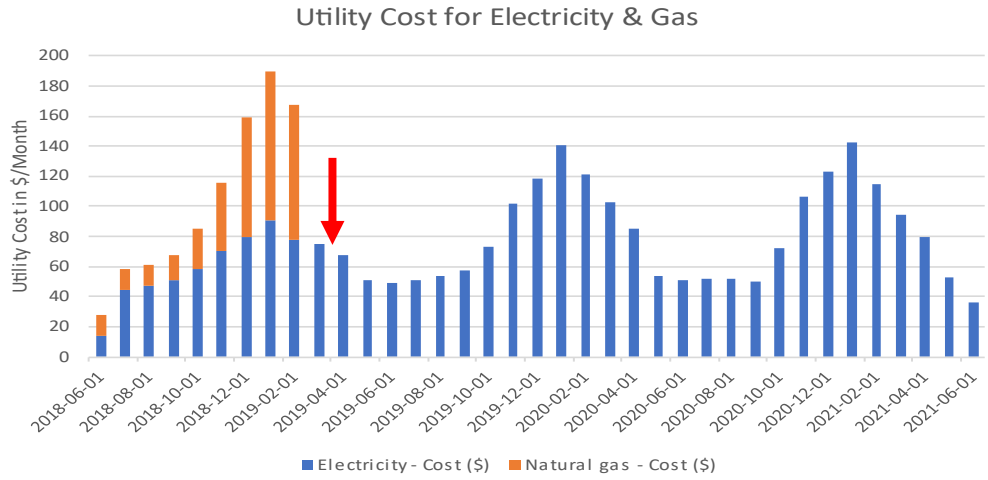
Heat pump installation date: March 2019




*Total energy consumption and greenhouse gas (GHG) emissions for ID #003. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #003. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #003. The red arrow indicates when the heat pump was installed.*

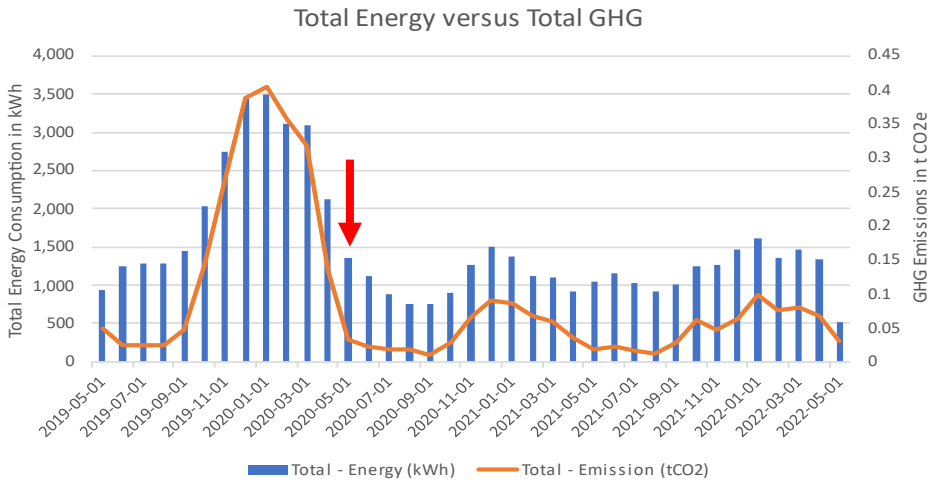
| AVERAGED SUMMARY TABLE: ID #003 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 531.08 | 680.22 | +28% |
| | **Monthly $** | 59.36 | 79.59 | +34% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.006 | 0.007 | +28% |
| **Natural Gas** | **Monthly kWh** | 509.26 | 0 | -100% |
| | **Monthly $** | 44.19 | 0 | -100% |
| | **GHG ($tCO_{2e}$)** | 0.094 | 0 | -100% |
| **Total** | **Monthly kWh** | 1,040.34 | 680.22 | -35% |
| | **Monthly $** | 103.54 | 79.59 | -23% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.100 | 0.007 | -93% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,198.96 | 515.87 | -57% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Renewable Natural Gas** | **Monthly $** | 55.10 | 0 | -100% |
| | **Monthly $ Compared to Regular Natural Gas** | +36% | 0% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 114.46 | 79.59 | -30% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 74.47 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -6% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 60.09 | 82.16 | +37% |
| **Natural Gas** | **Monthly $** | 56.06 | 0 | -100% |
| **Total** | **Monthly $** | 116.15 | 82.16 | -29% |

Observations:

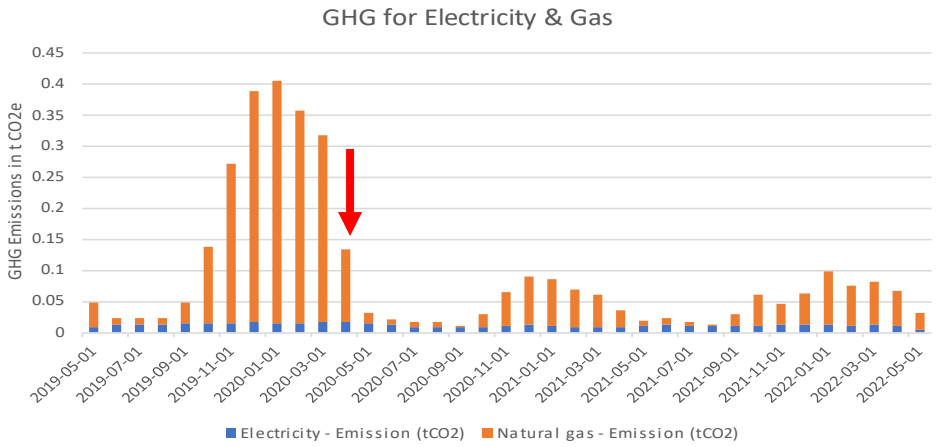
- **Post-Heat Pump Natural Gas Consumption:** After natural gas space heating was replaced with a heat pump, there is no natural gas consumption in the house, so consumption, bills, and GHG emissions due to natural gas are eliminated.

## ID #004

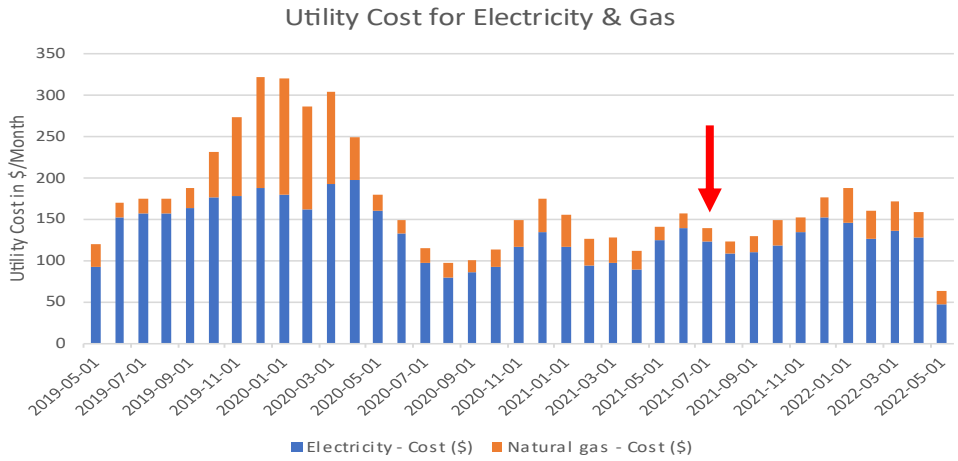
Heat pump installation date: May 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #004. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #004. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #004. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #004 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 1,280.70 | 933.28 | -27% |
| | **Monthly $** | 166.57 | 113.70 | -32% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.014 | 0.010 | -27% |
| **Natural Gas** | **Monthly kWh** | 905.07 | 196.61 | -78% |
| | **Monthly $** | 67.99 | 24.85 | -63% |
| | **GHG ($tCO_{2e}$)** | 0.167 | 0.036 | -78% |
| **Total** | **Monthly kWh** | 2,185.76 | 1,129.89 | -48% |
| | **Monthly $** | 234.55 | 138.55 | -41% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.182 | 0.047 | -74% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,284.58 | 1,035.18 | -55% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Renewable Natural Gas** | **Monthly $** | 87.20 | 29.58 | -66% |
| | **Monthly $ Compared to Regular Natural Gas** | +28% | +19% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 253.77 | 138.55 | -45% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 99.64 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -12% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 168.34 | 115.00 | -32% |
| **Natural Gas** | **Monthly $** | 89.08 | 29.43 | -67% |
| **Total** | **Monthly $** | 257.43 | 144.43 | -44% |

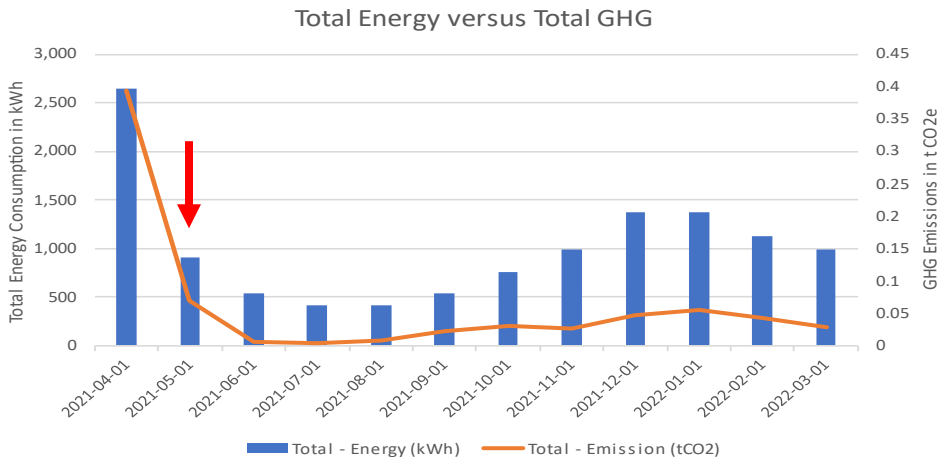
Observations:

- **Utility Bill Data:** Electricity consumption is expected to increase post-heat pump installation, but this dataset shows a decrease in electricity consumption despite having an electric heat pump for space heating. This is likely due to other

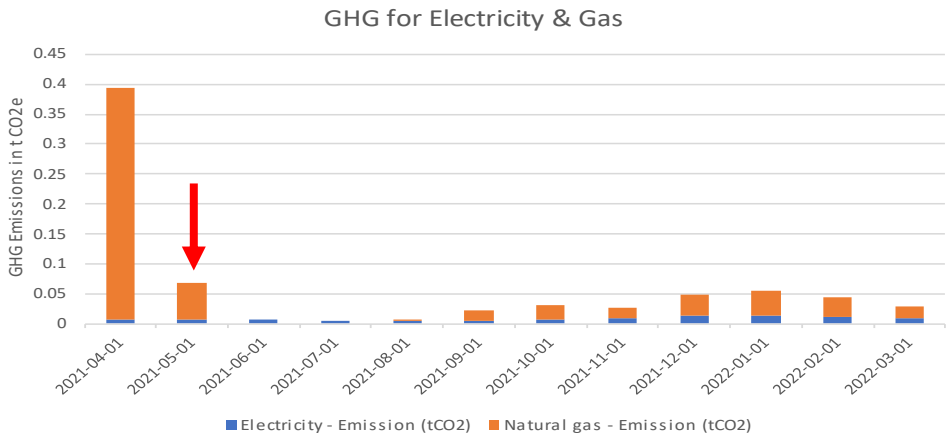
upgrades or changes in building use at the same time of the heat pump installation that decrease overall electricity consumption.

## ID #005

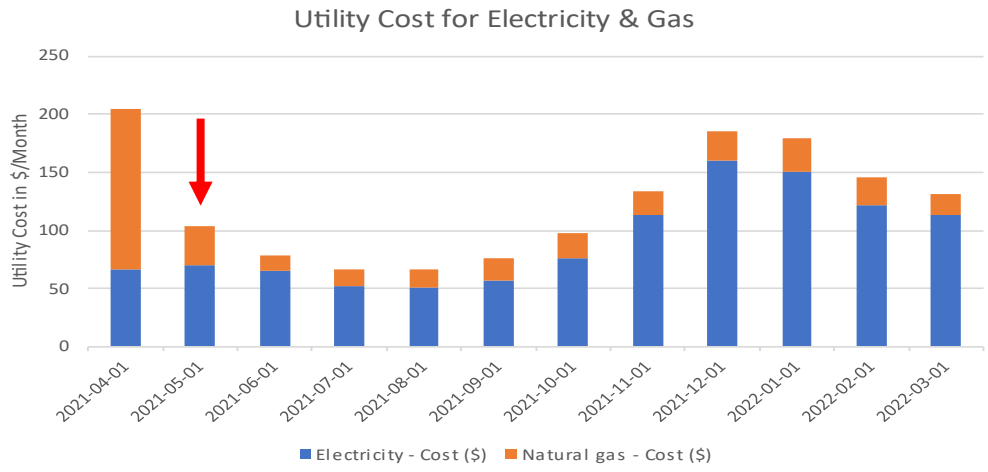
Heat pump installation date: May 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #005. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #005. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #005. The red arrow indicates when the heat pump was installed. Note that BC Hydro bill costs were not provided, so electricity costing was calculated by RDH based off of consumption using current BC Hydro rates.*

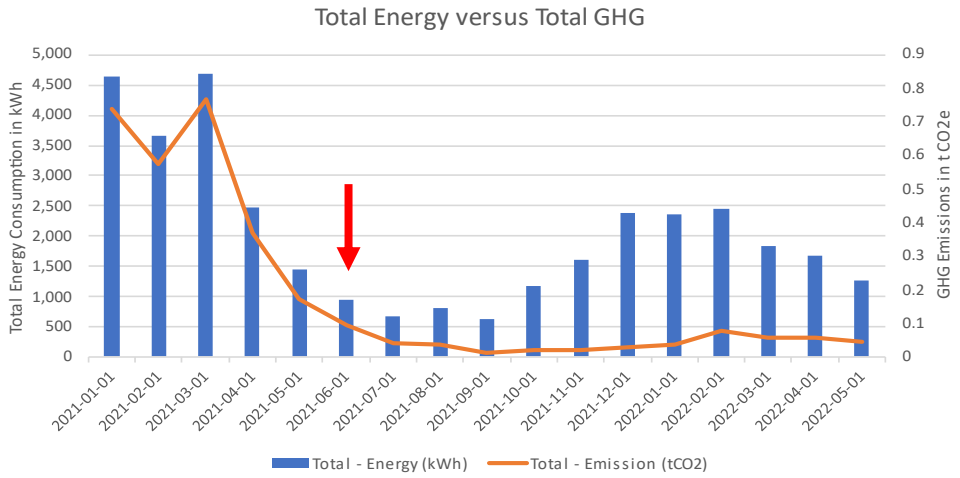
| AVERAGED SUMMARY TABLE: ID #005 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 548.64 | 733.81 | +34% |
| | **Monthly $** | 66.34 | 93.63 | +41% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.006 | 0.008 | +34% |
| **Natural Gas** | **Monthly kWh** | 2,098.98 | 124.00 | -94% |
| | **Monthly $** | 139.01 | 21.10 | -85% |
| | **GHG ($tCO_{2e}$)** | 0.388 | 0.023 | -94% |
| **Total** | **Monthly kWh** | 2,647.62 | 857.81 | -68% |
| | **Monthly $** | 205.35 | 114.73 | -44% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.394 | 0.031 | -92% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,827.83 | 1,576.22 | -14% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Renewable Natural Gas** | **Monthly $** | 183.57 | 23.98 | -87% |
| | **Monthly $ Compared to Regular Natural Gas** | +32% | +14% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 249.91 | 114.73 | -54% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 85.87 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -8% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 67.10 | 94.65 | +41% |
| **Natural Gas** | **Monthly $** | 187.93 | 23.99 | -87% |
| **Total** | **Monthly $** | 255.04 | 118.64 | -53% |

Observations:

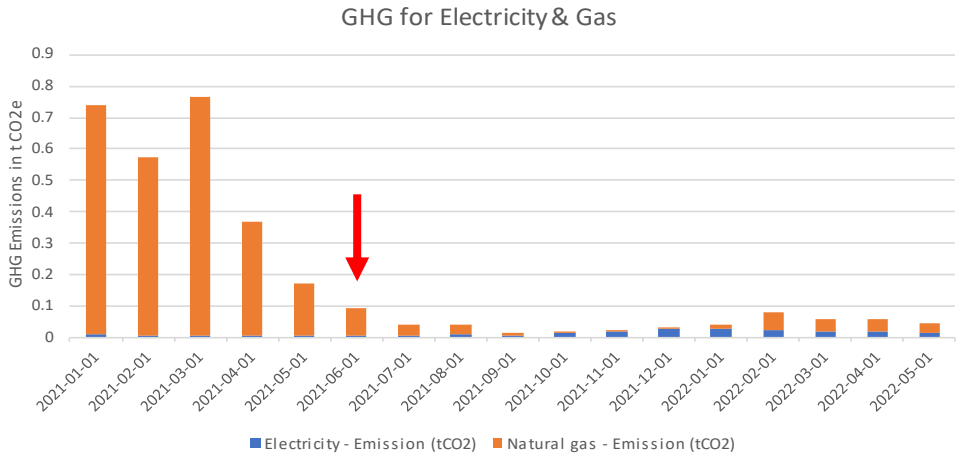
- **Utility Bill Data:** There is limited pre-heat pump installation available for this participant. With such a small dataset, results may not be representative of the true operating conditions.

## ID #006

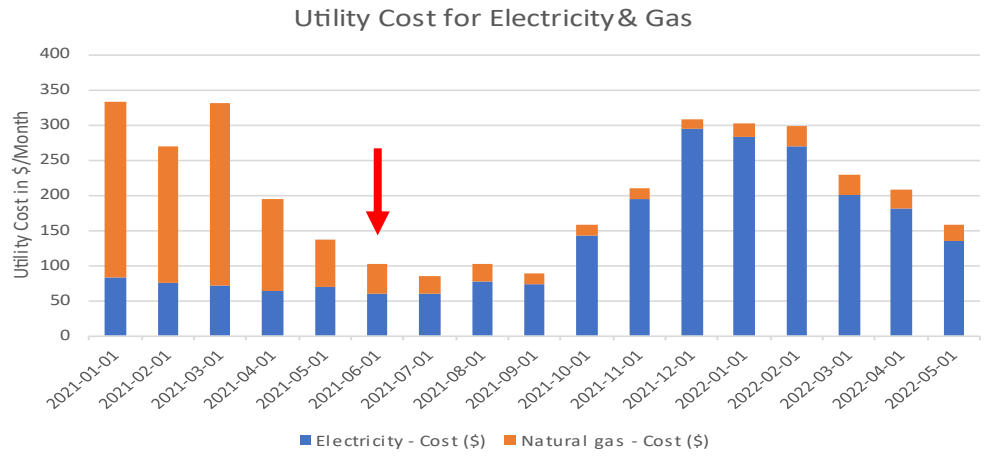
Heat pump installation date: June 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #006. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #006. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #006. The red arrow indicates when the heat pump was installed.*

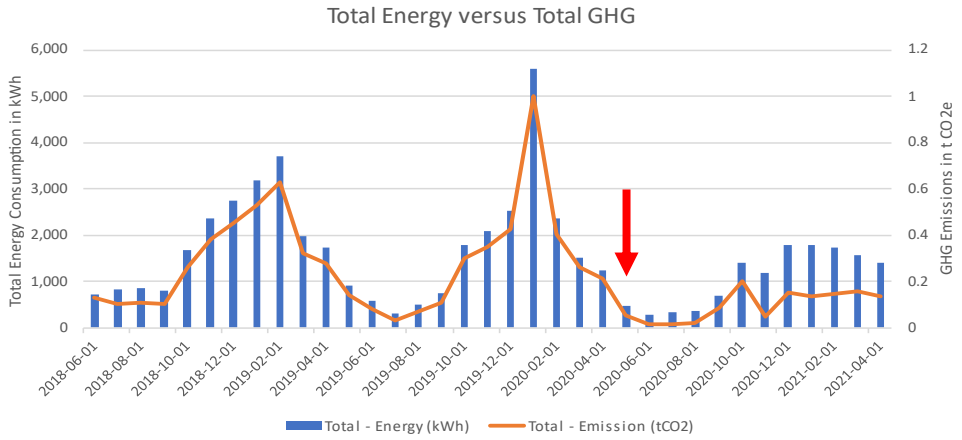
| AVERAGED SUMMARY TABLE: ID #006 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 584.42 | 1,323.47 | +126% |
| | **Monthly $** | 72.55 | 164.31 | +126% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.006 | 0.015 | +126% |
| **Natural Gas** | **Monthly kWh** | 2,796.45 | 156.50 | -94% |
| | **Monthly $** | 180.72 | 23.08 | -87% |
| | **GHG ($tCO_{2e}$)** | 0.517 | 0.029 | -94% |
| **Total** | **Monthly kWh** | 3,380.87 | 1,479.96 | -56% |
| | **Monthly $** | 253.28 | 187.39 | -26% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.524 | 0.044 | -92% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 3,453.57 | 2,117.14 | -39% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Renewable Natural Gas** | **Monthly $** | 240.10 | 26.41 | -89% |
| | **Monthly $ Compared to Regular Natural Gas** | +30% | +24% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 312.65 | 187.39 | -40% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 137.17 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -17% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 73.36 | 166.14 | +126% |
| **Natural Gas** | **Monthly $** | 245.91 | 26.73 | -89% |
| **Total** | **Monthly $** | 319.27 | 192.87 | -40% |

Observations:

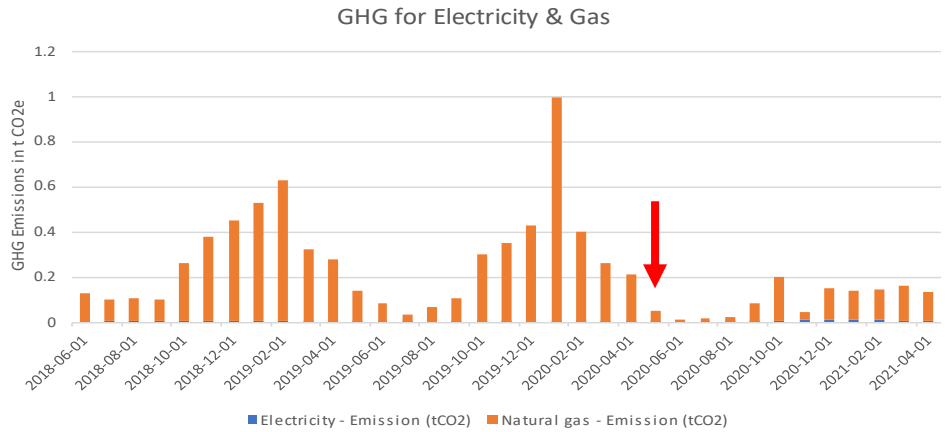
- **Utility Bill Data:** There is limited pre-heat pump installation available for this participant. The pre-heat pump data is mainly during the winter when more space heating is required, which may skew the pre- and post-heat pump results.

## ID #007

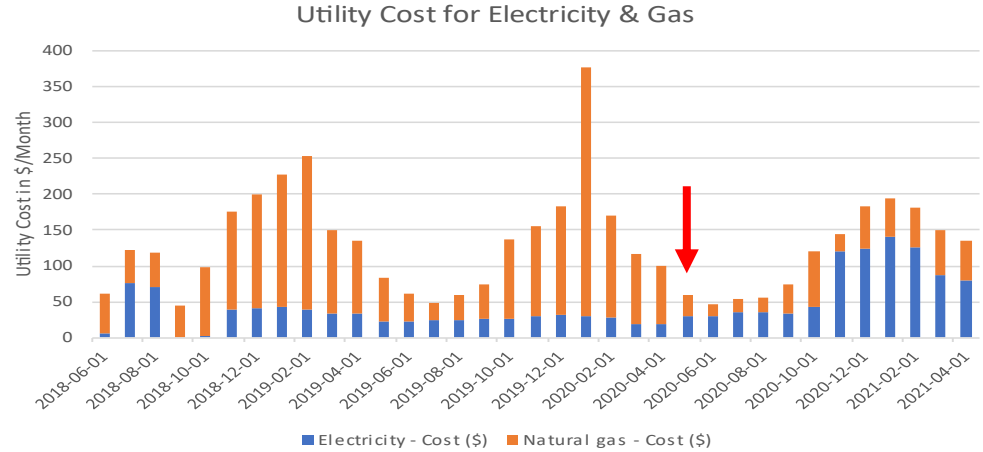
Heat pump installation date: May 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #007. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #007. The red arrow indicates when the heat pump was installed.*



*Utility costs for natural gas and electricity for ID #007. The red arrow indicates when the heat pump was installed. A spike occurred in BC Hydro billing at the time of heat pump installation, likely due to fees for BC Hydro equipment upgrades required to support a heat pump. This cost was removed from the data to limit the analysis to operating costs.*

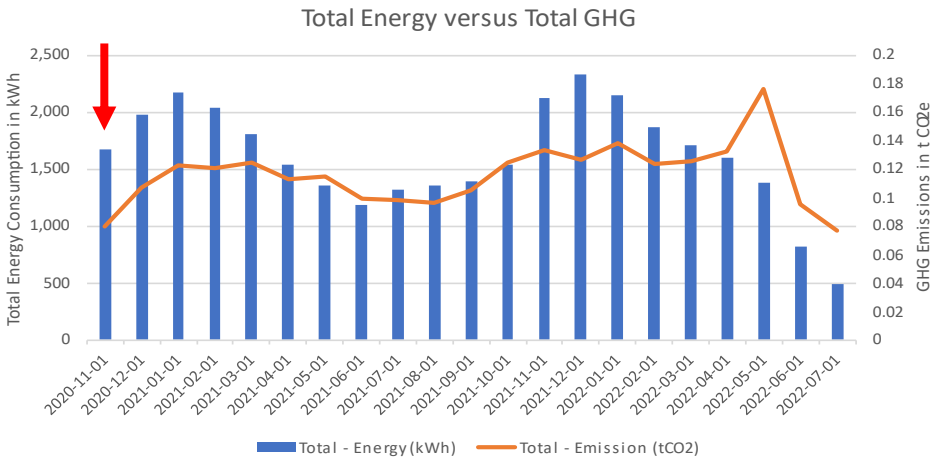
| AVERAGED SUMMARY TABLE: ID #007 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 214.59 | 594.36 | +177% |
| | **Monthly $** | 29.57 | 73.46 | +148% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.002 | 0.007 | +177% |
| **Natural Gas** | **Monthly kWh** | 1,558.54 | 491.49 | -68% |
| | **Monthly $** | 107.51 | 43.27 | -60% |
| | **GHG ($tCO_{2e}$)** | 0.288 | 0.091 | -68% |
| **Total** | **Monthly kWh** | 1,773.13 | 1,085.85 | -39% |
| | **Monthly $** | 137.08 | 116.73 | -15% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.291 | 0.097 | -66% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,704.77 | 1,089.71 | -36% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Renewable Natural Gas** | **Monthly $** | 140.05 | 53.70 | -62% |
| | **Monthly $ Compared to Regular Natural Gas** | +31% | +27% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 169.62 | 116.73 | -31% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 67.96 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -7% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 29.87 | 74.29 | +149% |
| **Natural Gas** | **Monthly $** | 143.84 | 54.72 | -62% |
| **Total** | **Monthly $** | 173.71 | 129.01 | -26% |

Observations:

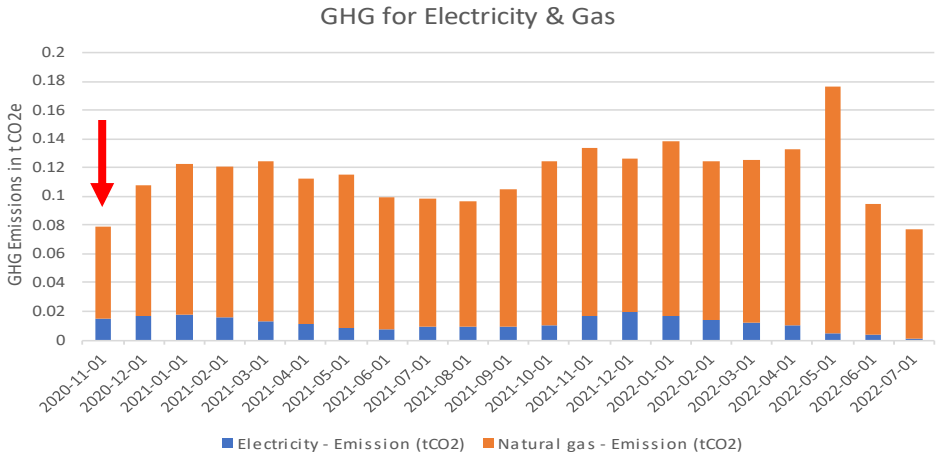
- **Utility Bill Data:** Overall decrease in post-heat pump energy consumption due to increased heating efficiency of electric heat pump, slight decrease in total cost, and large decrease in GHG emissions despite the high relative increases of electricity values.
- **Carbon Tax at $170 per tonne $CO_{2e}$:** Despite increased costs projected for the higher electricity use with a heat pump, the lower carbon emissions associated with BC Hydro electricity will yield a lower total utility bill than if the natural gas furnace were to remain (see actual utility bill data for pre-heat pump cost comparison).

# ID #008

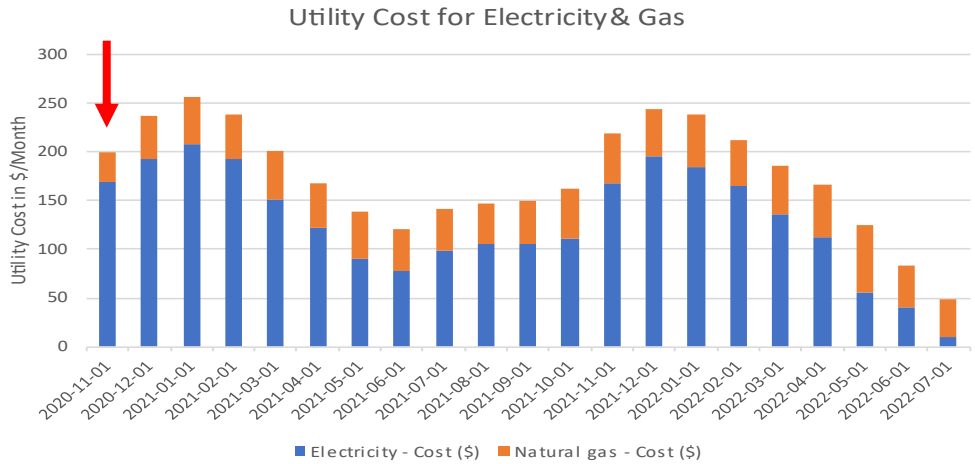
Heat pump installation date: October 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #008. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #008. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #008. The red arrow indicates when the heat pump was installed.*

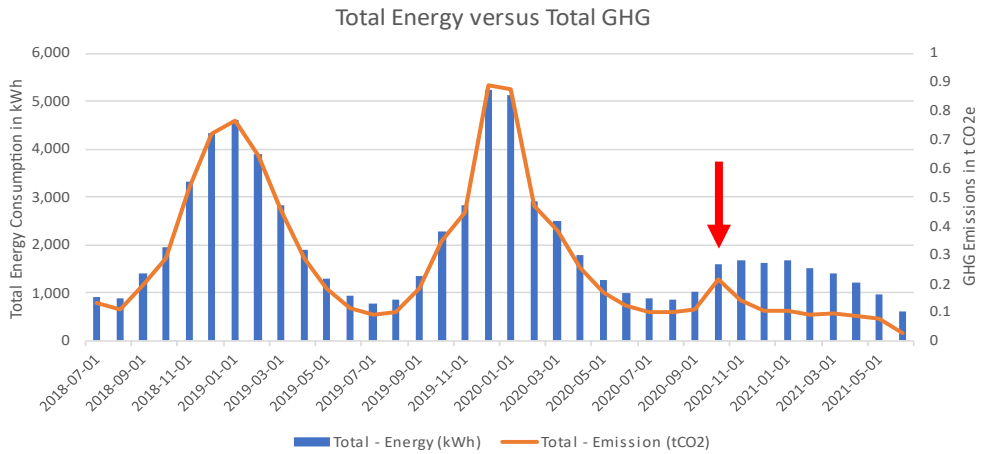
| AVERAGED SUMMARY TABLE: ID #008 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | - | 1,046.88 | - |
| | **Monthly $** | - | 128.18 | - |
| | **Monthly GHG ($tCO_{2e}$)** | - | 0.012 | - |
| **Natural Gas** | **Monthly kWh** | - | 564.63 | - |
| | **Monthly $** | - | 47.42 | - |
| | **GHG ($tCO_{2e}$)** | - | 0.104 | - |
| **Total** | **Monthly kWh** | - | 1,611.51 | - |
| | **Monthly $** | - | 175.60 | - |
| | **Monthly GHG ($tCO_{2e}$)** | - | 0.116 | - |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | - | 1,983.86 | - |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Renewable Natural Gas** | **Monthly $** | - | 65.06 | - |
| | **Monthly $ Compared to Regular Natural Gas** | - | +37% | - |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | - | 175.60 | - |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | - | 111.09 | - |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | - | -13% | - |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | - | 129.64 | - |
| **Natural Gas** | **Monthly $** | - | 60.58 | - |
| **Total** | **Monthly $** | - | 190.21 | - |

Observations:

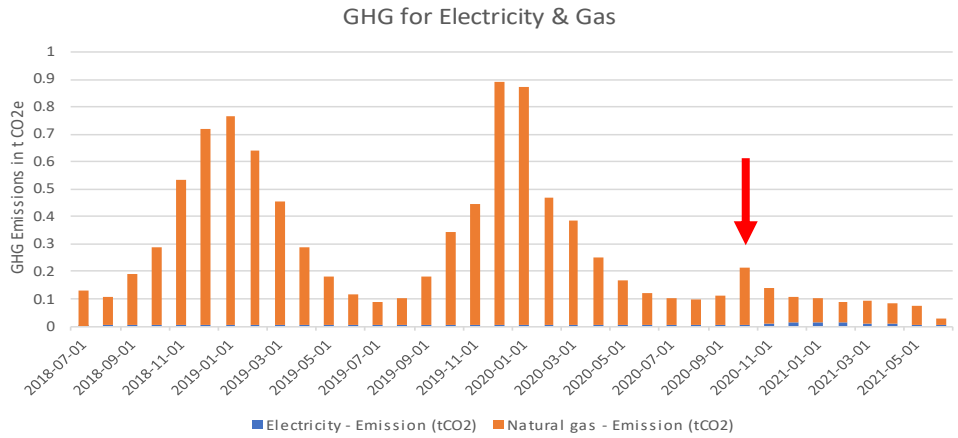
- **Utility Bill Data:** No pre-heat pump data was available. The analysis cannot provide a pre- and post-heat pump comparison.

# ID #009

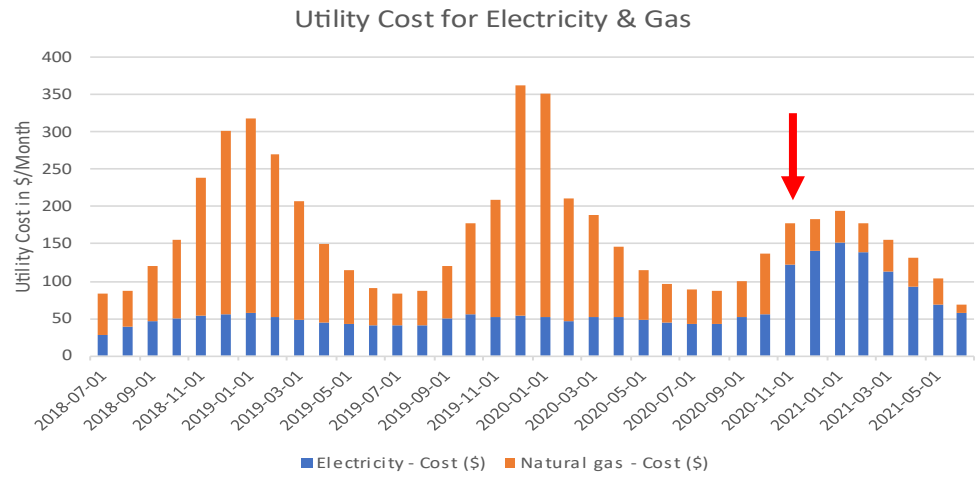
Heat pump installation date: October 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #009. The red arrow indicates when the heat pump was installed. There is a notable dip in energy consumption going into winter months when the heat pump is installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #009. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #009. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #009 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 395.43 | 904.00 | +129% |
| | **Monthly $** | 47.65 | 110.64 | +132% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.004 | 0.010 | +129% |
| **Natural Gas** | **Monthly kWh** | 1,788.39 | 431.82 | -76% |
| | **Monthly $** | 121.27 | 38.48 | -68% |
| | **GHG ($tCO_{2e}$)** | 0.331 | 0.080 | -76% |
| **Total** | **Monthly kWh** | 2,183.81 | 1,335.82 | -39% |
| | **Monthly $** | 168.92 | 149.12 | -12% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.335 | 0.090 | -73% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,151.06 | 710.79 | -67% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 158.67 | 48.80 | -69% |
| | **Monthly $ Compared to Regular Natural Gas** | +31% | +27% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 206.32 | 149.12 | -28% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 98.79 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -11% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 48.20 | 111.89 | +132% |
| **Natural Gas** | **Monthly $** | 162.96 | 48.55 | -70% |
| **Total** | **Monthly $** | 211.15 | 160.44 | -24% |

Observations:

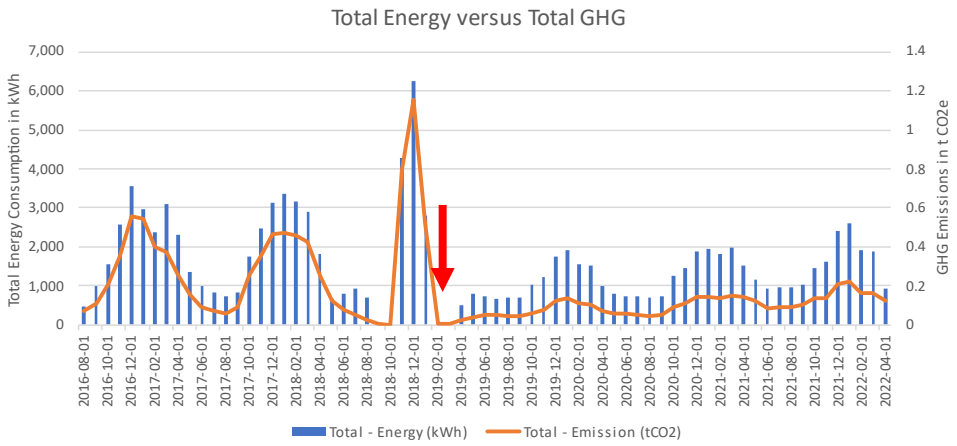
- **Utility Bill Data:** Overall decrease in post-heat pump energy consumption due to increased heating efficiency of electric heat pump, slight decrease in total cost,

and large decrease in GHG emissions despite the high relative increases of electricity values.

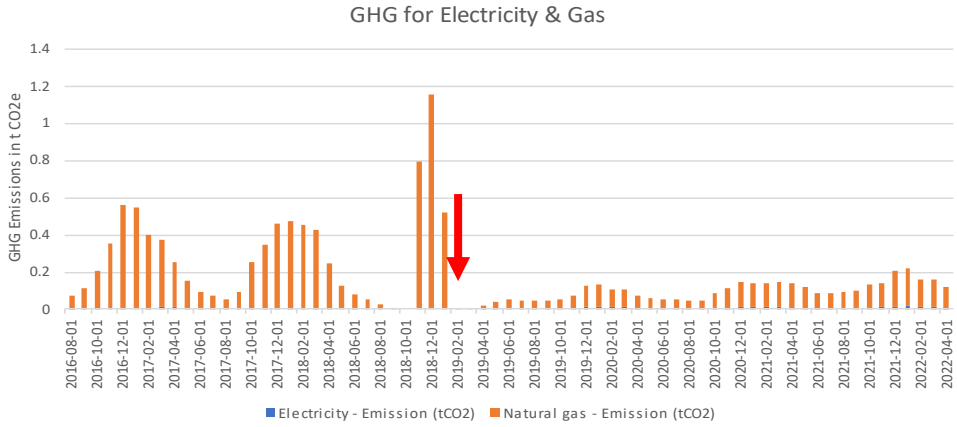
- **Carbon Tax at $170 per tonne $CO_{2e}$:** Despite increased costs projected for the higher electricity use with a heat pump, the lower carbon emissions associated with BC Hydro electricity will yield a lower total utility bill than if the natural gas furnace were to remain (see actual utility bill data for pre-heat pump cost comparison).

# ID #010

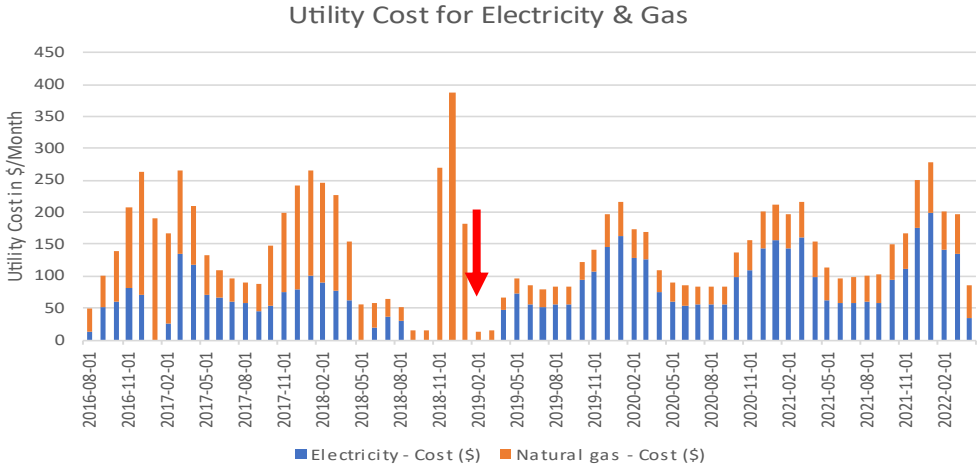
Heat pump installation date: February 2019




*Total energy consumption and greenhouse gas (GHG) emissions for ID #010. The red arrow indicates when the heat pump was installed. There is a gap in the provided data for the 2018/19 winter which makes the data appear to spike abruptly.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #010. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #010. The red arrow indicates when the heat pump was installed.*

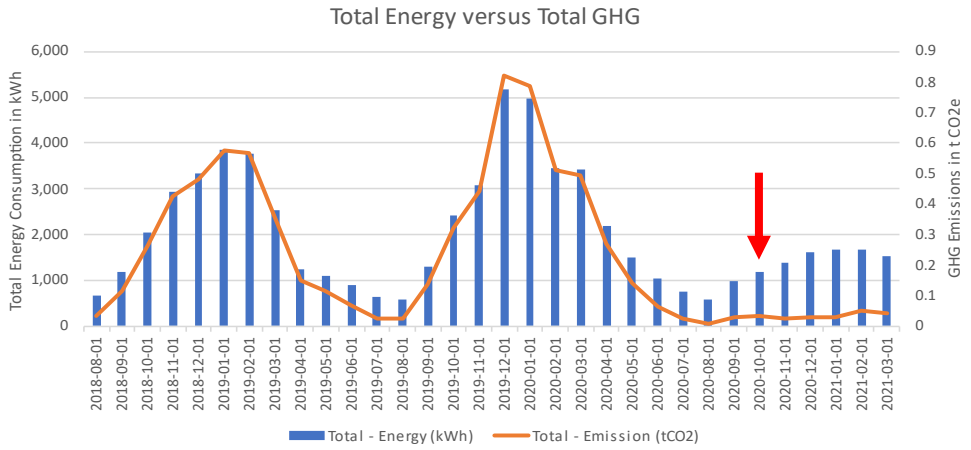
| AVERAGED SUMMARY TABLE: ID #010 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 570.26 | 783.35 | +37% |
| | **Monthly $** | 64.36 | 96.02 | +49% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.006 | 0.009 | +37% |
| **Natural Gas** | **Monthly kWh** | 1,554.44 | 475.69 | -69% |
| | **Monthly $** | 106.72 | 42.31 | -60% |
| | **GHG ($tCO_{2e}$)** | 0.288 | 0.088 | -69% |
| **Total** | **Monthly kWh** | 1,991.64 | 1,218.87 | -39% |
| | **Monthly $** | 156.07 | 133.41 | -15% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.292 | 0.096 | -67% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,984.73 | 1,301.95 | -34% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 139.73 | 52.41 | -62% |
| | **Monthly $ Compared to Regular Natural Gas** | +31% | +24% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 204.09 | 138.33 | -32% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 84.74 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -12% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 62.44 | 97.11 | +56% |
| **Natural Gas** | **Monthly $** | 142.96 | 53.40 | -63% |
| **Total** | **Monthly $** | 192.91 | 145.53 | -25% |

Observations:

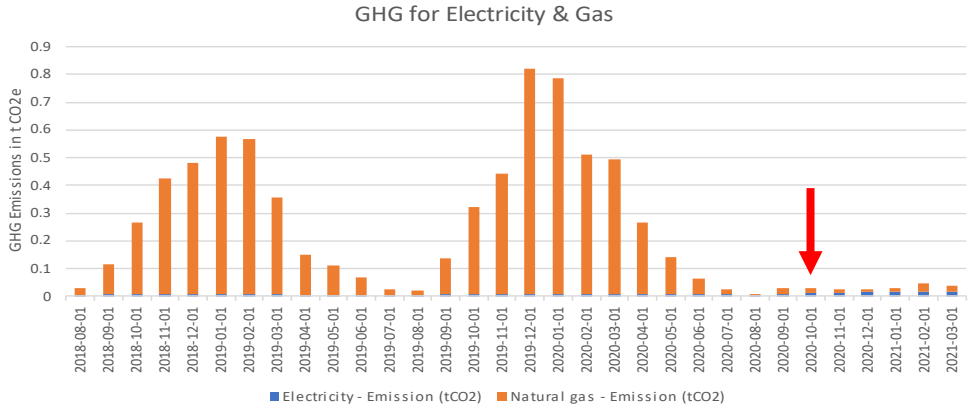
- **Utility Bill Data:** There is a gap in the provided data for the 2018/19 winter which makes the data appear to spike abruptly, which may slightly affect the weighting of pre-heat pump data.
- **Weather Normalized Data:** The larger dataset means weather normalized energy consumption is close to average actual consumption.

# ID #011

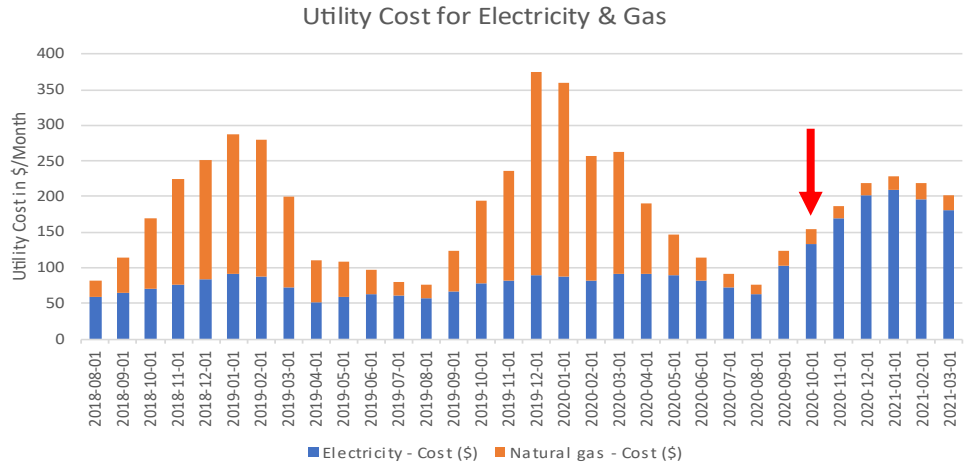
Heat pump installation date: October 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #011. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #011. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #011. The red arrow indicates when the heat pump was installed. A spike occurred in BC Hydro billing at the time of heat pump installation, likely due to fees for BC Hydro equipment upgrades required to support a heat pump. This cost was removed from the data to limit the analysis to operating costs.*

| AVERAGED SUMMARY TABLE: ID #011 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 673.11 | 1,416.87 | +110% |
| | **Monthly $** | 75.88 | 181.56 | +139% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.007 | 0.016 | +110% |
| **Natural Gas** | **Monthly kWh** | 1,468.12 | 98.46 | -93% |
| | **Monthly $** | 102.17 | 19.77 | -81% |
| | **GHG ($tCO_{2e}$)** | 0.272 | 0.018 | -93% |
| **Total** | **Monthly kWh** | 2,141.23 | 1,515.33 | -29% |
| | **Monthly $** | 178.04 | 201.33 | 13% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.279 | 0.034 | -88% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,035.98 | 654.84 | -68% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 132.74 | 21.86 | -84% |
| | **Monthly $ Compared to Regular Natural Gas** | +30% | +11% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 208.62 | 201.33 | -3% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 147.08 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -19% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 76.81 | 183.52 | +139% |
| **Natural Gas** | **Monthly $** | 136.39 | 22.07 | -84% |
| **Total** | **Monthly $** | 213.20 | 205.59 | -4% |

Observations:

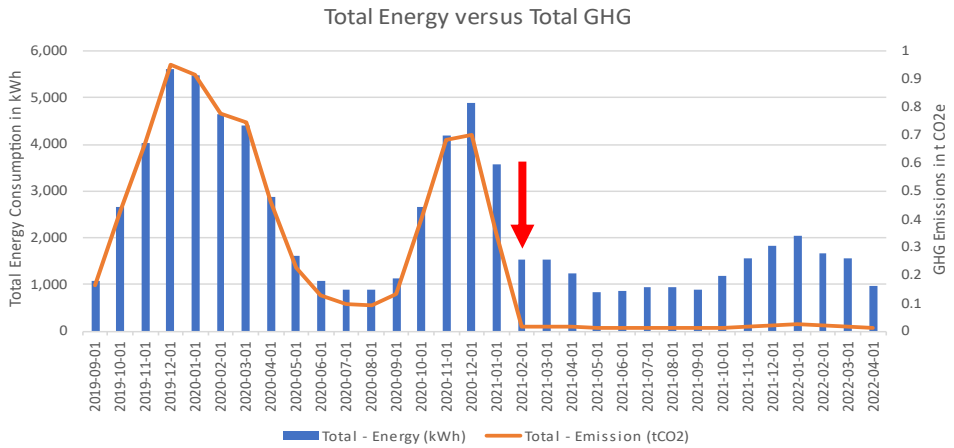
- **Utility Bill Data:** Overall decrease in post-heat pump energy consumption due to increased heating efficiency of electric heat pump, slight decrease in total cost,

and large decrease in GHG emissions despite the high relative increases of electricity values.

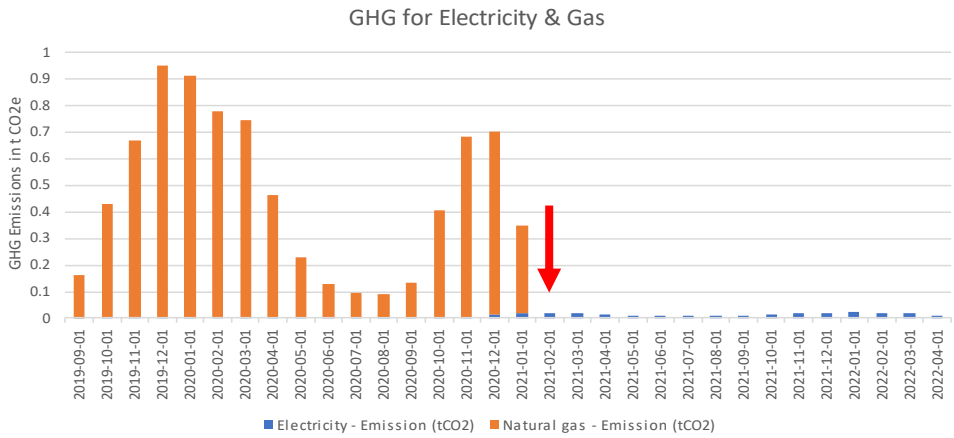
- **Carbon Tax at $170 per tonne $CO_{2e}$:** Despite increased costs projected for the higher electricity use with a heat pump, the lower carbon emissions associated with BC Hydro electricity will yield a lower total utility bill than if the natural gas furnace were to remain (see actual utility bill data for pre-heat pump cost comparison).

# ID #012

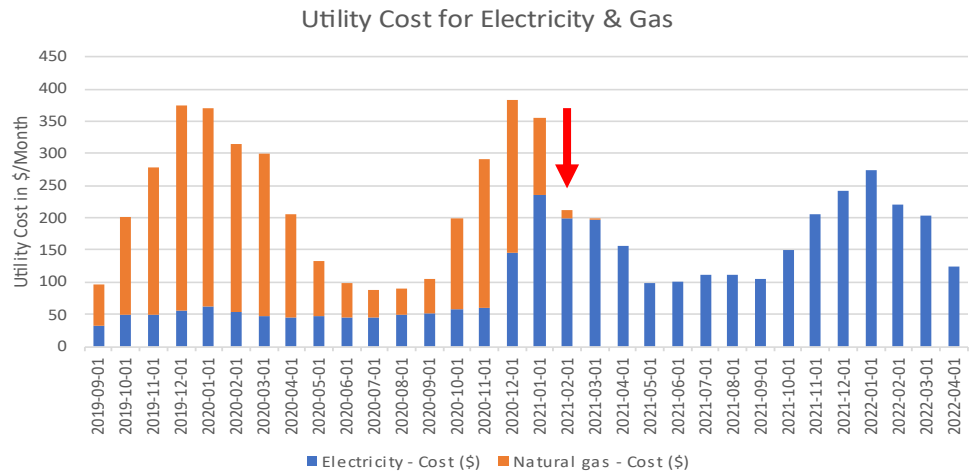
Heat pump installation date: January 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #012. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #012. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #012. The red arrow indicates when the heat pump was installed.*

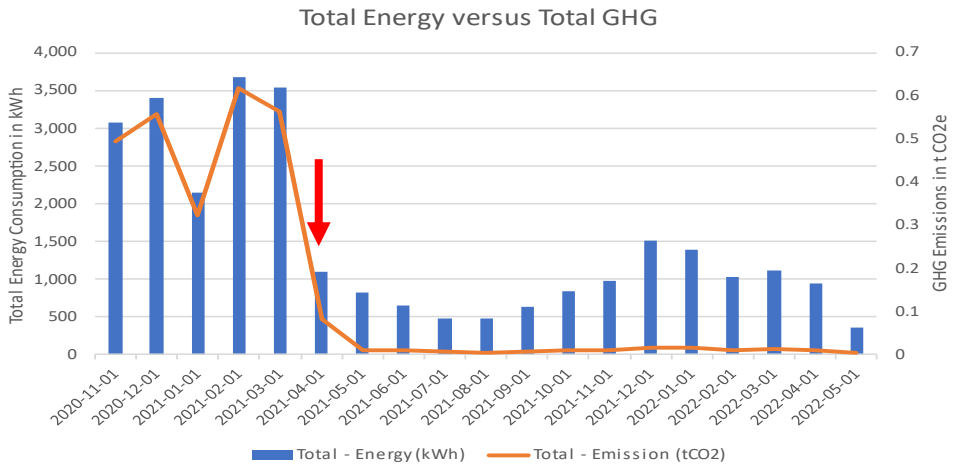
| AVERAGED SUMMARY TABLE: ID #012 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 475.08 | 1,303.42 | +174% |
| | **Monthly $** | 55.91 | 166.46 | +198% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.005 | 0.014 | +174% |
| **Natural Gas** | **Monthly kWh** | 2,532.35 | 0 | -100% |
| | **Monthly $** | 164.87 | 0 | -100% |
| | **GHG ($tCO_{2e}$)** | 0.468 | 0 | -100% |
| **Total** | **Monthly kWh** | 3,007.43 | 1,303.42 | -57% |
| | **Monthly $** | 220.78 | 167.56 | -24% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.474 | 0.014 | -97% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,976.39 | 1,031.63 | -65% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 218.64 | 0 | -100% |
| | **Monthly $ Compared to Regular Natural Gas** | +33% | 0% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 274.55 | 166.46 | -39% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 136.50 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -18% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 56.56 | 168.27 | +197% |
| **Natural Gas** | **Monthly $** | 223.90 | - | -100% |
| **Total** | **Monthly $** | 280.46 | 168.27 | -40% |

Observations:

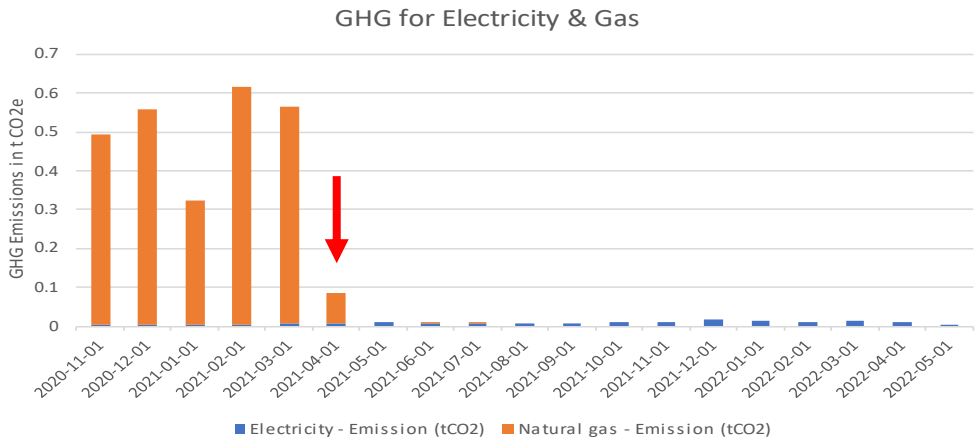
- **Post-Heat Pump Natural Gas Consumption:** After natural gas space heating was replaced with a heat pump, there is no natural gas consumption in the house, so consumption, bills, and GHG emissions due to natural gas are eliminated.

## ID #013

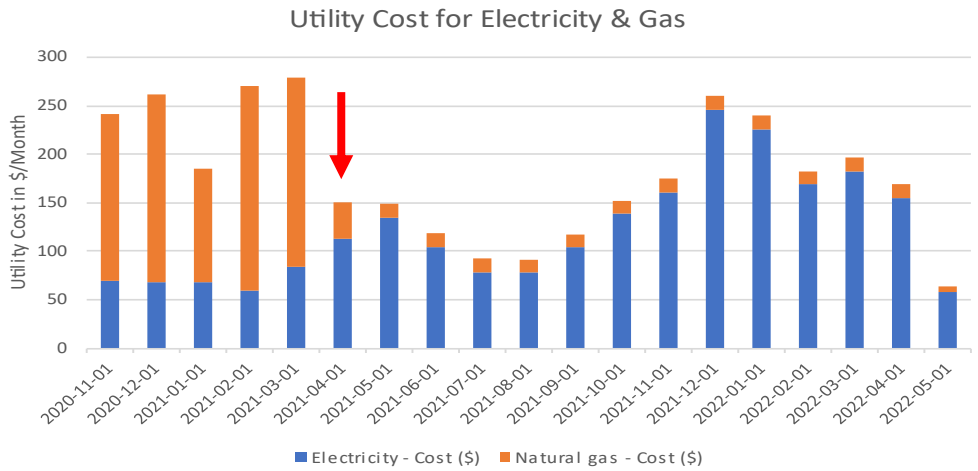
Heat pump installation date: April 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #013. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #013. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #013. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #013 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 429.09 | 853.04 | +99% |
| | **Monthly $** | 69.87 | 138.91 | +99% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.005 | 0.009 | +99% |
| **Natural Gas** | **Monthly kWh** | 2,741.67 | 31.50 | -99% |
| | **Monthly $** | 177.45 | 15.20 | -91% |
| | **GHG ($tCO_{2e}$)** | 0.507 | 0.006 | -99% |
| **Total** | **Monthly kWh** | 3,170.76 | 884.54 | -72% |
| | **Monthly $** | 247.33 | 154.10 | -38% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.512 | 0.015 | -97% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 3,408.23 | 253.75 | -93% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 235.67 | 15.87 | -93% |
| | **Monthly $ Compared to Regular Natural Gas** | +33% | +4% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 305.54 | 154.10 | -50% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 127.21 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -8% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 70.47 | 140.09 | +99% |
| **Natural Gas** | **Monthly $** | 241.36 | 15.93 | -93% |
| **Total** | **Monthly $** | 311.83 | 156.02 | -50% |

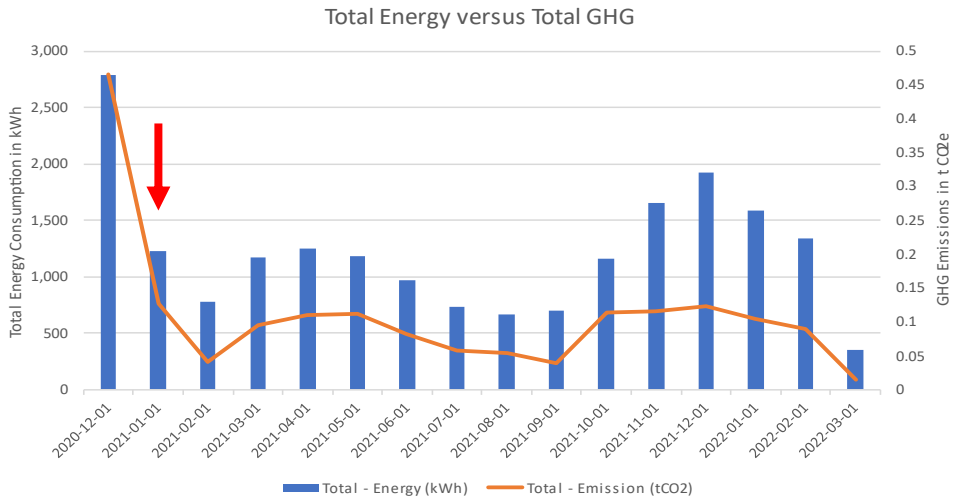
Observations:

- **Utility Bill Data:** Limited pre-heat pump data is available. Due to winter-only data when space heating is required, the pre-heat pump data may be skewed.

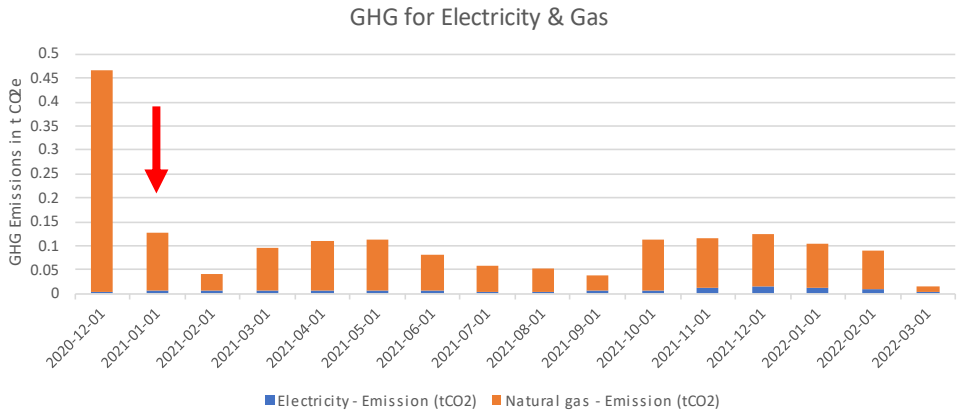
-

## ID #014

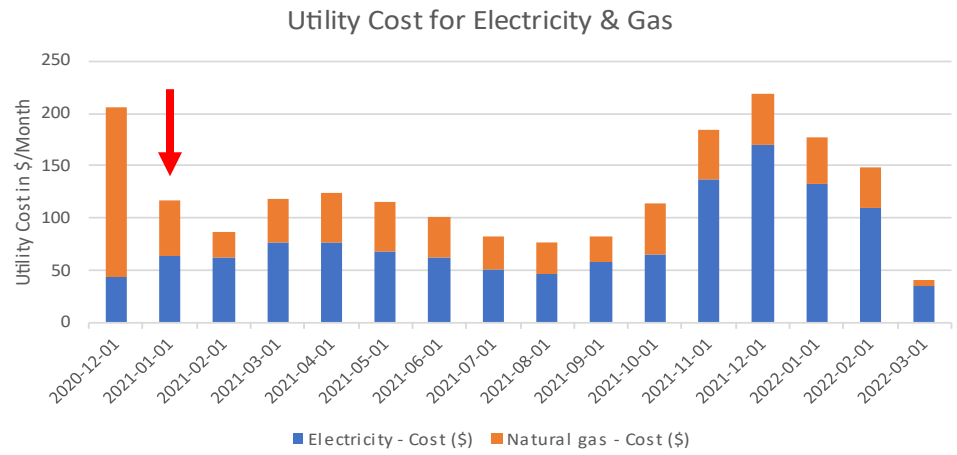
Heat pump installation date: January 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #014. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #014. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #014. The red arrow indicates when the heat pump was installed.*

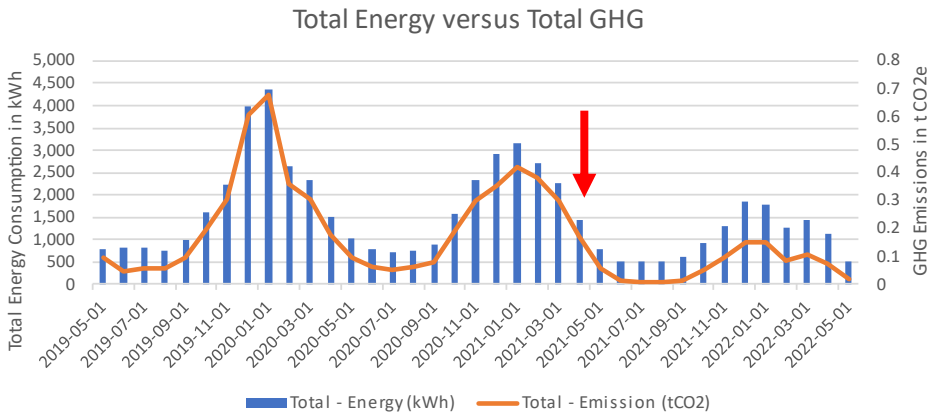
| AVERAGED SUMMARY TABLE: ID #014 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 284.81 | 695.82 | +144% |
| | **Monthly $** | 43.05 | 81.14 | +88% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.003 | 0.008 | +144% |
| **Natural Gas** | **Monthly kWh** | 2,504.65 | 419.06 | -83% |
| | **Monthly $** | 163.68 | 38.08 | -77% |
| | **GHG ($tCO_{2e}$)** | 0.463 | 0.078 | -83% |
| **Total** | **Monthly kWh** | 2,789.46 | 1,114.88 | -60% |
| | **Monthly $** | 206.73 | 119.22 | -42% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.466 | 0.085 | -82% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | - | - | - |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 216.86 | 47.13 | -78% |
| | **Monthly $ Compared to Regular Natural Gas** | +32% | +24% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 259.91 | 119.22 | -54% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 75.74 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -7% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 43.45 | 82.10 | 89% |
| **Natural Gas** | **Monthly $** | 222.06 | 47.85 | -78% |
| **Total** | **Monthly $** | 265.50 | 129.95 | -51% |

Observations:

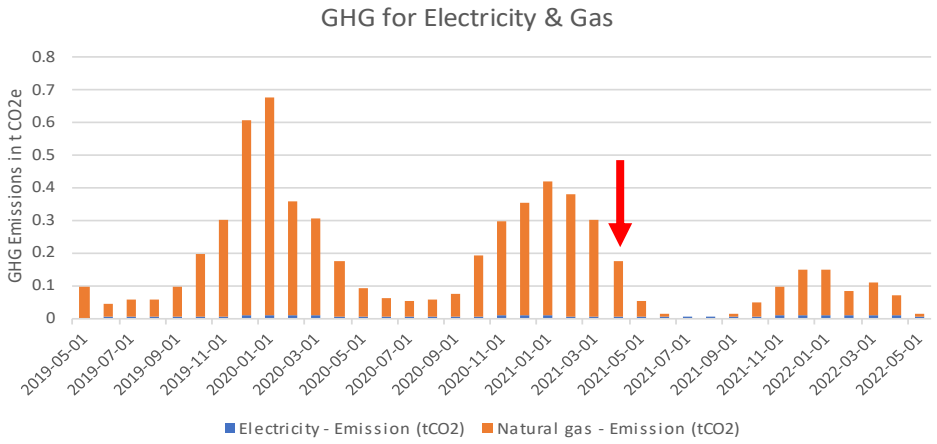
- **Utility Bill Data:** Due to limited pre-heat pump installation natural gas data, the regression and weather normalization for natural gas could not be completed.

## ID #015

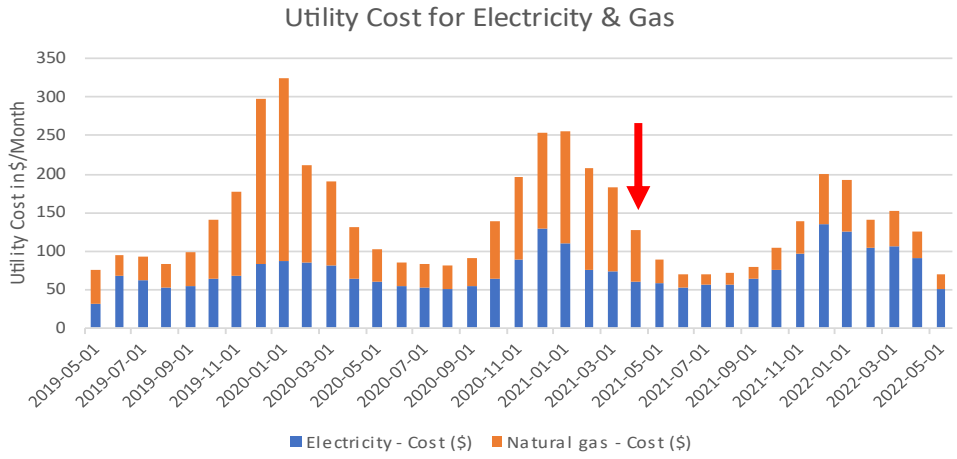
Heat pump installation date: April 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #015. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #015. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #015. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #015 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 618.93 | 697.55 | +13% |
| | **Monthly $** | 70.12 | 80.67 | +15% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.007 | 0.008 | +13% |
| **Natural Gas** | **Monthly kWh** | 1,199.71 | 340.55 | -72% |
| | **Monthly $** | 86.22 | 35.34 | -59% |
| | **GHG ($tCO_{2e}$)** | 0.222 | 0.063 | -72% |
| **Total** | **Monthly kWh** | 1,818.64 | 1,038.10 | -43% |
| | **Monthly $** | 156.33 | 116.01 | -26% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.229 | 0.071 | -69% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,683.55 | 1,111.17 | -34% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 111.03 | 41.49 | -63% |
| | **Monthly $ Compared to Regular Natural Gas** | +29% | +17% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 181.15 | 116.01 | -36% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 76.26 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -5% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 70.97 | 81.63 | +15% |
| **Natural Gas** | **Monthly $** | 114.18 | 43.28 | -62% |
| **Total** | **Monthly $** | 185.16 | 124.91 | -33% |

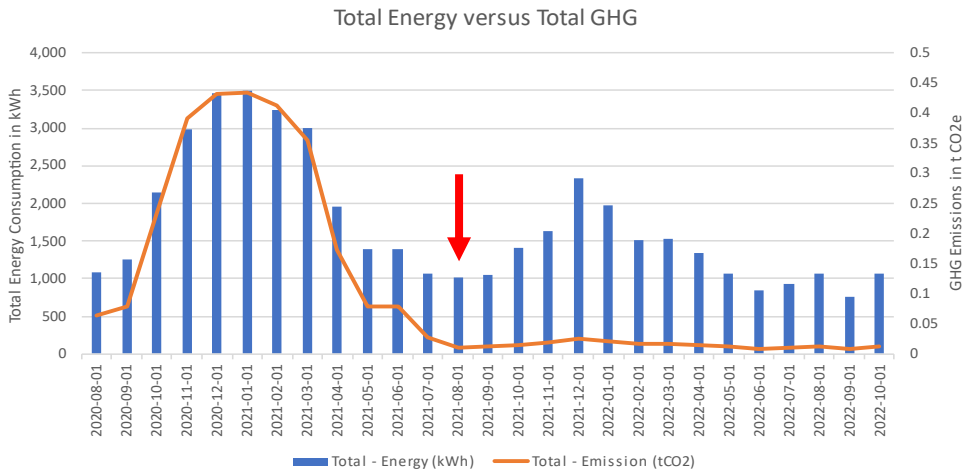
Observations:

- **Utility Bill Data:** The participant recorded heavy use of the natural gas fireplace in winter months even after heat pump installation. The resulting post-heat pump

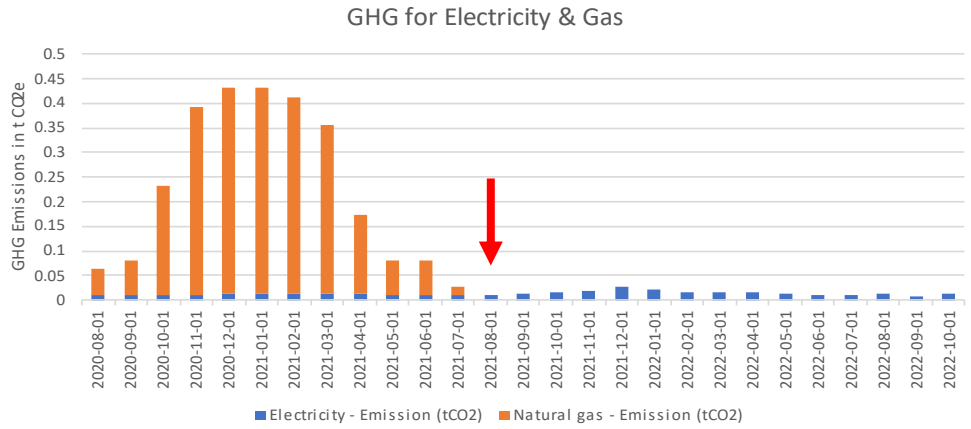
installation data may not be as dramatic since natural gas is still being used for space heating.

# ID #016

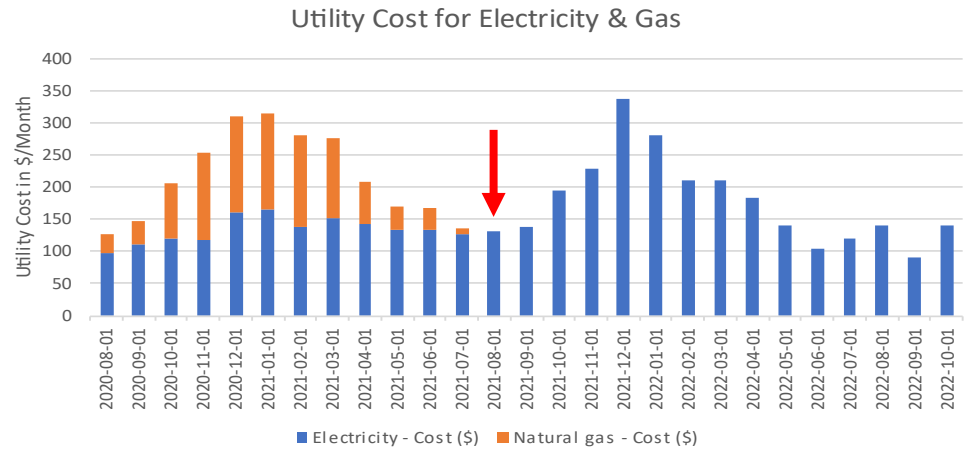
Heat pump installation date: August 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #016. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #016. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #016. The red arrow indicates when the heat pump was installed. Note that BC Hydro bill costs were not provided, so electricity costing was calculated by RDH based off of consumption using current BC Hydro rates.*

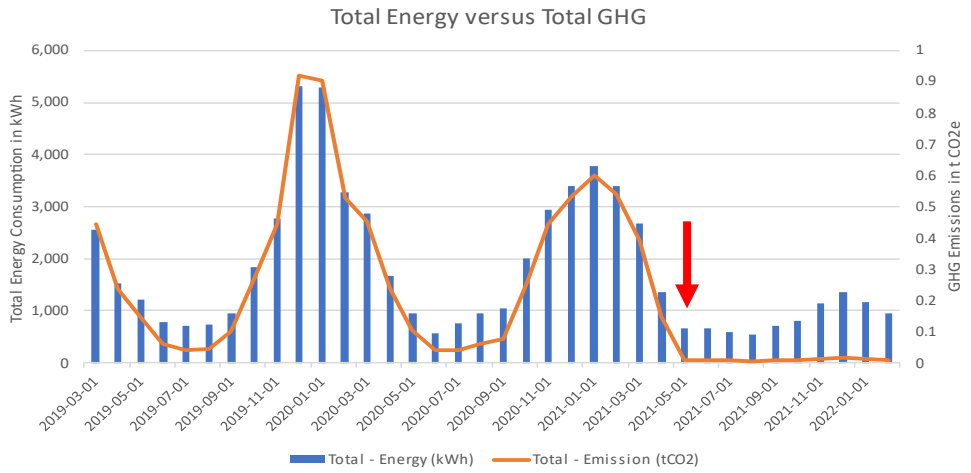
| AVERAGED SUMMARY TABLE: ID #016 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 1,044.27 | 1,303.20 | +25% |
| | **Monthly $** | 137.01 | 177.23 | +29% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.011 | 0.014 | +25% |
| **Natural Gas** | **Monthly kWh** | 1,263.13 | - | -100% |
| | **Monthly $** | 88.29 | - | -100% |
| | **GHG ($tCO_{2e}$)** | 0.234 | - | -100% |
| **Total** | **Monthly kWh** | 2,307.40 | 1,303.20 | -44% |
| | **Monthly $** | 225.29 | 177.23 | -21% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.245 | 0.014 | -94% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,191.02 | 1,382.96 | -37% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 116.11 | 0 | -100% |
| | **Monthly $ Compared to Regular Natural Gas** | +32% | 0% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 253.12 | 177.23 | -30% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 145.51 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -18% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 138.45 | 179.04 | +29% |
| **Natural Gas** | **Monthly $** | 117.73 | 0 | -100% |
| **Total** | **Monthly $** | 256.19 | 179.04 | -30% |

Observations:

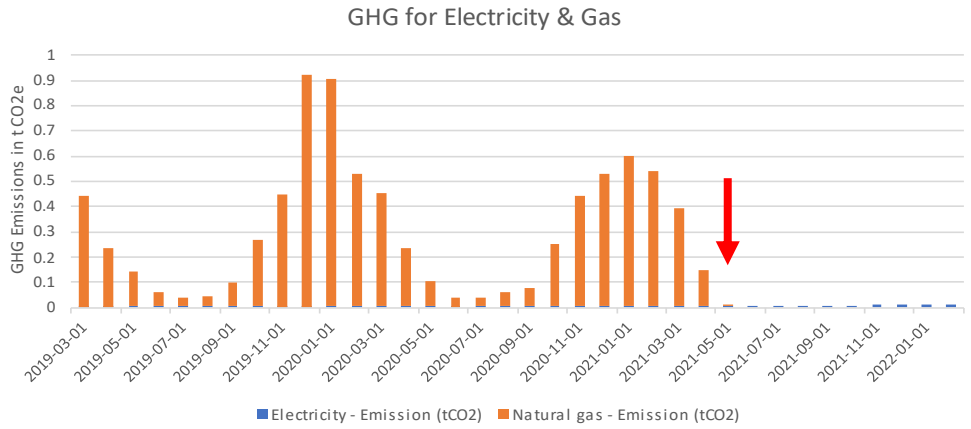
- **Utility Bill Data:** A large dataset was provided by the participant, but large gaps made earlier data unusable. Typically, utility bills decrease with a heat pump installation. In this case, they have increased. This could be due to usage, heat pump efficiency and capacity, or the incomplete dataset not providing an accurate reference point.

# ID #017

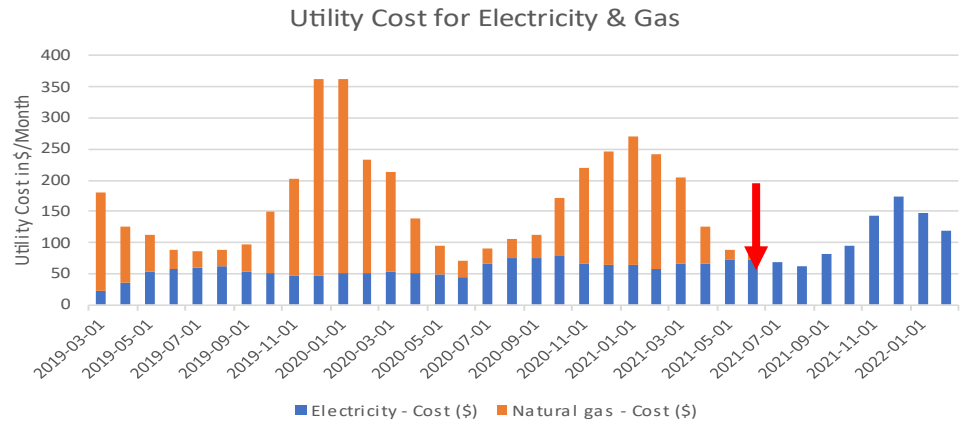
Heat pump installation date: June 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #017. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #017. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #017. The red arrow indicates when the heat pump was installed. A spike occurred in BC Hydro billing at the time of heat pump installation, likely due to fees for BC Hydro equipment upgrades required to support a heat pump. This cost was removed from the data to limit the analysis to operating costs.*

| AVERAGED SUMMARY TABLE: ID #017 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 491.97 | 847.91 | +72% |
| | **Monthly $** | 57.11 | 103.94 | +82% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.005 | 0.009 | +72% |
| **Natural Gas** | **Monthly kWh** | 1,584.88 | 0 | -100% |
| | **Monthly $** | 109.12 | 0 | -100% |
| | **GHG ($tCO_{2e}$)** | 0.293 | 0 | -100% |
| **Total** | **Monthly kWh** | 2,076.85 | 847.91 | -59% |
| | **Monthly $** | 166.24 | 103.94 | -37% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.299 | 0.009 | -97% |
| **Weather Normalized Data** | | | | |
| **Total** | 2,045.51 | 806.13 | -61% | 2,045.51 |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 142.20 | 0 | -100% |
| | **Monthly $ Compared to Regular Natural Gas** | +30% | 0% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 199.31 | 103.94 | -49% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 92.62 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -11% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 57.80 | 105.12 | +82% |
| **Natural Gas** | **Monthly $** | 146.07 | 0 | -100% |
| **Total** | **Monthly $** | 203.86 | 105.12 | -48% |

Observations:

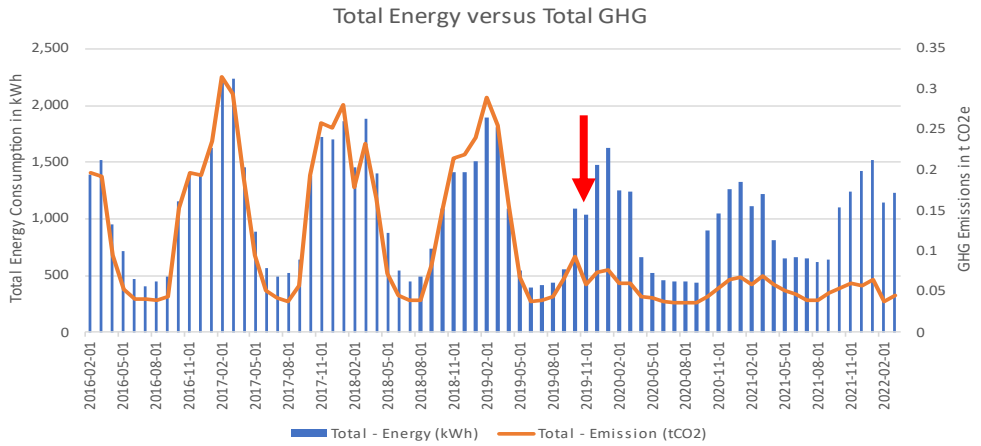
- **Utility Bill Data:** Overall decrease in post-heat pump energy consumption due to increased heating efficiency of electric heat pump, slight decrease in total cost,

and large decrease in GHG emissions despite the high relative increases of electricity values.

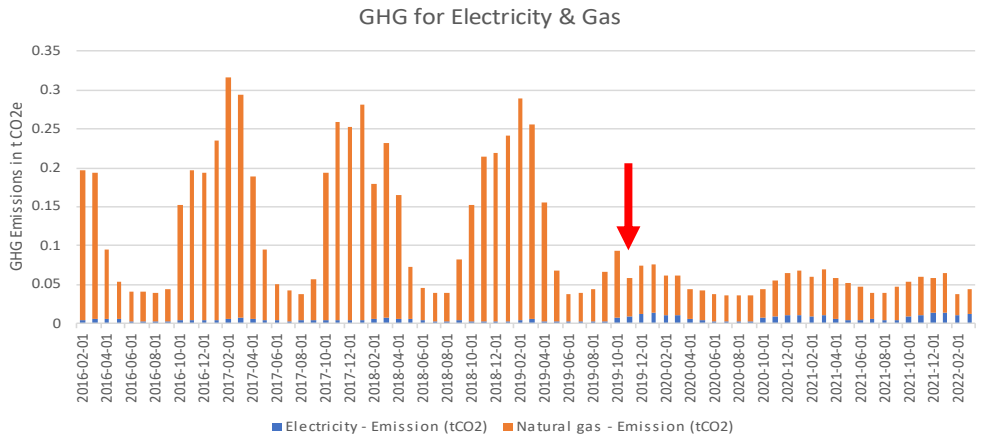
- **Carbon Tax at $170 per tonne $CO_{2e}$:** Despite increased costs projected for the higher electricity use with a heat pump, the lower carbon emissions associated with BC Hydro electricity will yield a lower total utility bill than if the natural gas furnace were to remain (see actual utility bill data for pre-heat pump cost comparison).

# ID #018

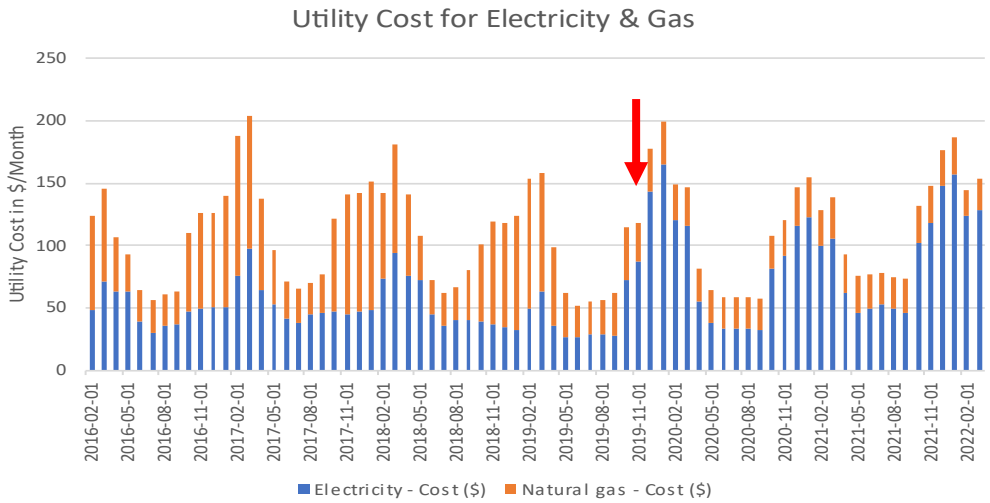
Heat pump installation date: November 2019




*Total energy consumption and greenhouse gas (GHG) emissions for ID #018. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #018. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #018. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #018 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 352.24 | 731.24 | +108% |
| | **Monthly $** | 48.51 | 88.11 | +82% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.004 | 0.008 | +108% |
| **Natural Gas** | **Monthly kWh** | 739.21 | 240.38 | -67% |
| | **Monthly $** | 58.05 | 28.28 | -51% |
| | **GHG ($tCO_{2e}$)** | 0.137 | 0.044 | -67% |
| **Total** | **Monthly kWh** | 1,091.45 | 971.62 | -11% |
| | **Monthly $** | 106.56 | 116.39 | +9% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.141 | 0.053 | -63% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,077.49 | 888.77 | -18% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 73.74 | 33.38 | -55% |
| | **Monthly $ Compared to Regular Natural Gas** | +27% | +18% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 122.25 | 116.39 | -5% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 79.62 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -10% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 49.00 | 89.13 | +82% |
| **Natural Gas** | **Monthly $** | 75.28 | 33.88 | -55% |
| **Total** | **Monthly $** | 124.28 | 123.01 | -1% |

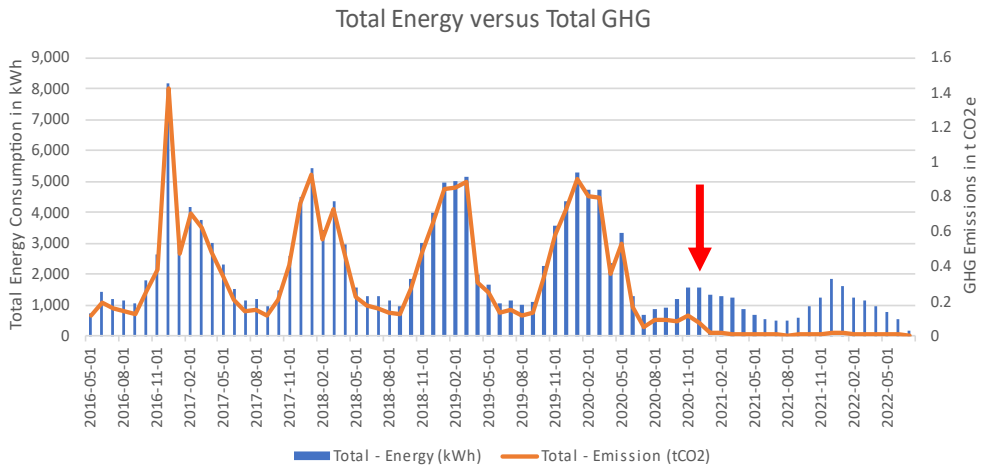
Observations:

- **Utility Bill Data:** Typically, a heat pump leads to a decrease in total utility bills since the natural gas savings outweigh the electricity increase. In this case, the

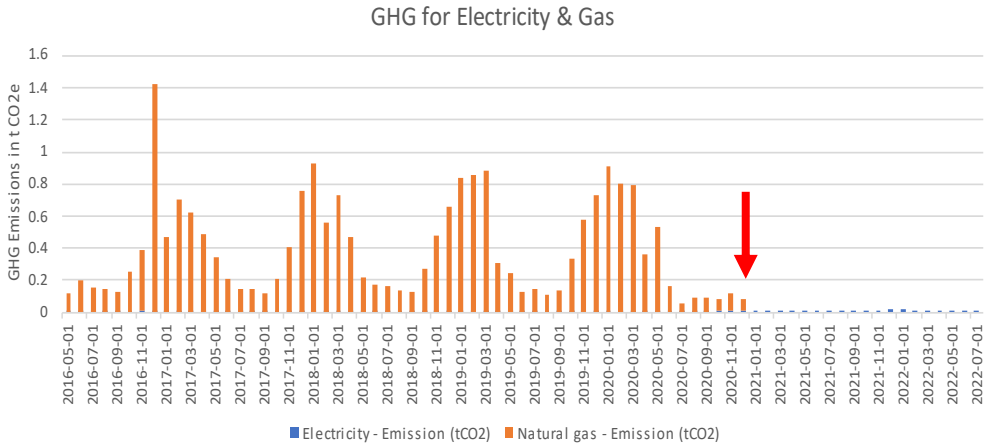
participants average utility bills have increased slightly. This could be due to usage or mechanical efficiency and capacity.

# ID #019

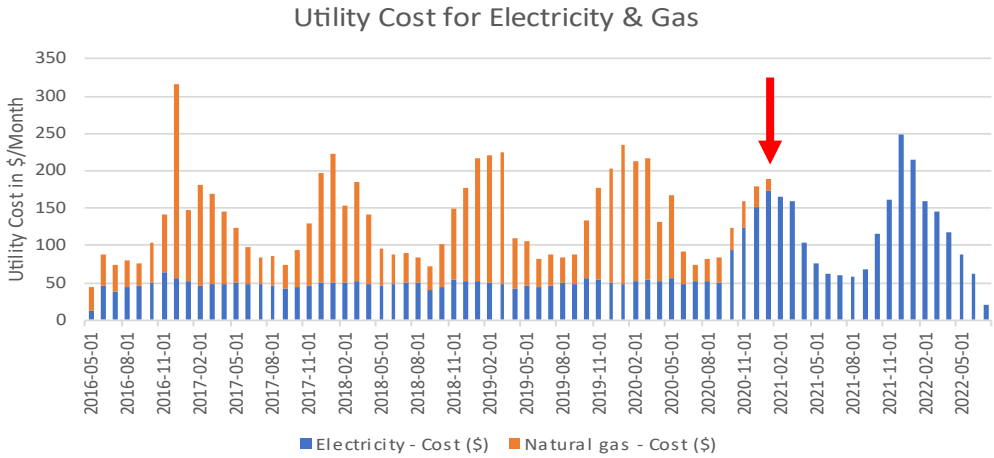
Heat pump installation date: December 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #019. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #019. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #019. The red arrow indicates when the heat pump was installed.*

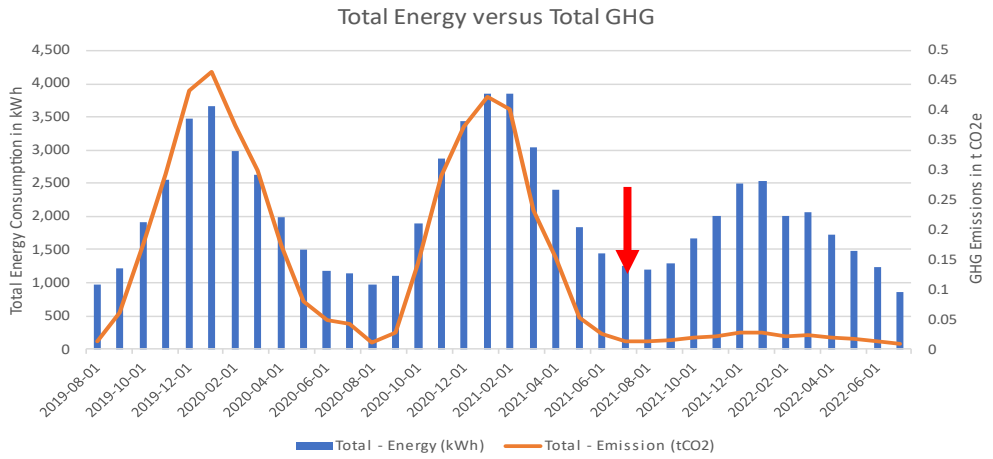
| AVERAGED SUMMARY TABLE: ID #019 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 433.21 | 954.79 | +120% |
| | **Monthly $** | 50.55 | 119.01 | +135% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.005 | 0.011 | +120% |
| **Natural Gas** | **Monthly kWh** | 2,102.79 | 0 | -100% |
| | **Monthly $** | 82.56 | 0 | -100% |
| | **GHG ($tCO_{2e}$)** | 0.389 | 0 | -100% |
| **Total** | **Monthly kWh** | 2,535.99 | 954.79 | -62% |
| | **Monthly $** | 133.11 | 119.82 | -10% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.394 | 0.011 | -97% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,511.79 | 755.37 | -70% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 184.09 | 0 | -100% |
| | **Monthly $ Compared to Regular Natural Gas** | +123% | 0% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 234.64 | 119.01 | -49% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 103.58 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -13% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 51.15 | 120.33 | +135% |
| **Natural Gas** | **Monthly $** | 92.21 | 0 | -100% |
| **Total** | **Monthly $** | 143.36 | 120.33 | -16% |

Observations:

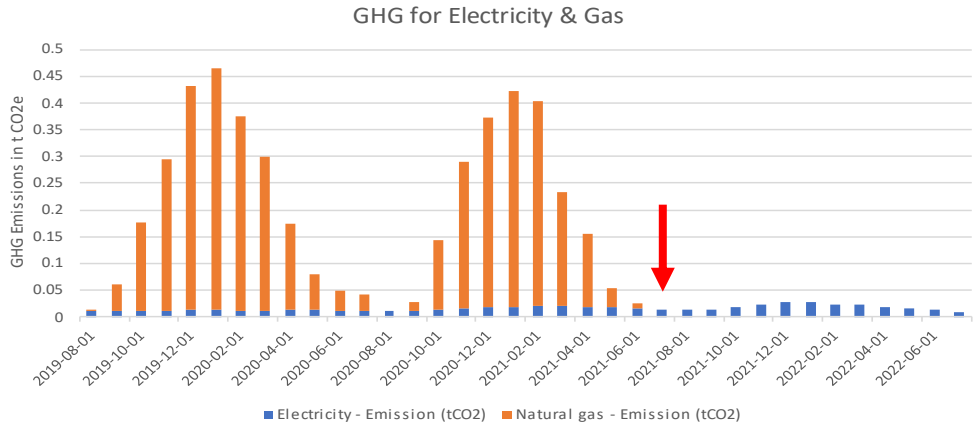
- **Post-Heat Pump Natural Gas Consumption:** After natural gas space heating was replaced with a heat pump, there is no natural gas consumption in the house, so consumption, bills, and GHG emissions due to natural gas are eliminated.

# ID #020

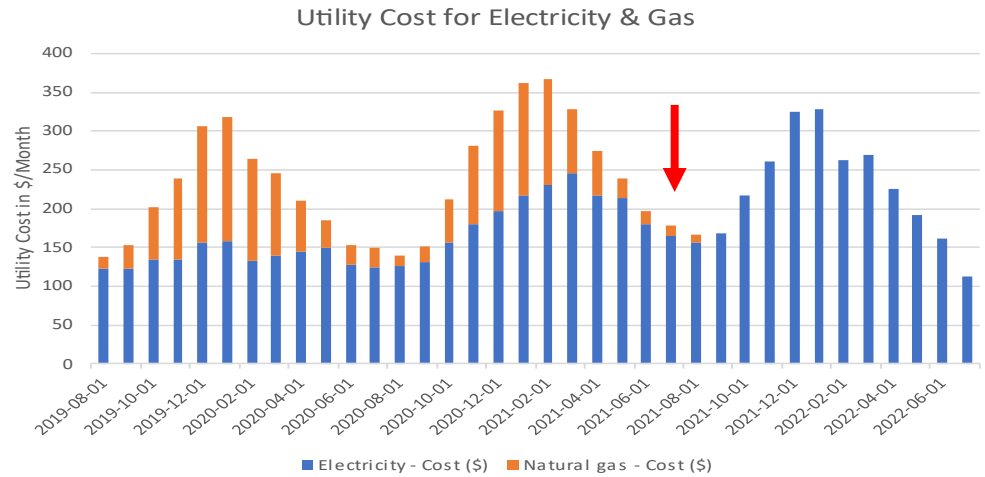
Heat pump installation date: July 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #020. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #020. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #020. The red arrow indicates when the heat pump was installed. Some base charges continue after heat pump installation despite zero natural gas consumption before Fortis BC billing was stopped.*

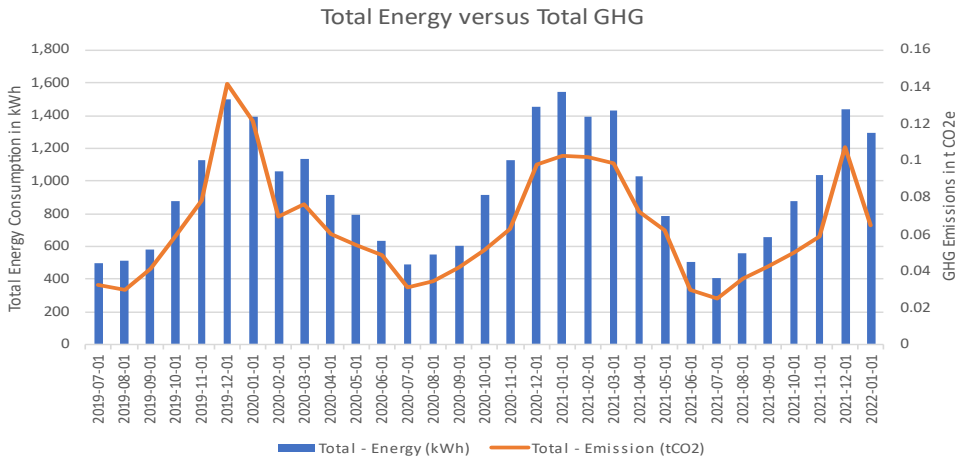
| AVERAGED SUMMARY TABLE: ID #020 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 1,249.46 | 1,714.11 | +37% |
| | **Monthly $** | 162.68 | 223.17 | +37% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.014 | 0.019 | +37% |
| **Natural Gas** | **Monthly kWh** | 1,006.04 | - | -100% |
| | **Monthly $** | 73.98 | 0.88 | -99% |
| | **GHG ($tCO_{2e}$)** | 0.186 | - | -100% |
| **Total** | **Monthly kWh** | 2,255.50 | 1,714.11 | -24% |
| | **Monthly $** | 236.66 | 224.05 | -5% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.200 | 0.019 | -91% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,490.23 | 1,448.95 | -42% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 95.34 | 0 | -100% |
| | **Monthly $ Compared to Regular Natural Gas** | +29% | 0% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 258.02 | 223.17 | -14% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 177.46 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -20% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 164.41 | 225.55 | +37% |
| **Natural Gas** | **Monthly $** | 97.43 | 0 | -100% |
| **Total** | **Monthly $** | 261.84 | 226.42 | -14% |

Observations:

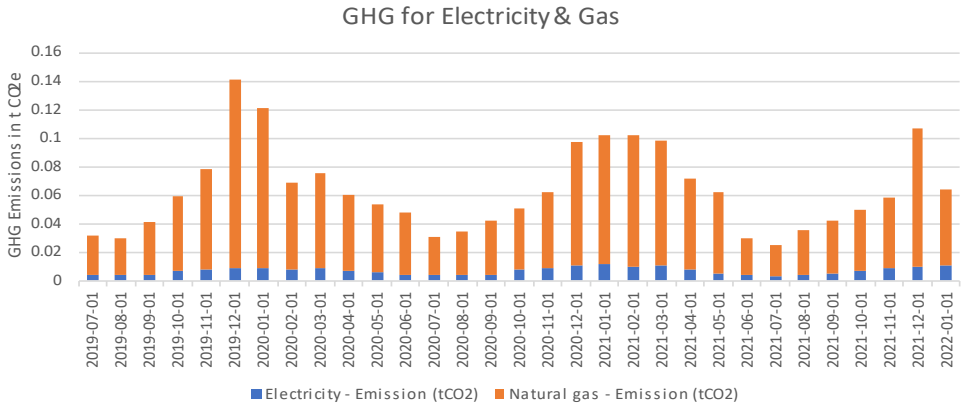
- **Post-Heat Pump Natural Gas Consumption:** After natural gas space heating was replaced with a heat pump, there is no natural gas consumption in the house, so consumption, bills, and GHG emissions due to natural gas are eliminated.

# ID #021

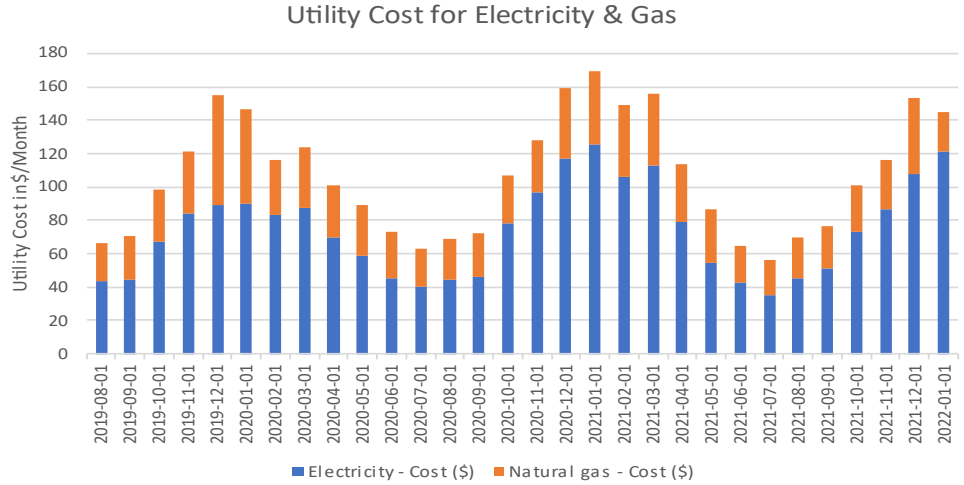
Heat pump installation date: June 2018




*Total energy consumption and greenhouse gas (GHG) emissions for ID #021. The heat pump was installed before the available data begins.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #021. The heat pump was installed before the available data begins.*




*Utility costs for natural gas and electricity for ID #021. The heat pump was installed before the available data begins.*

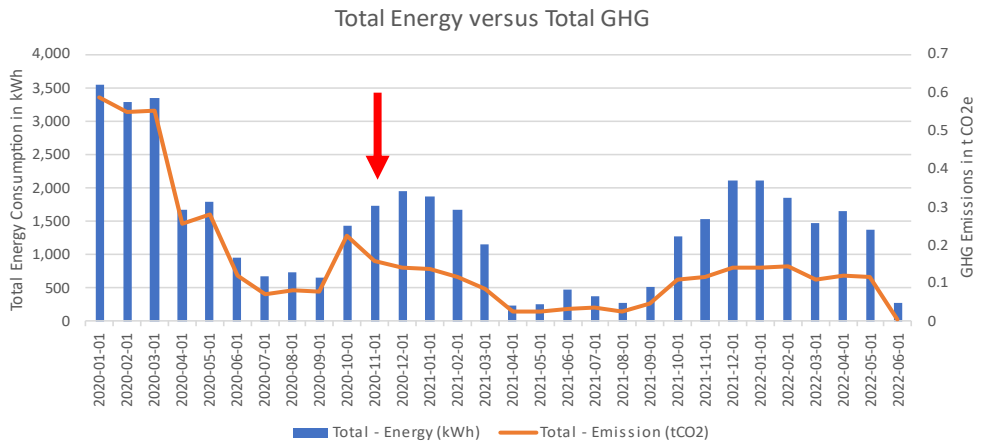
| AVERAGED SUMMARY TABLE: ID #021 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | - | 630.71 | - |
| | **Monthly $** | - | 73.24 | - |
| | **Monthly GHG (tCO2e)** | - | 0.007 | - |
| **Natural Gas** | **Monthly kWh** | - | 307.86 | - |
| | **Monthly $** | - | 32.59 | - |
| | **GHG (tCO2e)** | - | 0.057 | - |
| **Total** | **Monthly kWh** | - | 938.56 | - |
| | **Monthly $** | - | 105.83 | - |
| | **Monthly GHG (tCO2e)** | - | 0.064 | - |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | - | 872.22 | - |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | - | 38.89 | - |
| | **Monthly $ Compared to Regular Natural Gas** | - | +19% | - |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | - | 105.83 | - |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | - | 69.61 | - |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | - | -5% | - |
| **Carbon Tax at $170 per tonne CO2e** | | | | |
| **Electricity** | **Monthly $** | - | 74.11 | - |
| **Natural Gas** | **Monthly $** | - | 39.76 | - |
| **Total** | **Monthly $** | - | 113.88 | - |

Observations:

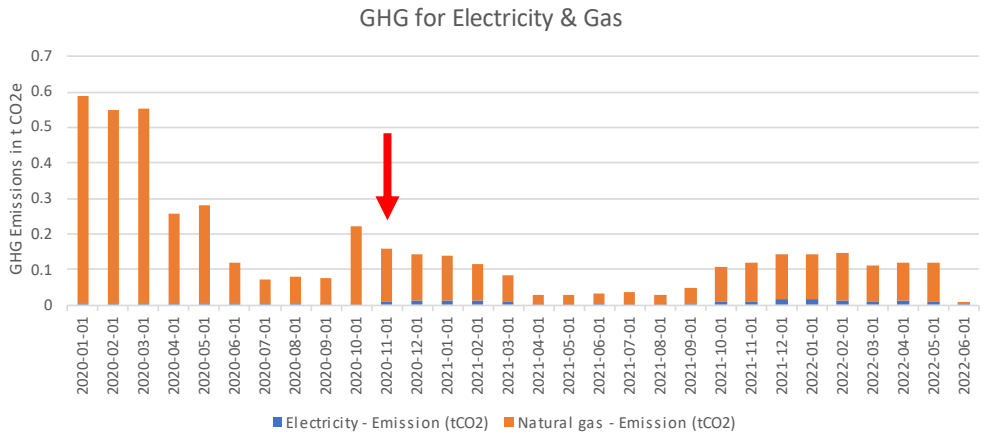
- **Utility Bill Data:** No pre-heat pump data was available. The analysis cannot provide a pre- and post-heat pump comparison.

# ID #022

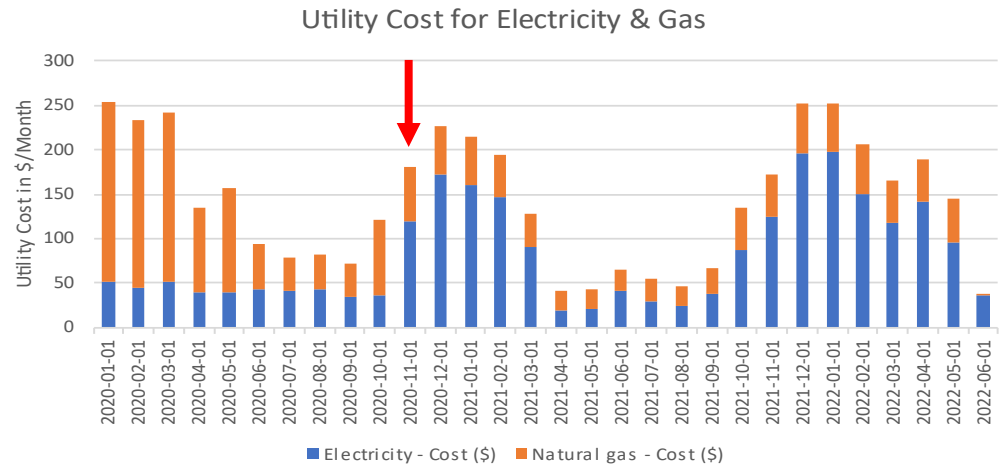
Heat pump installation date: November 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #022. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #022. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #022. The red arrow indicates when the heat pump was installed. Note that BC Hydro bill costs were not provided, so electricity costing was calculated by RDH based off of consumption using current BC Hydro rates.*

| AVERAGED SUMMARY TABLE: ID #022 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 319.34 | 745.35 | +133% |
| | **Monthly $** | 42.47 | 99.44 | +134% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.004 | 0.008 | +133% |
| **Natural Gas** | **Monthly kWh** | 1,493.84 | 437.05 | -71% |
| | **Monthly $** | 104.54 | 39.29 | -62% |
| | **GHG ($tCO_{2e}$)** | 0.276 | 0.081 | -71% |
| **Total** | **Monthly kWh** | 1,813.18 | 1,182.40 | -35% |
| | **Monthly $** | 147.02 | 138.74 | -6% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.280 | 0.089 | -68% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,753.82 | 761.46 | -57% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 134.84 | 49.27 | -63% |
| | **Monthly $ Compared to Regular Natural Gas** | +29% | +25% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 177.31 | 138.74 | -22% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 87.05 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -12% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 42.92 | 100.48 | +134% |
| **Natural Gas** | **Monthly $** | 139.36 | 49.48 | -64% |
| **Total** | **Monthly $** | 182.28 | 149.96 | -18% |

Observations:

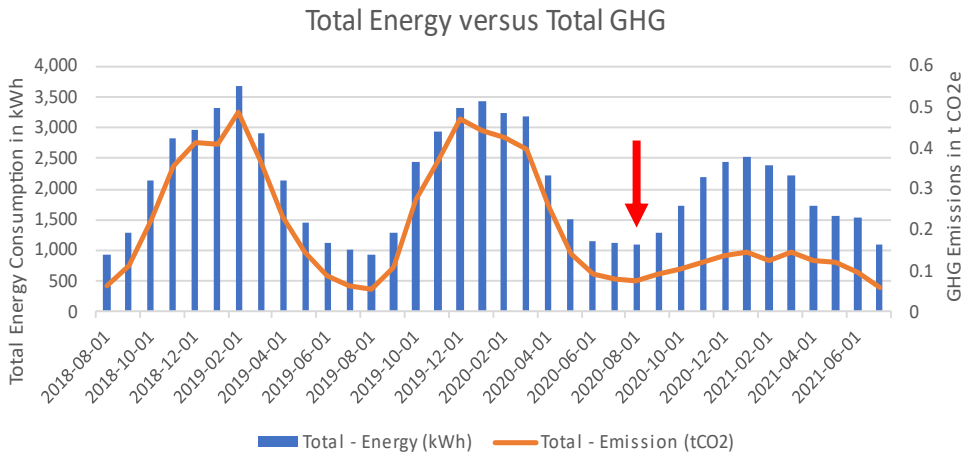
- **Utility Bill Data:** Overall decrease in post-heat pump energy consumption due to increased heating efficiency of electric heat pump, slight decrease in total cost,

and large decrease in GHG emissions despite the high relative increases of electricity values.

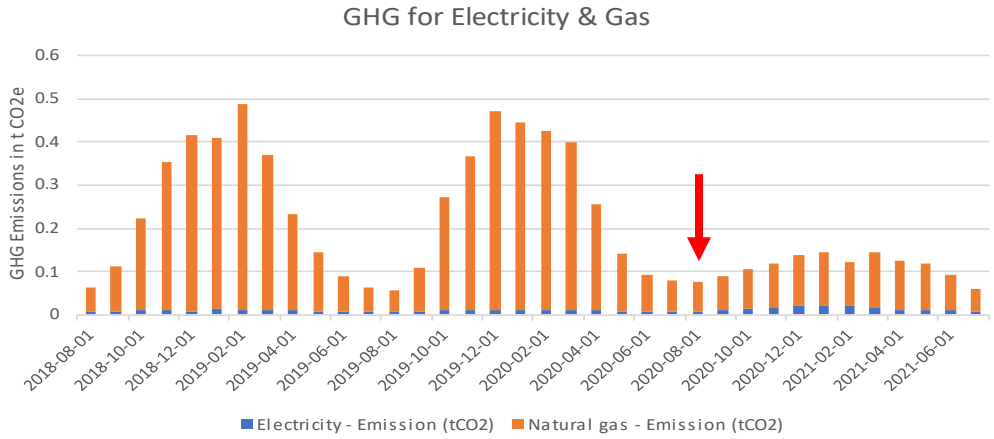
- **Carbon Tax at $170 per tonne $CO_{2e}$:** Despite increased costs projected for the higher electricity use with a heat pump, the lower carbon emissions associated with BC Hydro electricity will yield a lower total utility bill than if the natural gas furnace were to remain (see actual utility bill data for pre-heat pump cost comparison).

## ID #023

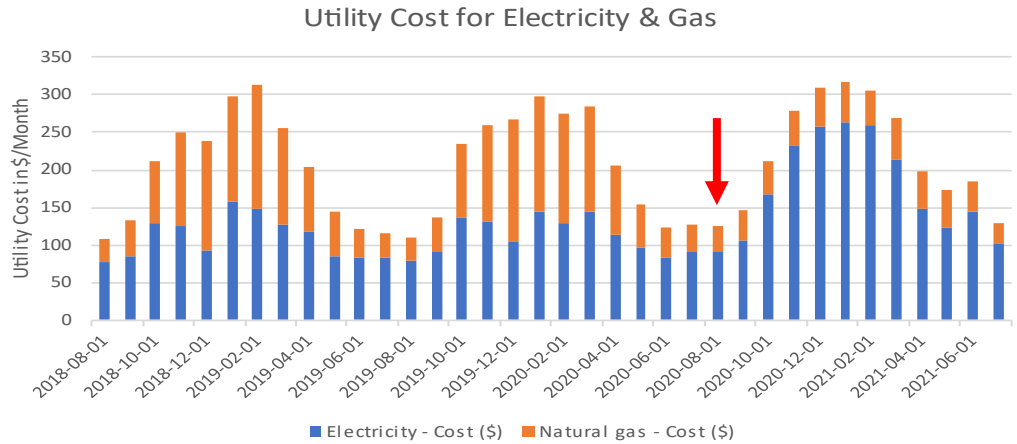
Heat pump installation date: August 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #023. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #023. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #023. The red arrow indicates when the heat pump was installed. Note that BC Hydro bill costs were not provided, so electricity costing was calculated by RDH based off of consumption using current BC Hydro rates.*

| AVERAGED SUMMARY TABLE: ID #023 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 873.57 | 1,294.38 | +48% |
| | **Monthly $** | 110.61 | 175.85 | +59% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.010 | 0.014 | +48% |
| **Natural Gas** | **Monthly kWh** | 1,316.76 | 524.20 | -60% |
| | **Monthly $** | 92.54 | 44.91 | -51% |
| | **GHG ($tCO_{2e}$)** | 0.244 | 0.097 | -60% |
| **Total** | **Monthly kWh** | 2,190.33 | 1,818.58 | -17% |
| | **Monthly $** | 203.14 | 220.76 | +9% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.253 | 0.111 | -56% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,351.94 | 1,664.29 | -29% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 120.49 | 56.35 | -53% |
| | **Monthly $ Compared to Regular Natural Gas** | +30% | +25% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 231.10 | 220.76 | -4% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 144.57 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -18% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 111.82 | 177.64 | +59% |
| **Natural Gas** | **Monthly $** | 123.23 | 57.13 | -54% |
| **Total** | **Monthly $** | 235.05 | 234.77 | 0% |

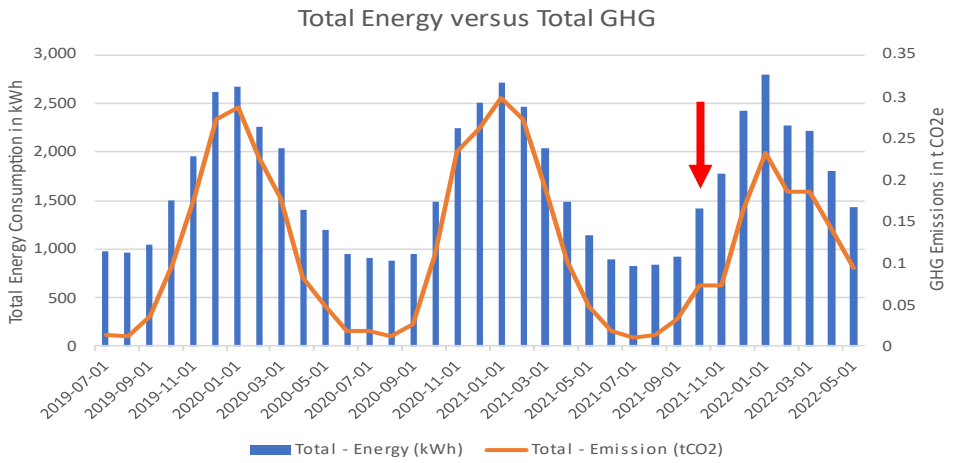
Observations:

- **Utility Bill Data:** Typically, a heat pump leads to a decrease in total utility bills since the natural gas savings outweigh the electricity increase. In this case, the

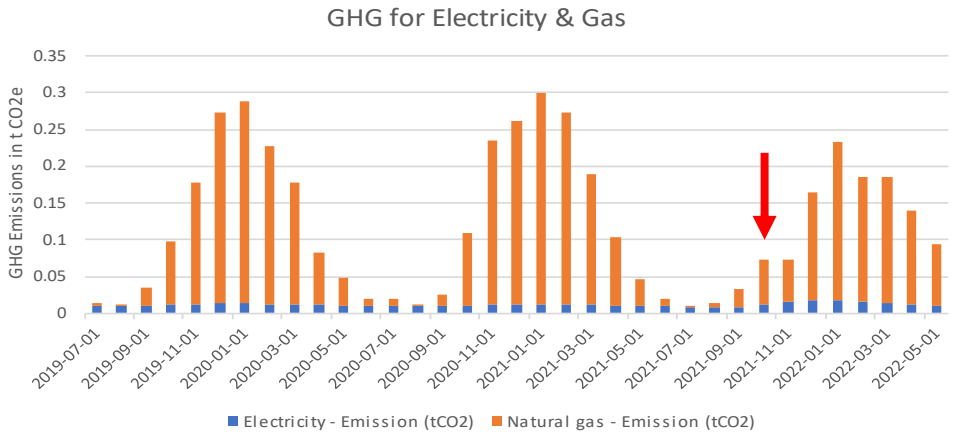
participants average utility bills have increased slightly. This could be due to usage or mechanical efficiency and capacity.

## ID #024

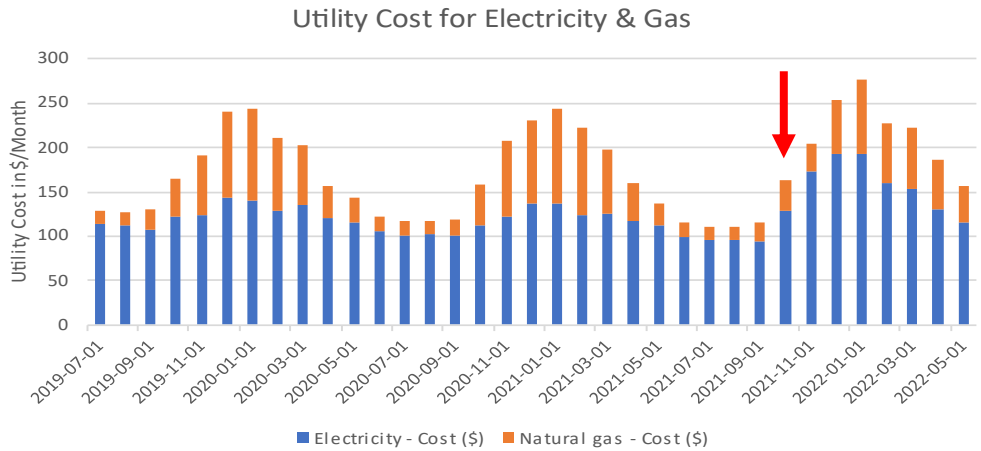
Heat pump installation date: October 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #024. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #024. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #024. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #024 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 990.86 | 1,324.52 | +34% |
| | **Monthly $** | 116.58 | 155.84 | +34% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.011 | 0.015 | +34% |
| **Natural Gas** | **Monthly kWh** | 562.42 | 697.36 | +24% |
| | **Monthly $** | 47.53 | 55.53 | +17% |
| | **GHG ($tCO_{2e}$)** | 0.104 | 0.129 | +24% |
| **Total** | **Monthly kWh** | 1,553.27 | 2,021.88 | +30% |
| | **Monthly $** | 164.11 | 211.37 | +29% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.115 | 0.144 | +25% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,707.40 | 1,247.84 | -27% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 59.47 | 70.31 | +18% |
| | **Monthly $ Compared to Regular Natural Gas** | +25% | +27% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 176.05 | 211.37 | +20% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 128.51 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -18% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 117.95 | 157.68 | +34% |
| **Natural Gas** | **Monthly $** | 60.64 | 71.79 | +18% |
| **Total** | **Monthly $** | 178.59 | 229.46 | +28% |

Observations:

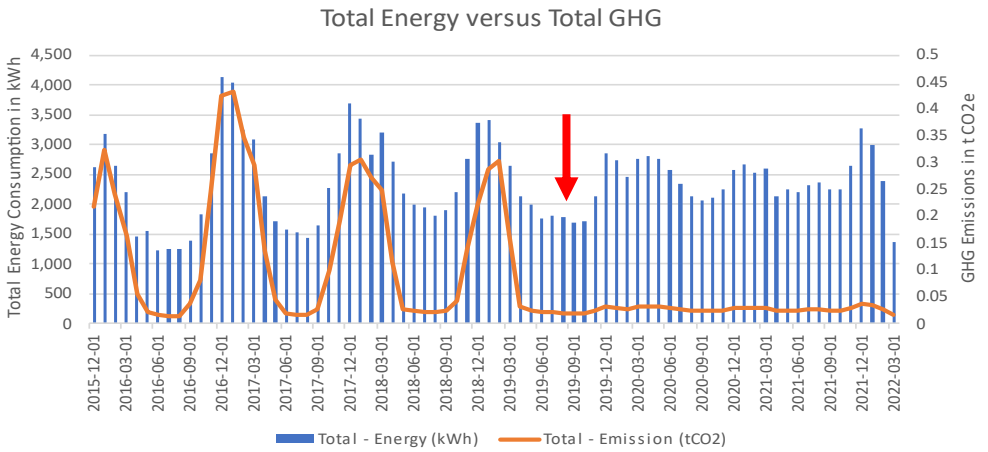
- **Utility Bill Data:** The post-heat pump data is skewed from the limited data available. The post-heat pump data only shows the winter and spring seasons,

where energy consumption is highest. This causes the post-heat pump averages (energy consumption, utility cost, and GHGs) to be higher than they actually are.

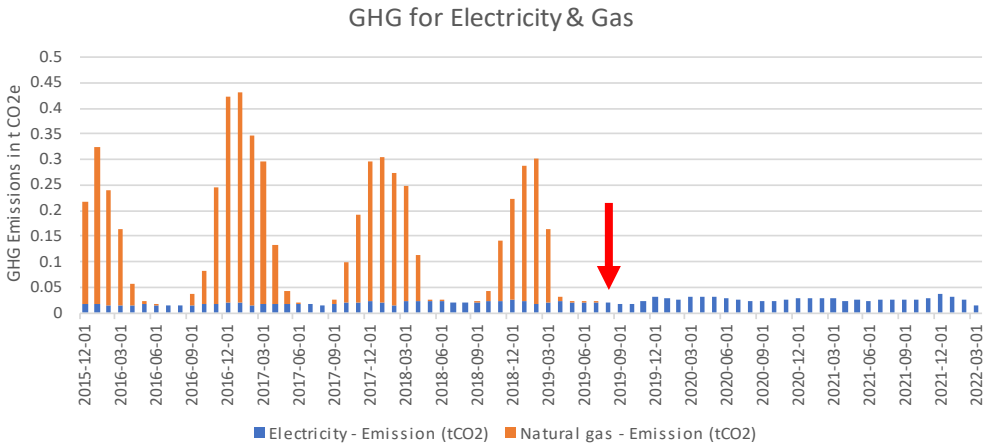
- **Natural Gas Usage:** Typically, natural gas consumption decreases after heat pump installation. In this case, natural gas usage appears to increase. The participant reported daily natural gas fireplace usage in the winter. The high seasonal natural gas usage is over-represented in this skewed to appear higher than it is without summer data. It is expected that post-heat pump data that includes summer (to represent a full year) would “even out” average usage.

## ID #025

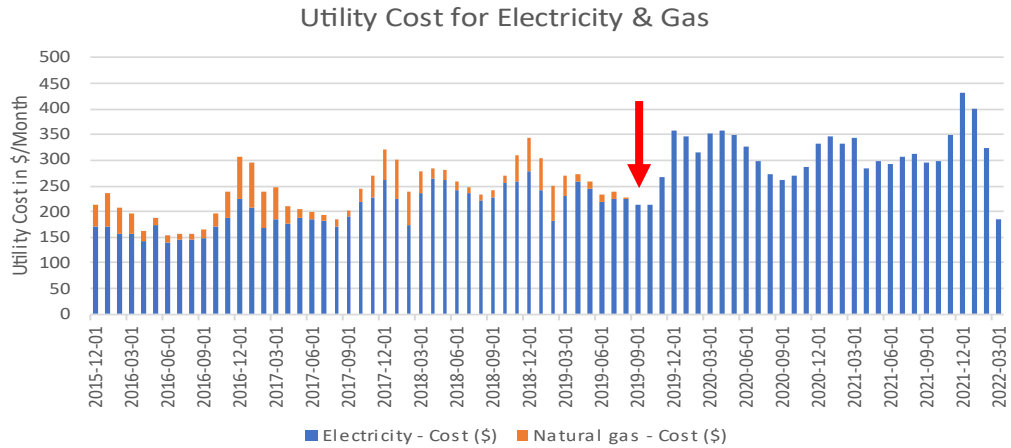
Heat pump installation date: August 2019




*Total energy consumption and greenhouse gas (GHG) emissions for ID #025. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #025. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #025. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #025 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 1,718.64 | 2,375.33 | +38% |
| | **Monthly $** | 203.92 | 307.65 | +51% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.019 | 0.026 | +38% |
| **Natural Gas** | **Monthly kWh** | 645.83 | 0 | -100% |
| | **Monthly $** | 34.66 | 0 | -100% |
| | **GHG ($tCO_{2e}$)** | 0.119 | 0 | -100% |
| **Total** | **Monthly kWh** | 2,364.47 | 2,375.33 | 0% |
| | **Monthly $** | 238.58 | 307.66 | +29% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.138 | 0.026 | -81% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,397.14 | 2,301.05 | -4% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 66.20 | 0 | -100% |
| | **Monthly $ Compared to Regular Natural Gas** | +91% | 0% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 270.12 | 307.65 | +14% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 231.92 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -25% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 206.30 | 310.94 | +51% |
| **Natural Gas** | **Monthly $** | 49.71 | 0 | -100% |
| **Total** | **Monthly $** | 256.01 | 310.96 | +21% |

Observations:

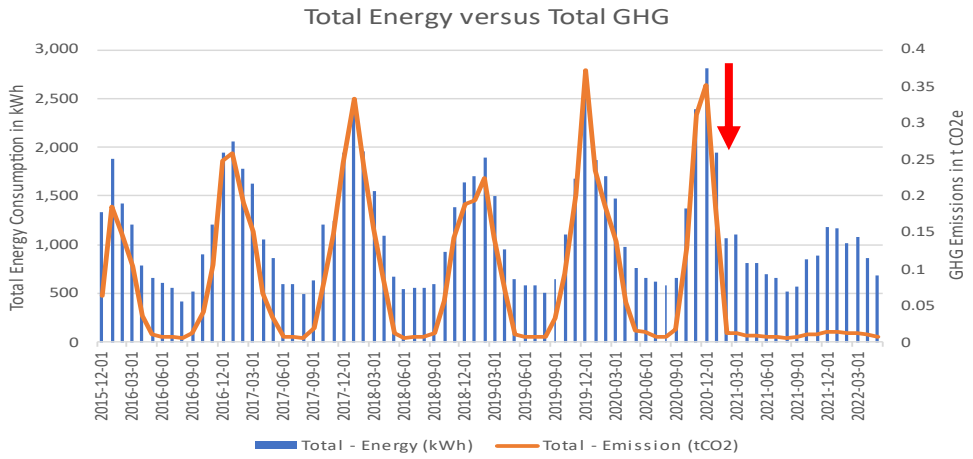
- **Utility Bill Data:** Typically, despite increased electricity consumption, the total cost will be lower due to the increased efficiency of the heat pump. However, in

this case, the total cost increases after the heat pump installation. This is likely due to reported high electricity usage in the participant's home due to frequent space heater usage, heavy domestic hot water usage, and an electric vehicle.

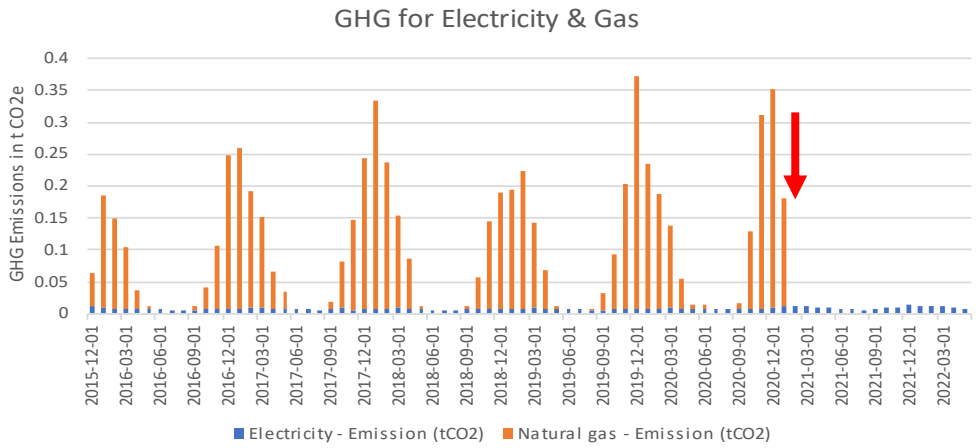
- **Carbon Tax at $170 per tonne $CO_{2e}$:** Typically, the lower carbon emissions associated with BC Hydro electricity will yield a lower total utility bill than if the natural gas furnace were to remain. However, in this case, the total future cost is expected to increase from the pre-heat pump cost with natural gas. This is likely due to the reported heavy electricity consumption in the home.

# ID #026

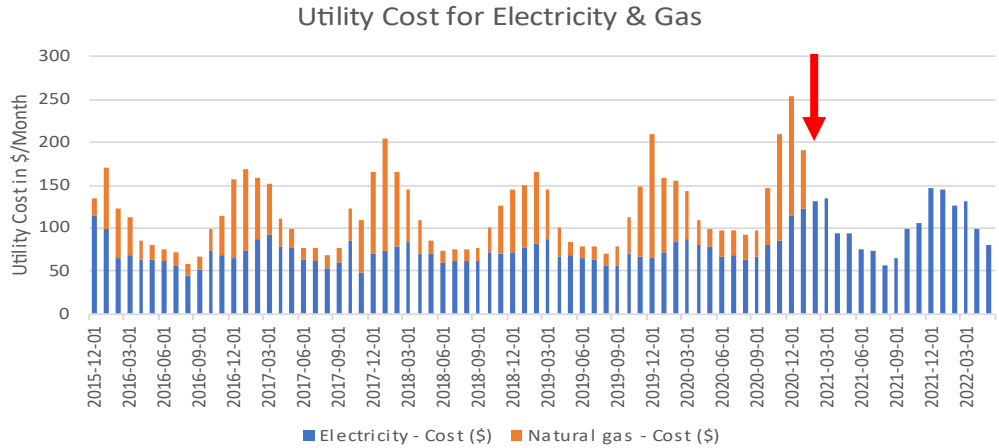
Heat pump installation date: January 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #026. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #026. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #026. The red arrow indicates when the heat pump was installed.*

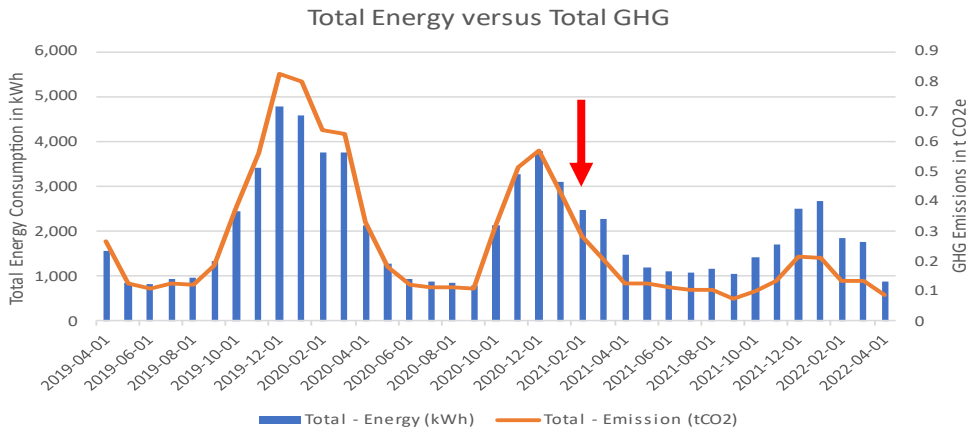
| AVERAGED SUMMARY TABLE: ID #026 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 660.26 | 872.18 | +32% |
| | **Monthly $** | 71.32 | 103.67 | +45% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.007 | 0.010 | +32% |
| **Natural Gas** | **Monthly kWh** | 514.99 | 0 | -100% |
| | **Monthly $** | 46.68 | 0 | -100% |
| | **GHG ($tCO_{2e}$)** | 0.095 | 0 | -100% |
| **Total** | **Monthly kWh** | 1,175.24 | 872.18 | -26% |
| | **Monthly $** | 118.00 | 103.67 | -12% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.103 | 0.010 | -91% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,144.56 | 803.00 | -30% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 55.62 | 0 | -100% |
| | **Monthly $ Compared to Regular Natural Gas** | +19% | 0% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 126.94 | 103.67 | -18% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 93.56 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -10% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 72.23 | 104.87 | +45% |
| **Natural Gas** | **Monthly $** | 58.69 | 0 | -100% |
| **Total** | **Monthly $** | 130.92 | 104.87 | -20% |

Observations:

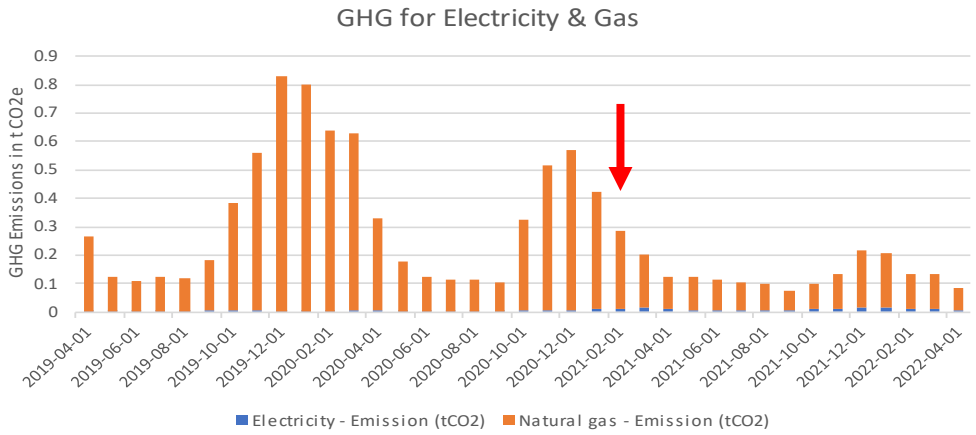
- **Post-Heat Pump Natural Gas Consumption:** After natural gas space heating was replaced with a heat pump, there is no natural gas consumption in the house, so consumption, bills, and GHG emissions due to natural gas are eliminated.

## ID #028

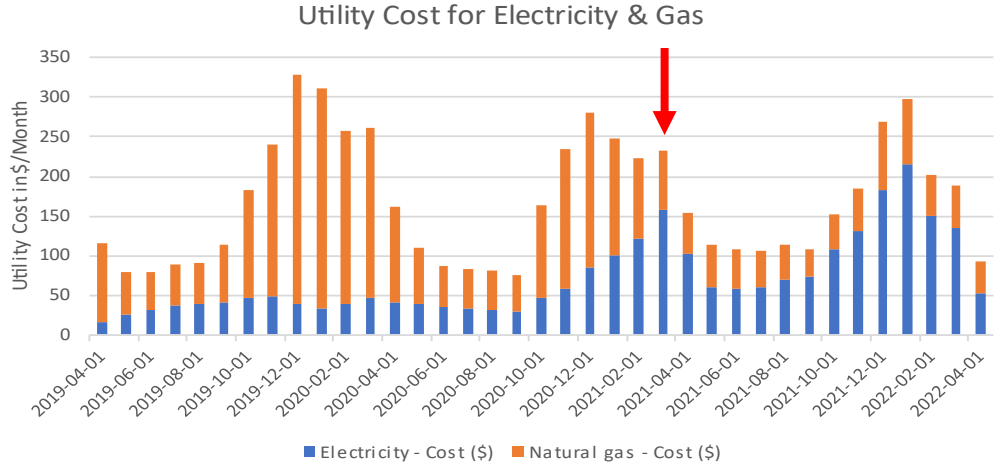
Heat pump installation date: February 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #028. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #028. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #028. The red arrow indicates when the heat pump was installed. A spike occurred in BC Hydro billing at the time of heat pump installation, likely due to fees for BC Hydro equipment upgrades required to support a heat pump. This cost was removed from the data to limit the analysis to operating costs.*

| AVERAGED SUMMARY TABLE: ID #028 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 358.80 | 918.63 | +156% |
| | **Monthly $** | 42.73 | 112.02 | +162% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.004 | 0.010 | +156% |
| **Natural Gas** | **Monthly kWh** | 1,837.32 | 717.25 | -61% |
| | **Monthly $** | 124.35 | 57.62 | -54% |
| | **GHG ($tCO_{2e}$)** | 0.340 | 0.133 | -61% |
| **Total** | **Monthly kWh** | 2,196.11 | 1,635.88 | -26% |
| | **Monthly $** | 167.08 | 169.63 | +2% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.344 | 0.143 | -58% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,086.44 | 1,316.07 | -37% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 162.65 | 71.90 | -56% |
| | **Monthly $ Compared to Regular Natural Gas** | +31% | +25% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 205.38 | 169.63 | -17% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 98.28 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -12% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 43.23 | 113.29 | +162% |
| **Natural Gas** | **Monthly $** | 167.18 | 74.34 | -56% |
| **Total** | **Monthly $** | 210.41 | 187.62 | -11% |

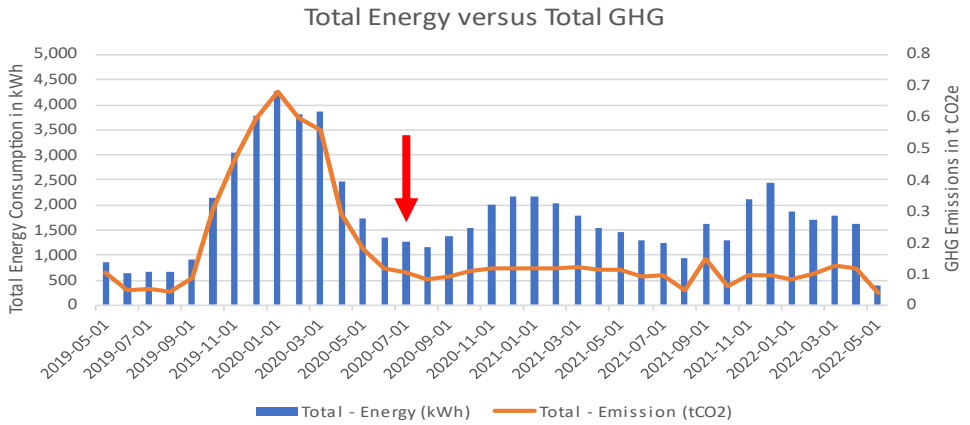
Observations:

- **Utility Bill Data:** Typically, a heat pump leads to a decrease in total utility bills since the natural gas savings outweigh the electricity increase. In this case, the

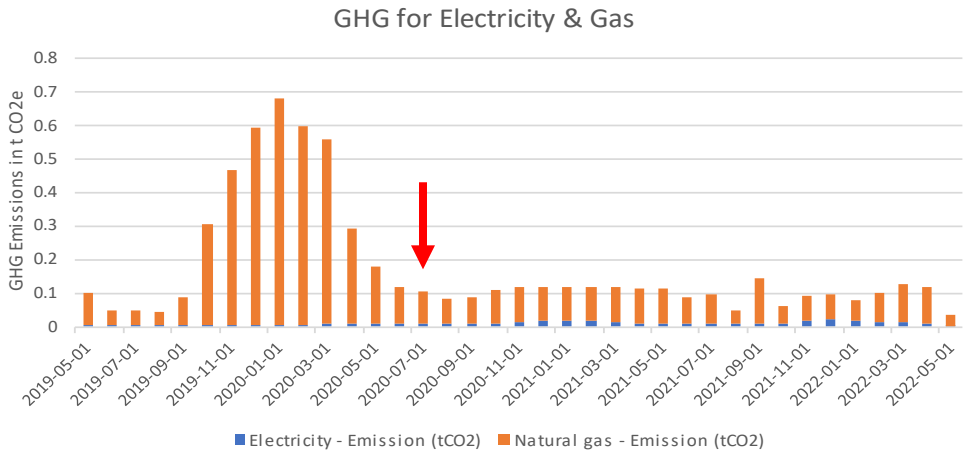
participants average utility bills have increased slightly. This could be due to usage or mechanical efficiency and capacity. However, the difference is nearly negligible at 2%.

## ID #029

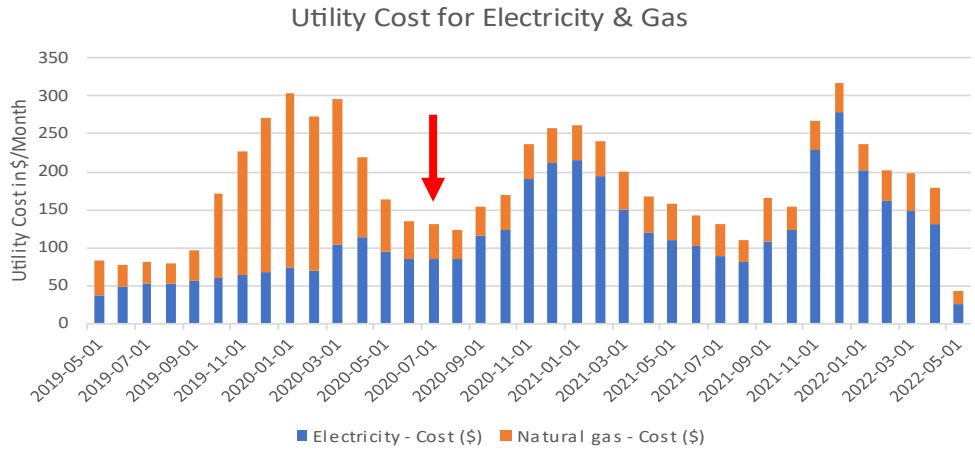
Heat pump installation date: July 2020




*Total energy consumption and greenhouse gas (GHG) emissions for ID #029. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #029. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #029. The red arrow indicates when the heat pump was installed. A spike occurred in BC Hydro billing at the time of heat pump installation, likely due to fees for BC Hydro equipment upgrades required to support a heat pump. This cost was removed from the data to limit the analysis to operating costs.*

| AVERAGED SUMMARY TABLE: ID #029 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 595.12 | 1,130.71 | +90% |
| | **Monthly $** | 69.87 | 142.76 | +104% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.007 | 0.012 | +90% |
| **Natural Gas** | **Monthly kWh** | 1,561.44 | 474.72 | -70% |
| | **Monthly $** | 107.16 | 41.85 | -61% |
| | **GHG ($tCO_{2e}$)** | 0.289 | 0.088 | -70% |
| **Total** | **Monthly kWh** | 2,156.56 | 1,605.43 | -26% |
| | **Monthly $** | 177.02 | 184.61 | +4% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.295 | 0.100 | -66% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,102.64 | 1,367.48 | -35% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 140.31 | 51.93 | -63% |
| | **Monthly $ Compared to Regular Natural Gas** | +31% | +24% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 210.18 | 184.61 | -12% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 121.20 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -15% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 70.69 | 144.33 | +104% |
| **Natural Gas** | **Monthly $** | 143.55 | 52.92 | -63% |
| **Total** | **Monthly $** | 214.24 | 197.25 | -8% |

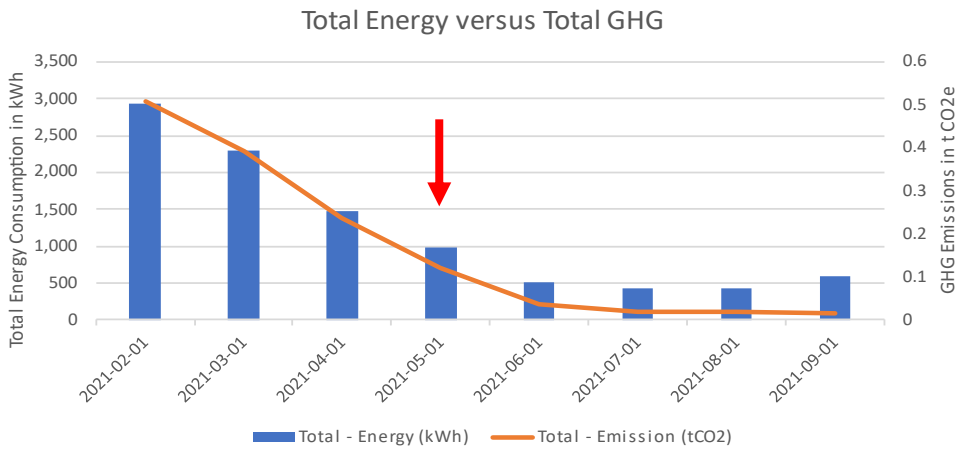
Observations:

- **Utility Bill Data:** Typically, a heat pump leads to a decrease in total utility bills since the natural gas savings outweigh the electricity increase. In this case, the

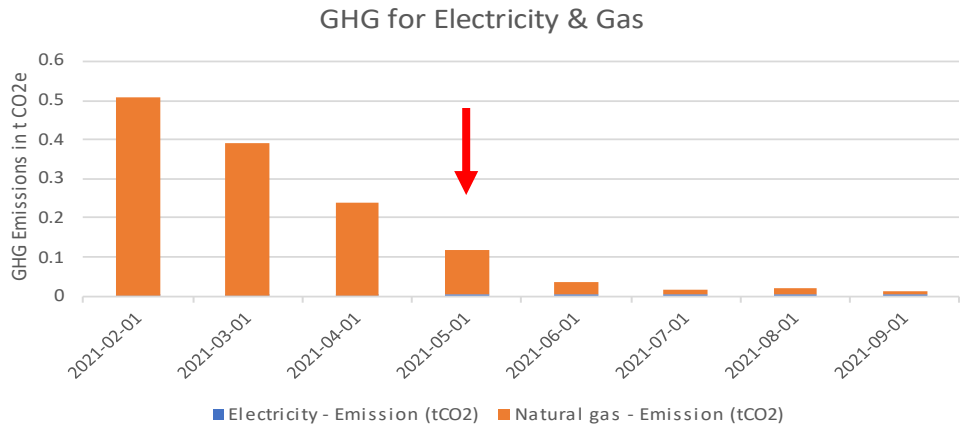
participants average utility bills have increased slightly. This could be due to usage or mechanical efficiency and capacity. However, the difference is nearly negligible at 4%.

## ID #030

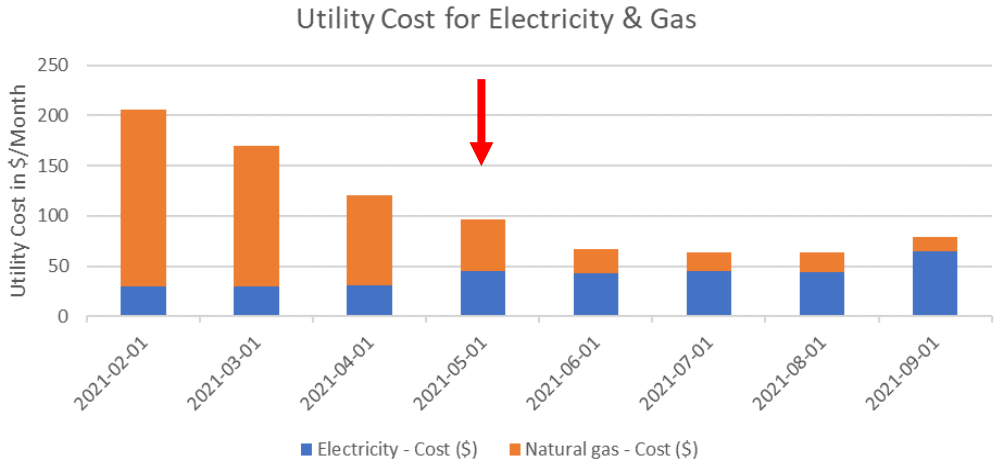
Heat pump installation date: May 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #030. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #030. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #030. The red arrow indicates when the heat pump was installed.*

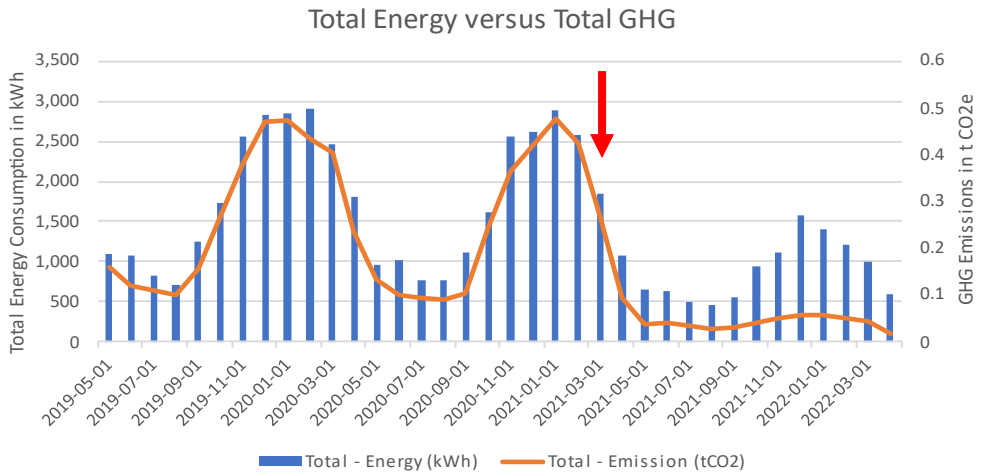
| AVERAGED SUMMARY TABLE: ID #030 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 205.53 | 379.60 | +85% |
| | **Monthly $** | 30.31 | 48.81 | +61% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.002 | 0.004 | +85% |
| **Natural Gas** | **Monthly kWh** | 2,037.04 | 200.00 | -90% |
| | **Monthly $** | 135.16 | 25.40 | -81% |
| | **GHG ($tCO_{2e}$)** | 0.377 | 0.037 | -90% |
| **Total** | **Monthly kWh** | 2,242.56 | 579.60 | -74% |
| | **Monthly $** | 165.46 | 74.22 | -55% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.379 | 0.041 | -89% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 2,972.30 | 2,403.35 | -19% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 178.41 | 30.20 | -83% |
| | **Monthly $ Compared to Regular Natural Gas** | +32% | +19% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 178.41 | 74.22 | -58% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 48.81 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | 0% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 30.59 | 49.34 | +61% |
| **Natural Gas** | **Monthly $** | 182.64 | 30.07 | -84% |
| **Total** | **Monthly $** | 213.23 | 79.41 | -63% |

Observations:

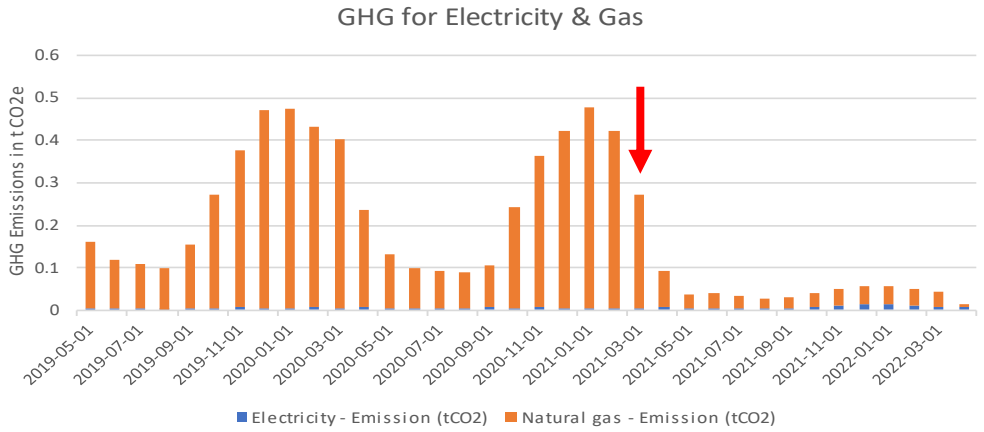
- **Utility Bill Data:** There is limited pre- and post-heat pump installation available for this participant. With such a small dataset, results may not be representative of the true operating conditions.

## ID #031

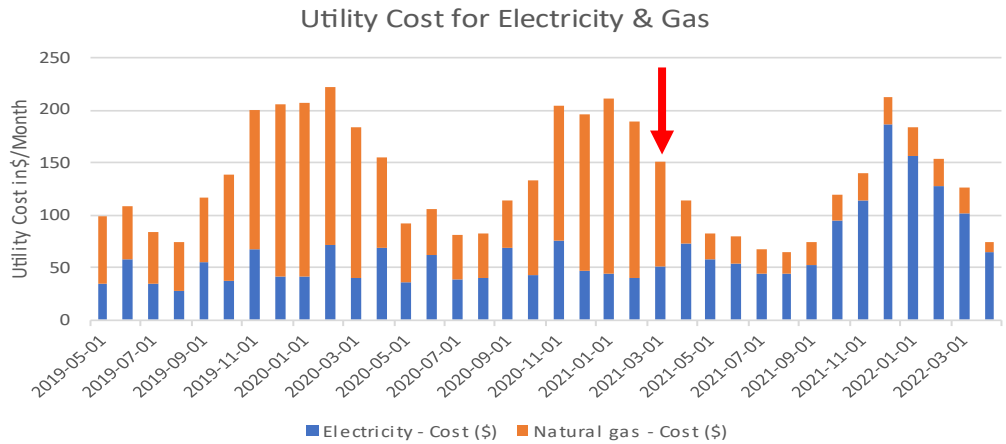
Heat pump installation date: March 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #031. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #031. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #031. The red arrow indicates when the heat pump was installed. Note that BC Hydro bill costs were not provided, so electricity costing was calculated by RDH based off of consumption using current BC Hydro rates.*

| AVERAGED SUMMARY TABLE: ID #031 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 380.79 | 702.03 | +84% |
| | **Monthly $** | 48.90 | 90.04 | +84% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.004 | 0.008 | +84% |
| **Natural Gas** | **Monthly kWh** | 1,390.56 | 194.44 | -86% |
| | **Monthly $** | 96.94 | 24.92 | -74% |
| | **GHG ($tCO_{2e}$)** | 0.257 | 0.036 | -86% |
| **Total** | **Monthly kWh** | 1,771.35 | 896.48 | -49% |
| | **Monthly $** | 145.83 | 114.96 | -21% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.261 | 0.044 | -83% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,779.78 | 726.05 | -59% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 126.46 | 29.62 | -77% |
| | **Monthly $ Compared to Regular Natural Gas** | +30% | +19% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 175.36 | 114.96 | -34% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 82.50 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -8% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 49.42 | 91.01 | +84% |
| **Natural Gas** | **Monthly $** | 129.35 | 29.46 | -77% |
| **Total** | **Monthly $** | 178.78 | 120.47 | -33% |

Observations:

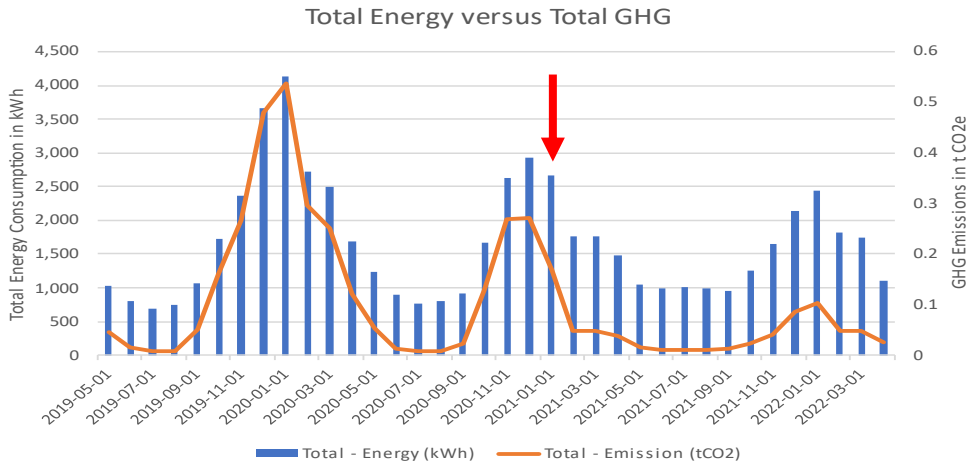
- **Utility Bill Data:** Overall decrease in post-heat pump energy consumption due to increased heating efficiency of electric heat pump, slight decrease in total cost,

and large decrease in GHG emissions despite the high relative increases of electricity values.

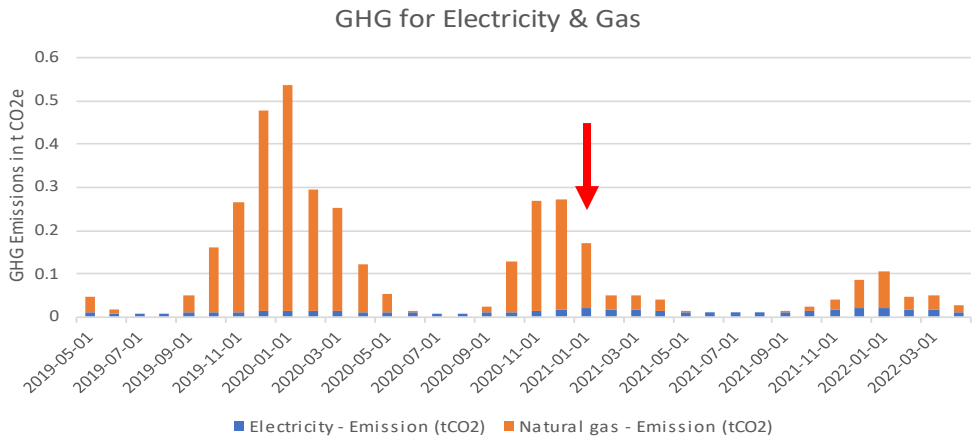
- **Carbon Tax at $170 per tonne $CO_{2e}$:** Despite increased costs projected for the higher electricity use with a heat pump, the lower carbon emissions associated with BC Hydro electricity will yield a lower total utility bill than if the natural gas furnace were to remain (see actual utility bill data for pre-heat pump cost comparison).

# ID #032

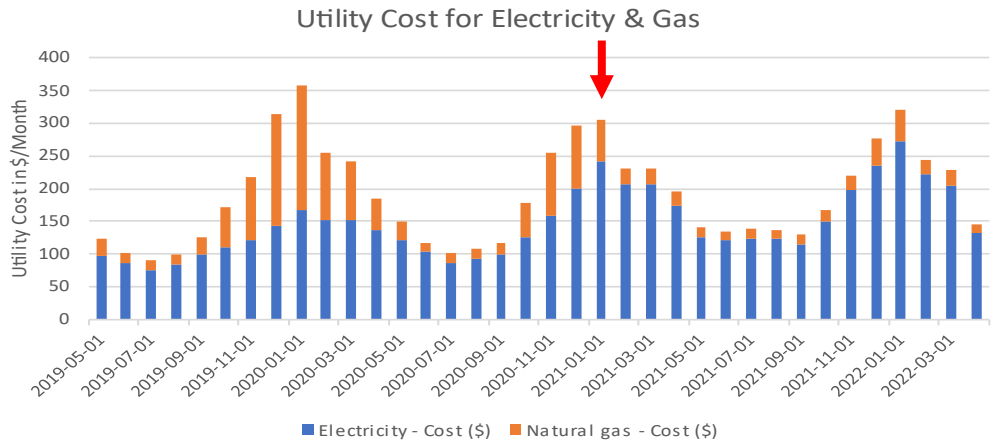
Heat pump installation date: January 2021




*Total energy consumption and greenhouse gas (GHG) emissions for ID #032. The red arrow indicates when the heat pump was installed.*




*Greenhouse gas (GHG) emissions for natural gas and electricity for ID #032. The red arrow indicates when the heat pump was installed.*




*Utility costs for natural gas and electricity for ID #032. The red arrow indicates when the heat pump was installed.*

| AVERAGED SUMMARY TABLE: ID #032 | | | | |
|---|---|---|---|---|
| | | **Pre-Heat Pump** | **Post-Heat Pump** | **Change (%)** |
| **Utility Bill Data** | | | | |
| **Electricity** | **Monthly kWh** | 991.81 | 1,349.64 | +36% |
| | **Monthly $** | 120.44 | 174.09 | +45% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.011 | 0.015 | +36% |
| **Natural Gas** | **Monthly kWh** | 756.11 | 126.73 | -83% |
| | **Monthly $** | 59.87 | 22.10 | -63% |
| | **GHG ($tCO_{2e}$)** | 0.140 | 0.023 | -83% |
| **Total** | **Monthly kWh** | 1,747.91 | 1,476.37 | -16% |
| | **Monthly $** | 180.31 | 196.19 | +9% |
| | **Monthly GHG ($tCO_{2e}$)** | 0.151 | 0.038 | -75% |
| **Weather Normalized Data** | | | | |
| **Total** | **Monthly kWh** | 1,678.07 | 1,272.26 | -24% |
| **Renewable Natural Gas vs. Heat Pump Approach to Decarbonization** | | | | |
| **Natural Gas** | **Monthly $** | 75.17 | 23.81 | -68% |
| | **Monthly $ Compared to Regular Natural Gas** | +26% | +8% | |
| **Total Energy Costs for an RNG vs. Heat Pump Approach** | **Monthly $ Using RNG vs. Monthly $ Using Heat Pump** | 195.61 | 196.19 | 0% |
| **BC Hydro Step 1 Billing Rate Only (i.e. If Step 2 Billing Rate Was Eliminated)** | | | | |
| **Electricity** | **Monthly $ Step 1 Billing Rate** | | 143.06 | |
| | **Monthly $ Compared to Step 1 + 2 Billing Rate** | | -18% | |
| **Carbon Tax at $170 per tonne $CO_{2e}$** | | | | |
| **Electricity** | **Monthly $** | 121.81 | 175.96 | +44% |
| **Natural Gas** | **Monthly $** | 77.50 | 25.05 | -68% |
| **Total** | **Monthly $** | 199.31 | 201.01 | +1% |

Observations:

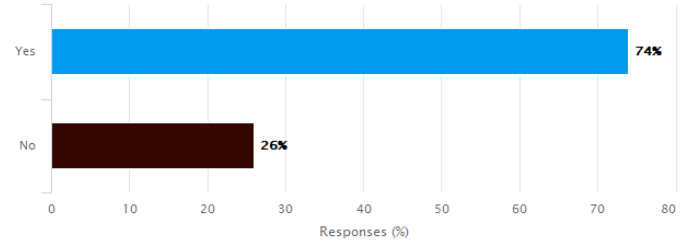
- **Utility Bill Data:** Typically, a heat pump leads to a decrease in total utility bills since the natural gas savings outweigh the electricity increase. In this case, the

participants average utility bills have increased slightly. This could be due to usage or mechanical efficiency and capacity.

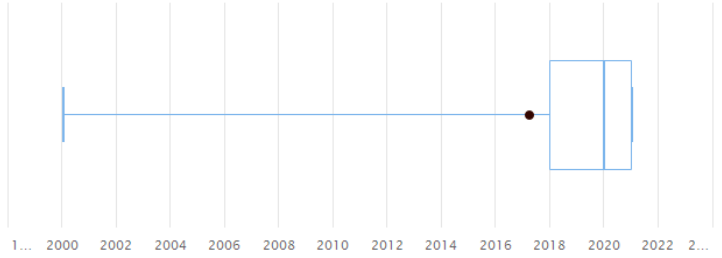
# Appendix C – Survey Responses

## Home Upgrade Needs and Awareness

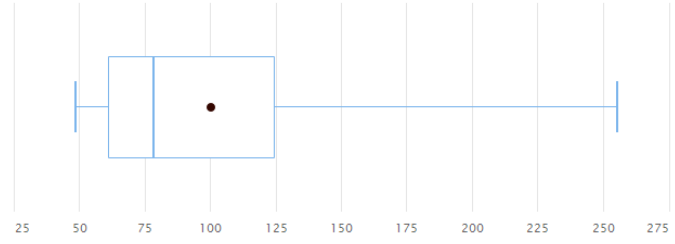
### Has the home had an EnerGuide Home Evaluation?



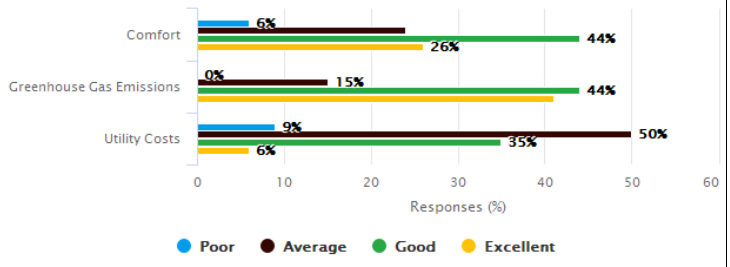

### What year did the EnerGuide Evaluation occur?



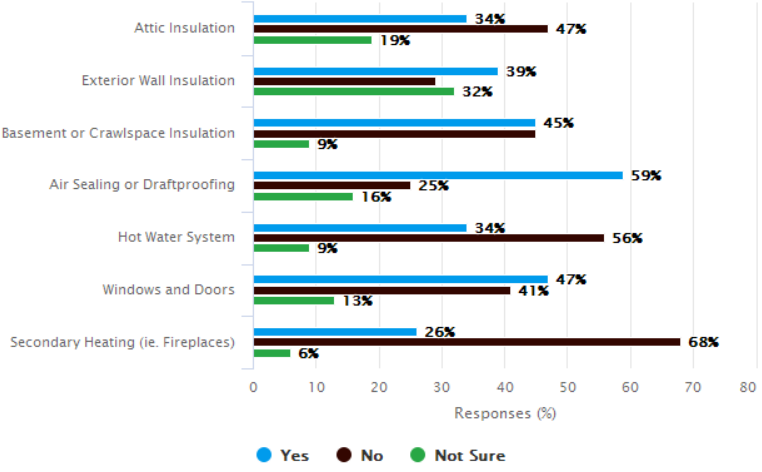

### What was your home's EnerGuide Rating?




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

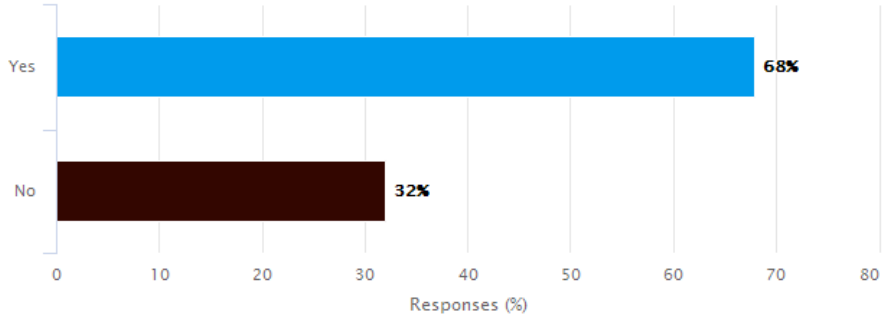



### Are you aware of any home energy upgrades that your home currently needs?

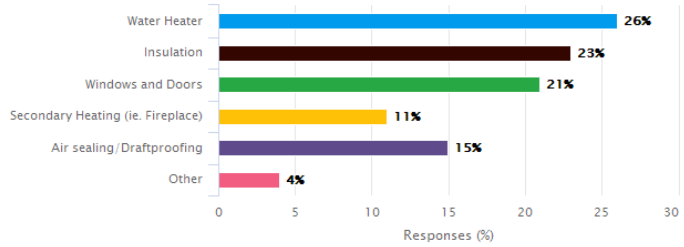


## Other Upgrades

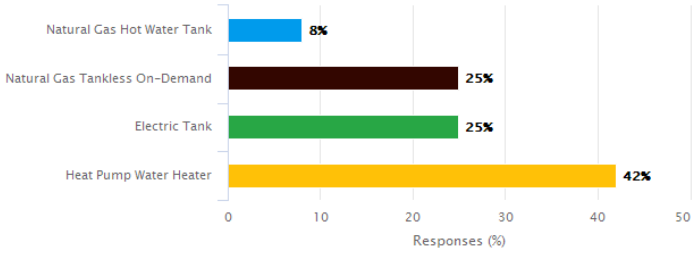
Have you completed any other upgrades besides your heat pump between January 01 2018 and 2022?



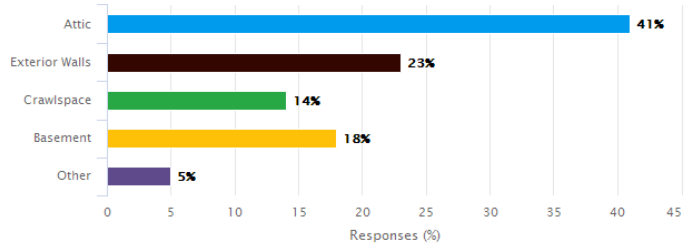

### Which upgrades?



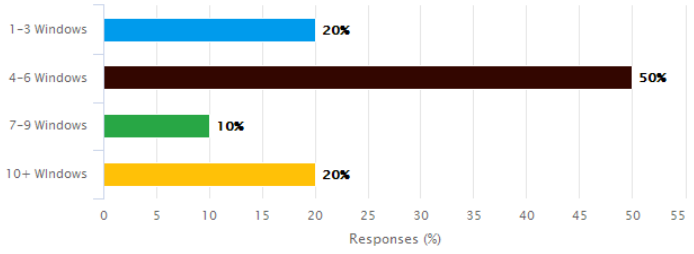

### Hot Water Upgrades



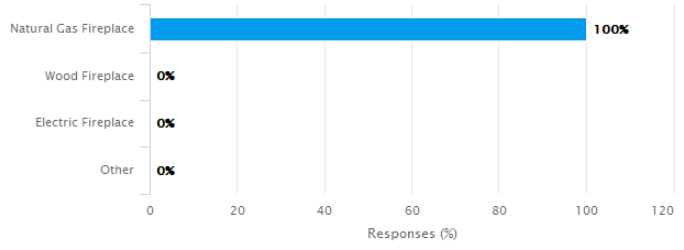

### Insulation Upgrades




### Window Upgrades



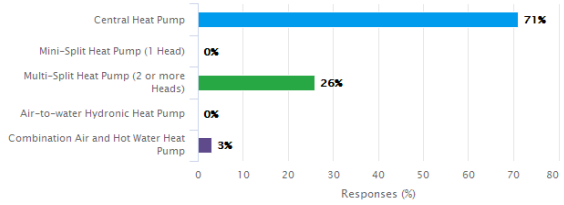

### Secondary Heating Upgrades



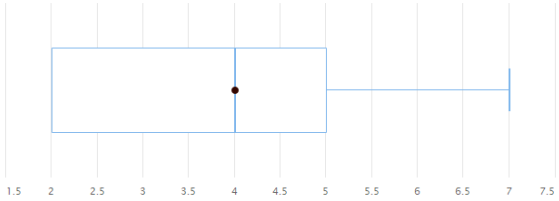

### Locations of secondary heating upgrades

## Heat Pump Upgrade

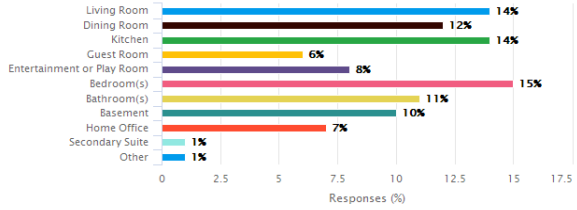
### The type of heat pump we installed is



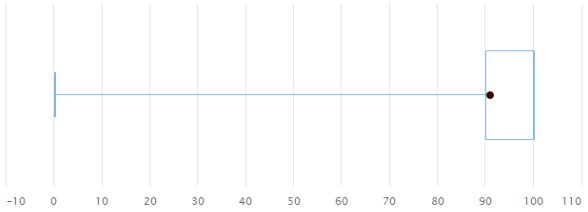

### How many indoor heads does your multi-split heat pump have (ductless only)?



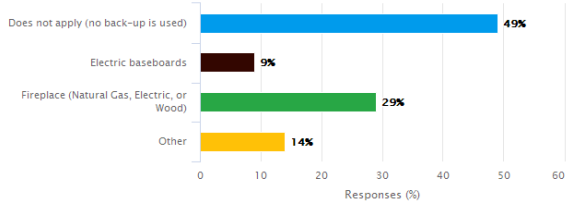

### The heat pump I installed provides heat to these areas (ductless)



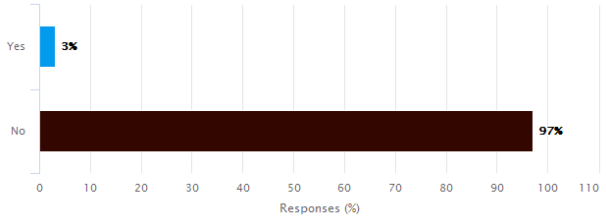

### Approximately what percentage of your home is heated by your heat pump?



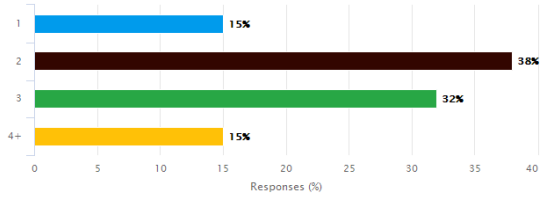

### The heat pump back-up is



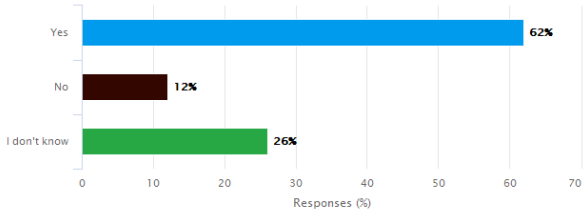

### Prior to installing a heat pump, did you home have air conditioning?



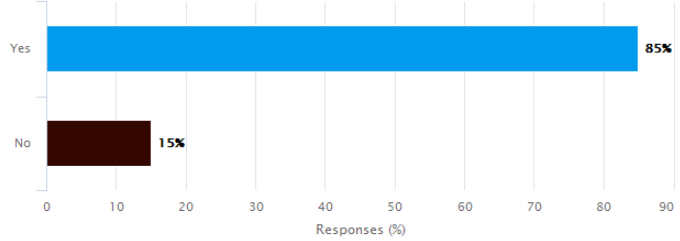

### How many installation quotes did you collect before you chose your heat pump system?



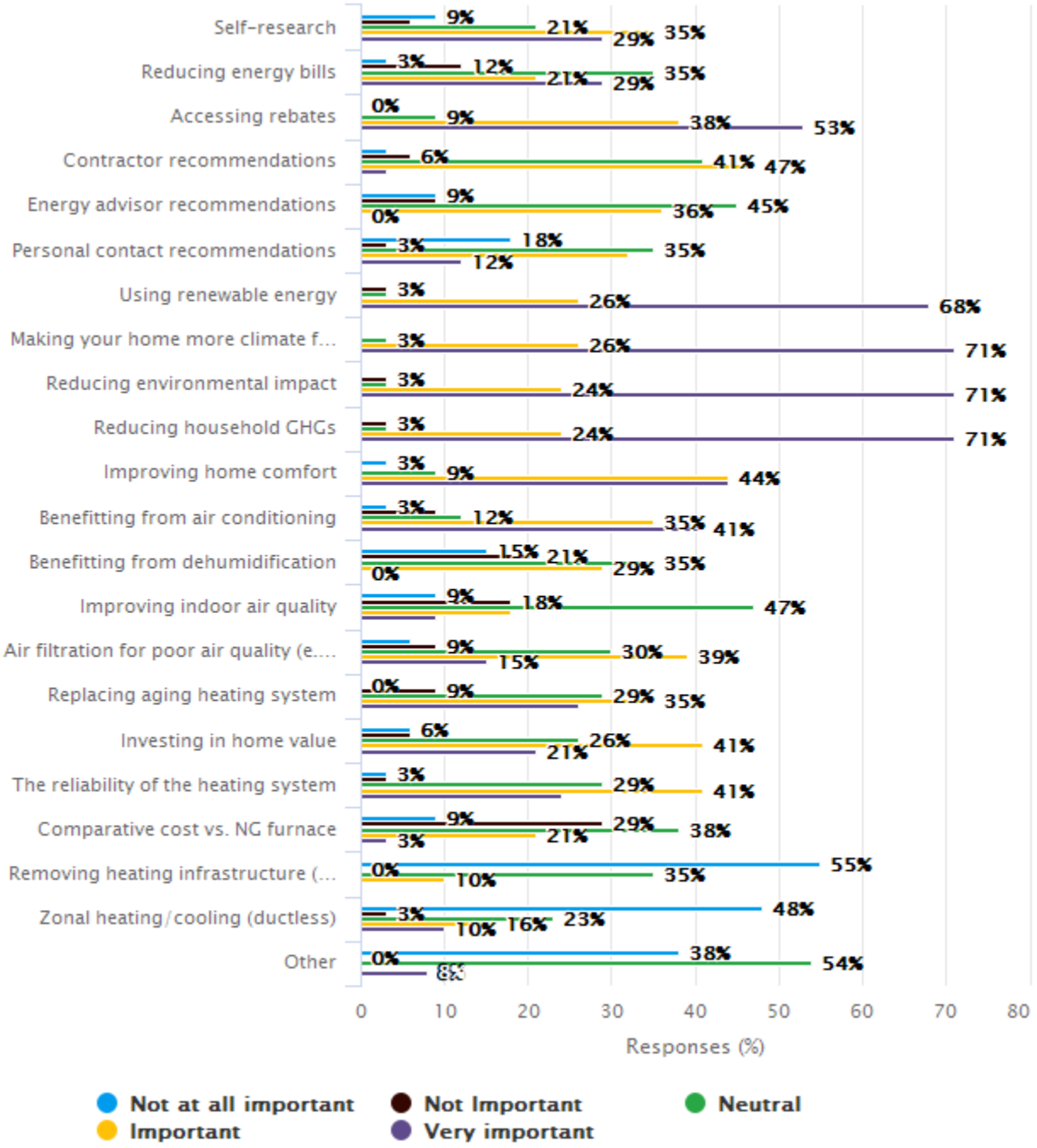

### Did your contractor complete a sizing calculation for your heat pump?



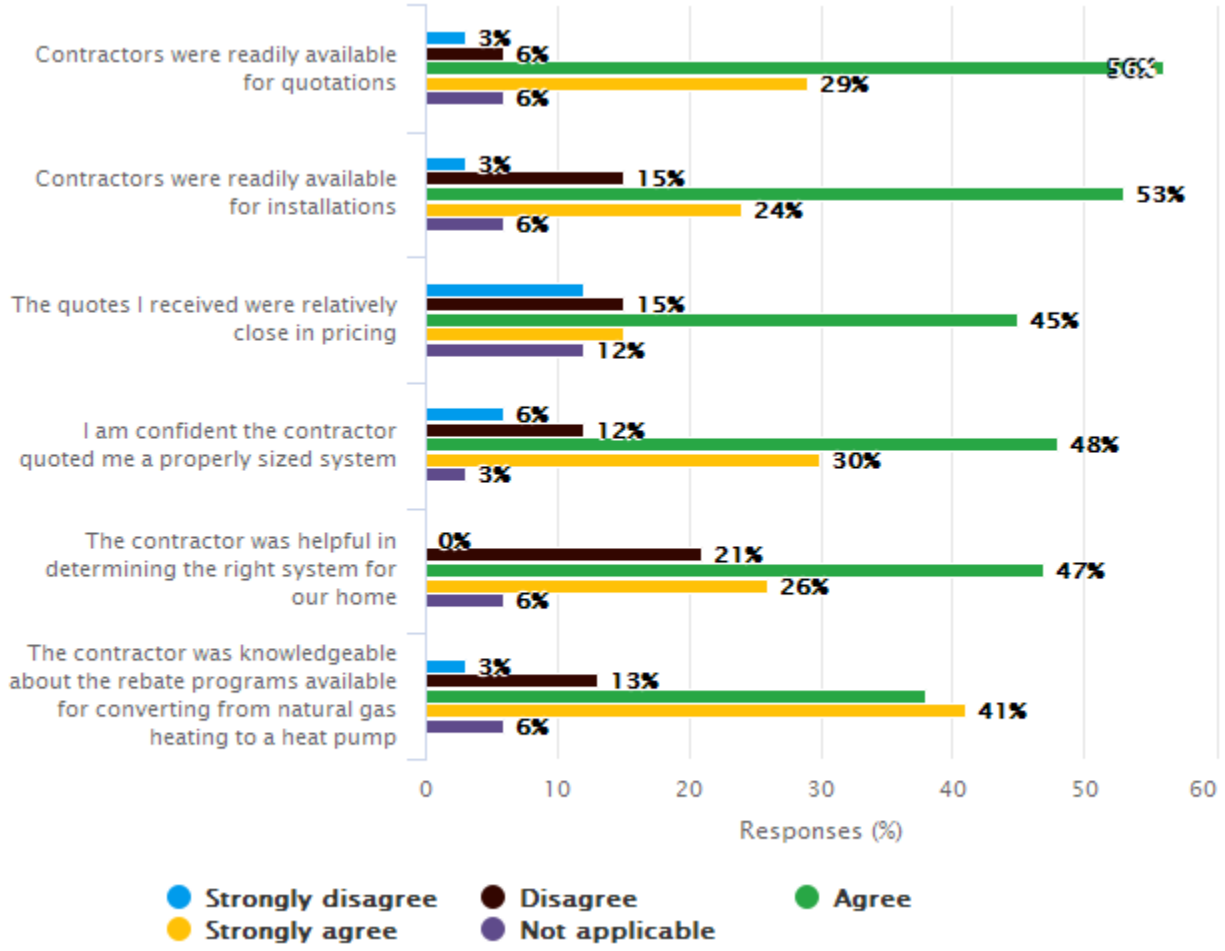

### Did your contractor teach you how to operate the heat pump controls?



How important were the following factors in choosing to upgrade to a heat pump?

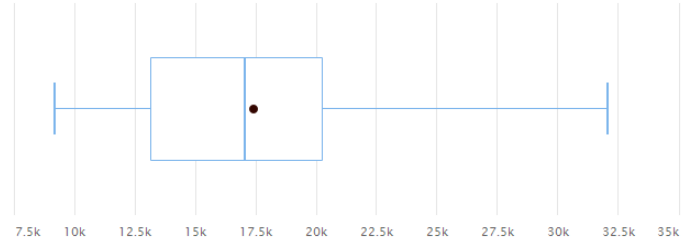


How much do you agree with the following statements?



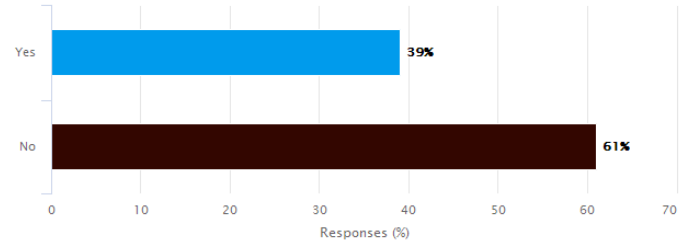
# Heat pump purchase costs

Approximately how much did the installation of your heat pump cost?

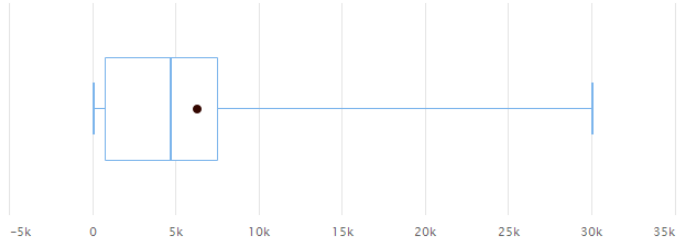



Cost distribution based on location

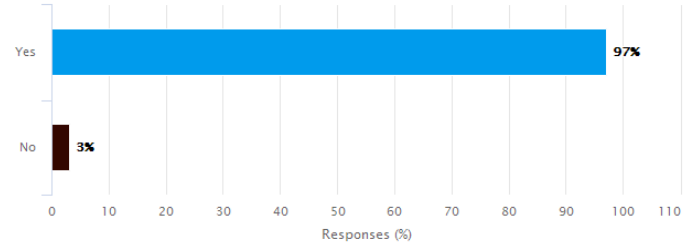
Did you also upgrade the Electrical Service to your home?



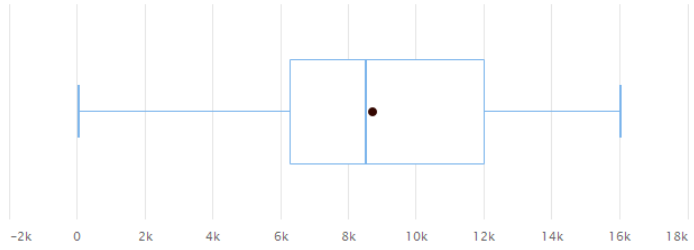

Approximately how much did it cost to upgrade your home's Electrical Service?




Did you access any rebates towards the cost of your heat pump?




What was the total value of rebates you received?

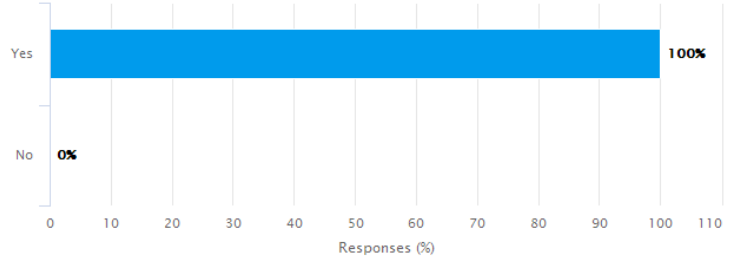


## Heat Pump Experience

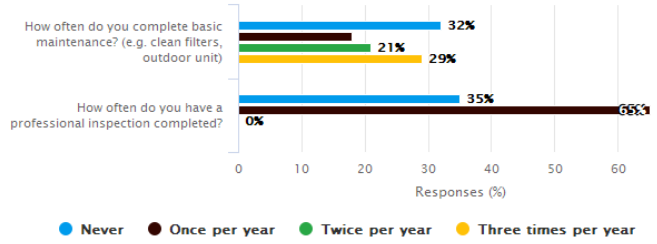
How much knowledge and understanding do you, and/or your other household members, have about your heat pump?

| | % |
|---|---|
| **Very little knowledge** | 0.00% |
| **Little knowledge** | 17.65 % |
| **Knowledgeable** | 58.82 % |
| **Very knowledgeable** | 23.53 % |

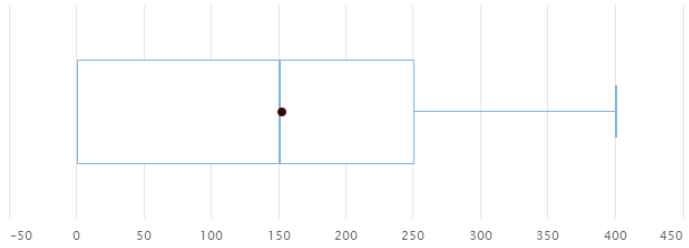
Would you install a heat pump again for a different home?



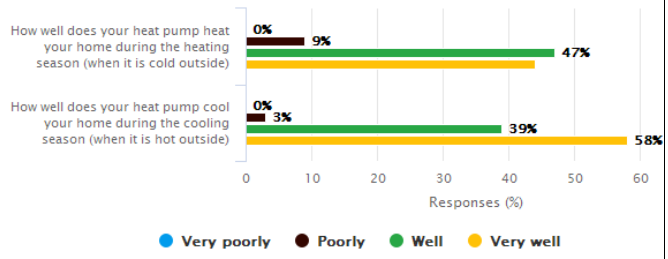

Maintenance




How much does the annual maintenance cost for your heat pump?




Heating and cooling performance

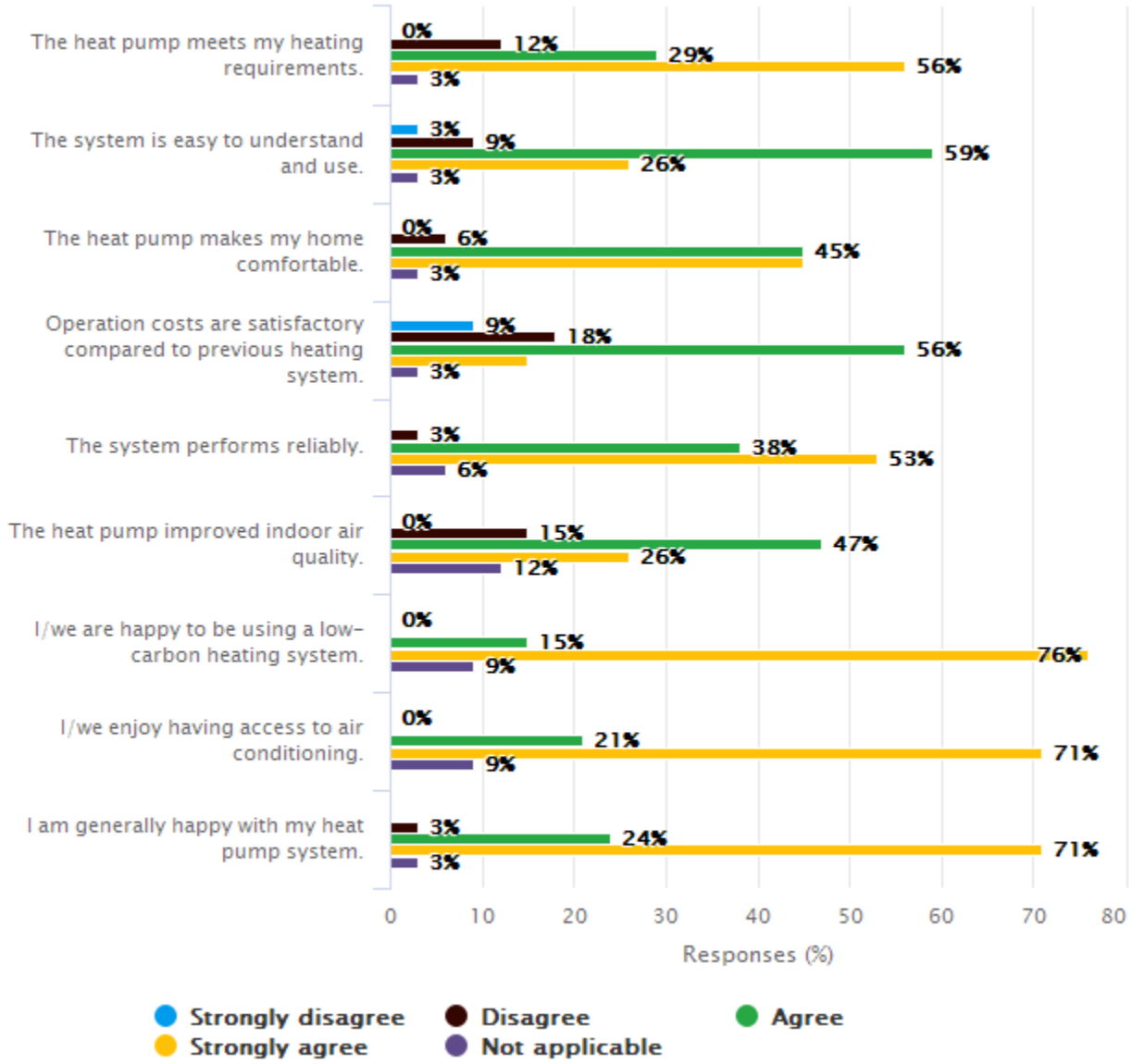



Compared to the previous heating system

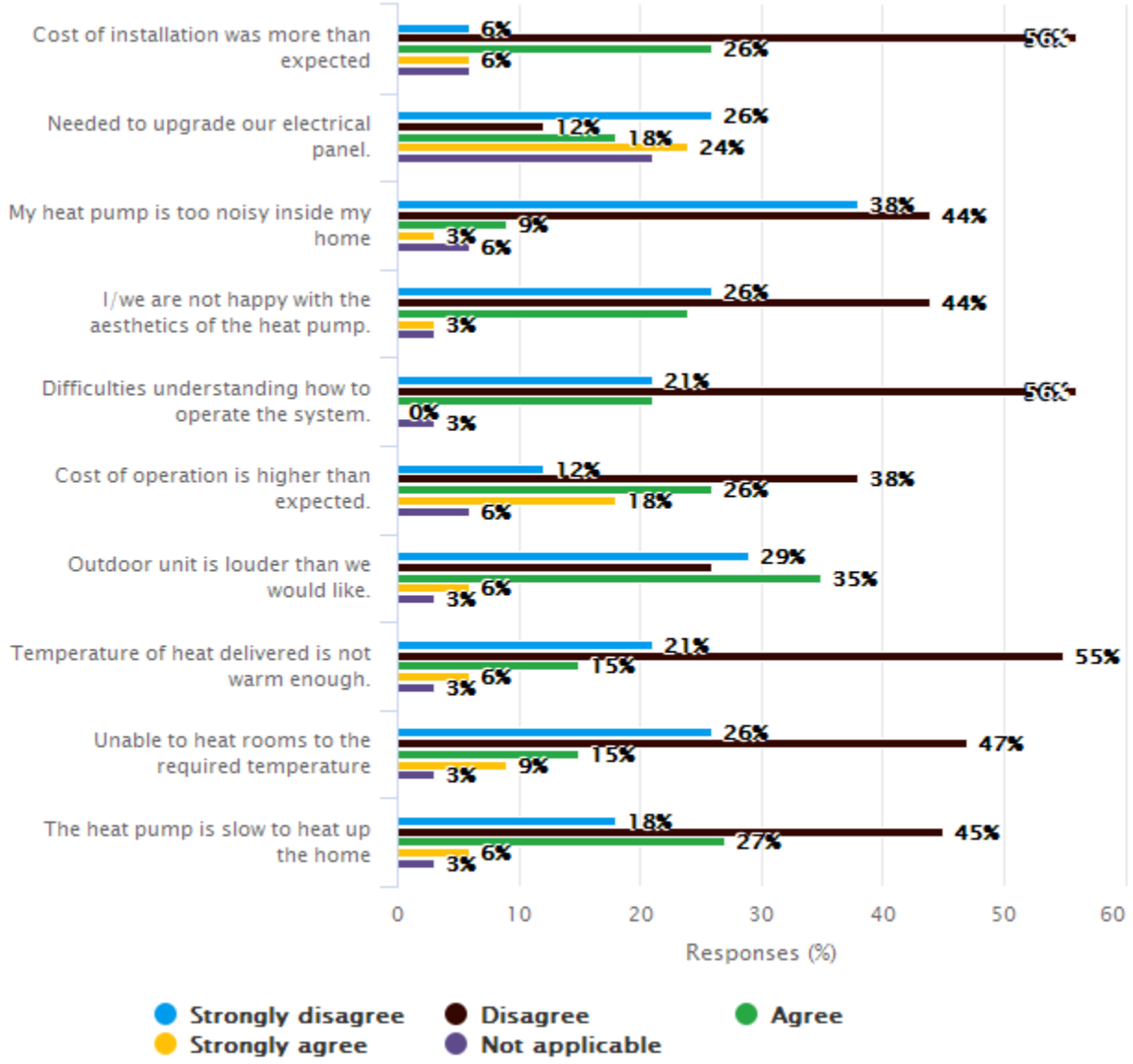
Overall, how does your heat pump compare to your previous natural gas system?

| | % |
|---|---|
| **Much worse** | 0.00% |
| **Worse** | 2.94% |
| **Better** | 47.06% |
| **Much Better** | 50.00% |
| **Total** | |

How much do you agree with the following statements?

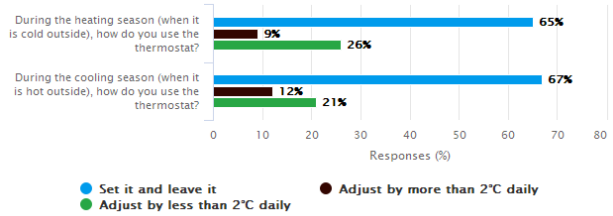


Have you experienced any drawbacks during or after installing your heat pump?

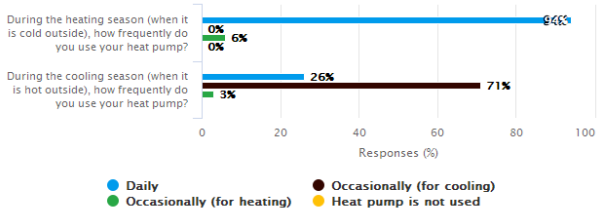


# Household Habits

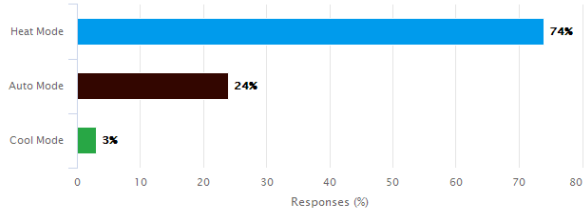
## Thermostat Settings



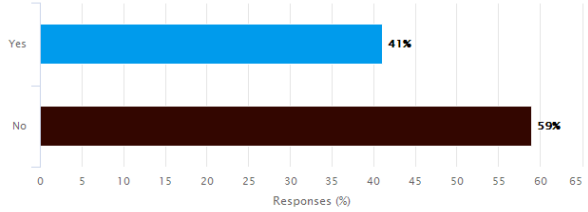

## Heat Pump Operation



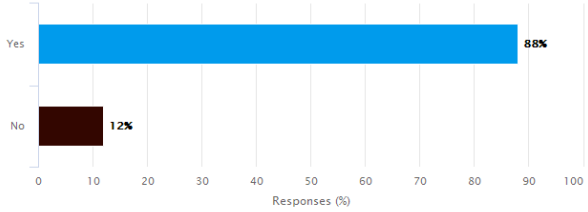

## What operation mode is your heat pump set to most frequently?



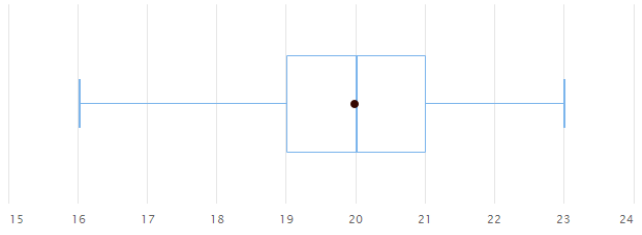

## Prior to January 01 2020 did you, or anyone in your household, work from home for extended periods of time (more than 30 days)?



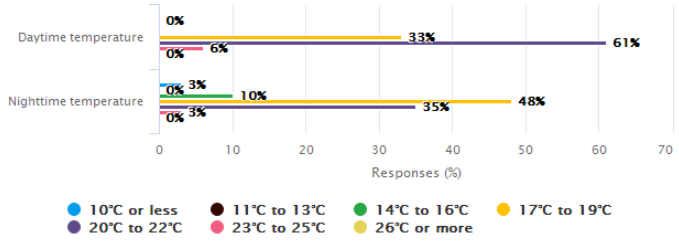

## After January 01 2020 did you, or anyone in your household, work from home for extended periods of time (more than 30 days)?



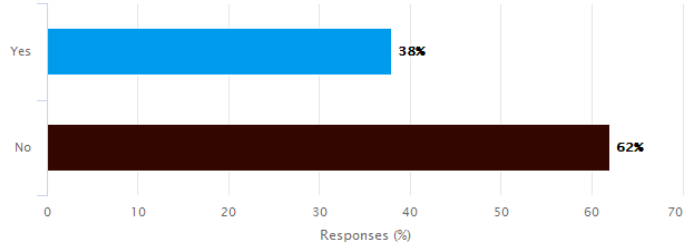

## What temperature did you typically set your previous natural gas furnace to? (Celsius)



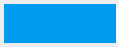

## After the heat pump installation, what temperature do you typically set your home to for daytime and nighttime?




## Do you use any secondary heating systems such as fireplaces or electric baseboards?



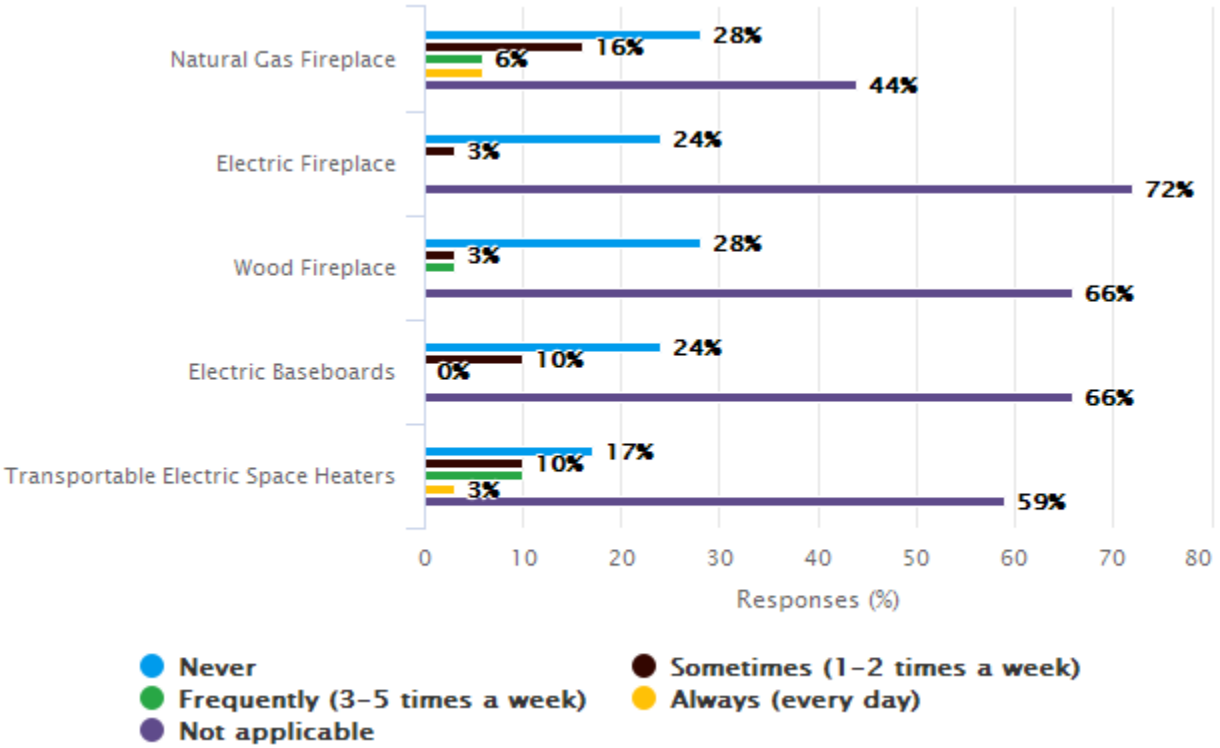
How did working from home after January 01 2020 differ from working from home prior to January 01 2020?
Compared to before January 01 2020, I worked from home...

| | % | Frequency | |
|---|---|---|---|
| **100% more** | 39.39% | 13 |  |
| **75% more** | 9.09% | 3 |  |
| **50% more** | 6.06% | 2 |  |
| **25% more** | 9.09% | 3 |  |
| **Same as before** | 33.33% | 11 |  |
| **25% less** | 0.00% | 0 | |
| **50% less** | 0.00% | 0 | |
| **75% less** | 0.00% | 0 | |
| **100% less** | 3.03% | 1 |  |
| **Total** | | 33 | |

Cooling with your heat pump
During warm periods, how often do you use the cooling feature of your heat pump?

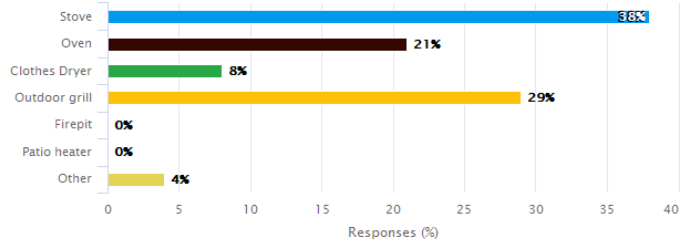
| | % | Frequency | |
|---|---|---|---|
| **Never** | 6.25% | 2 |  |
| **Sometimes (1-2 times a week)** | 25.00% | 8 |  |
| **Frequently (3-5 times a week)** | 25.00% | 8 |  |
| **Always (every day)** | 37.50% | 12 |  |
| **Not applicable** | 6.25% | 2 |  |
| **Total** | | 32 | |

How frequently do you use your secondary heating systems?

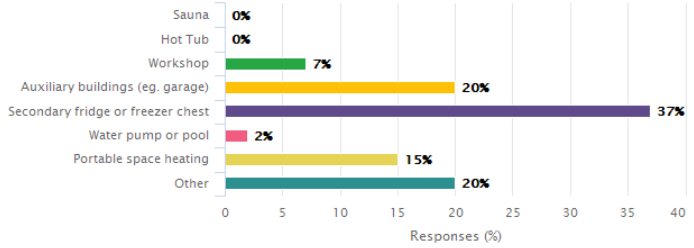



## Other Energy Use Habits

Does your home use natural gas for any other appliances?



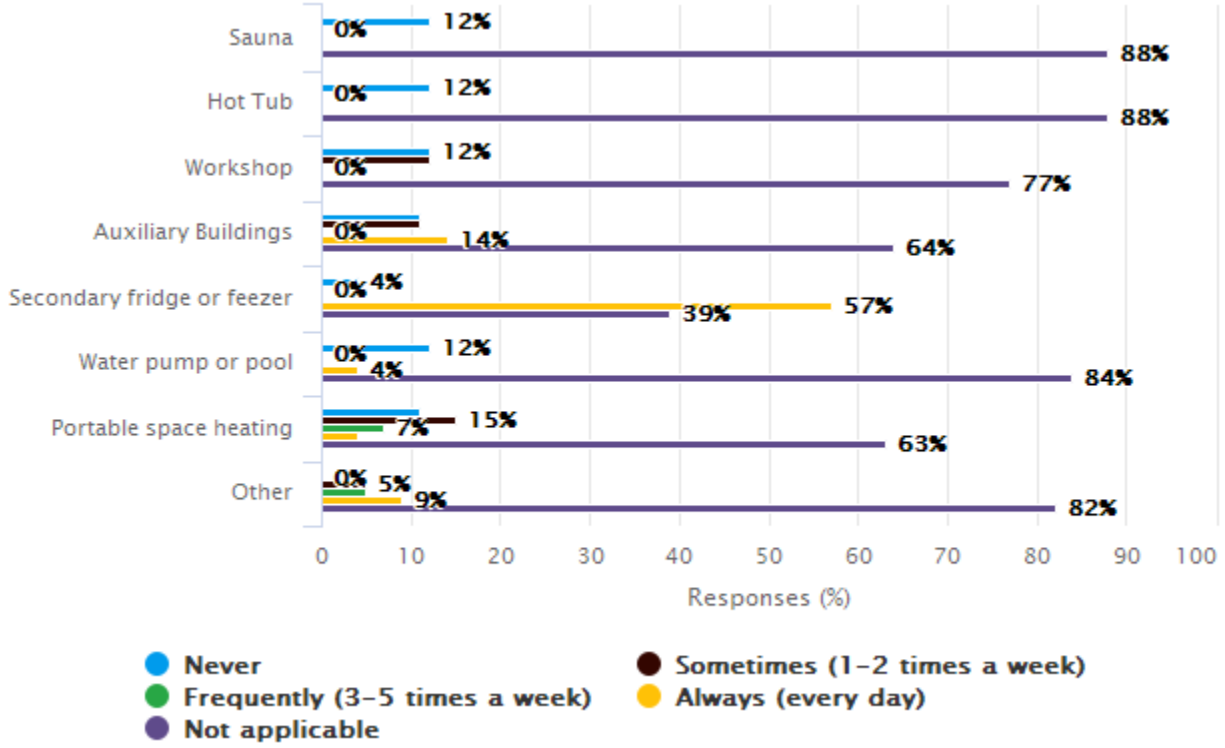

Does your home have any of the following connected to the same electricity utility meter as your home?



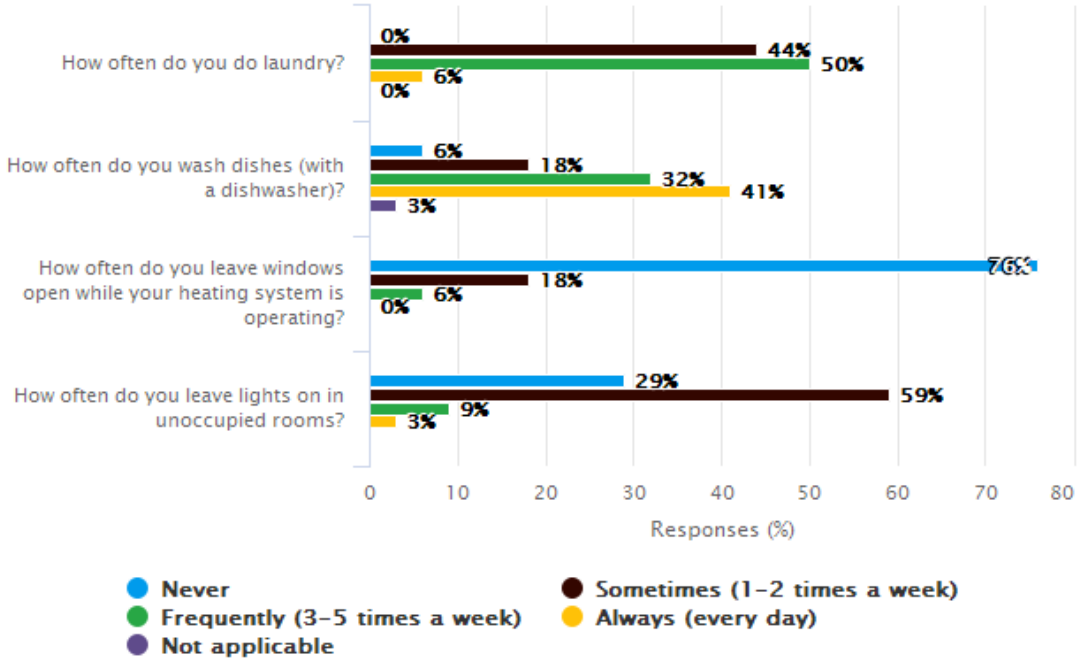
How would you describe the daily overall hot water consumption for your home?

| | % | Frequency | |
|---|---|---|---|
| **Minimal** | 14.71% | 5 | |
| **Moderate** | 70.59% | 24 | |
| **Heavy** | 14.71% | 5 | |
| **Total** | | 34 | |

How frequently do you use these features and services?

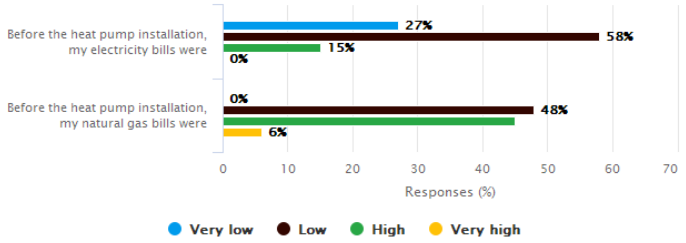


Occupant activities

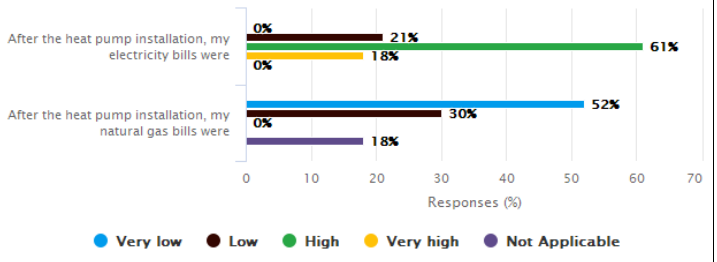



Utility Bill Comparison

Consider your utility bills before the installation of your heat pump when answering these questions



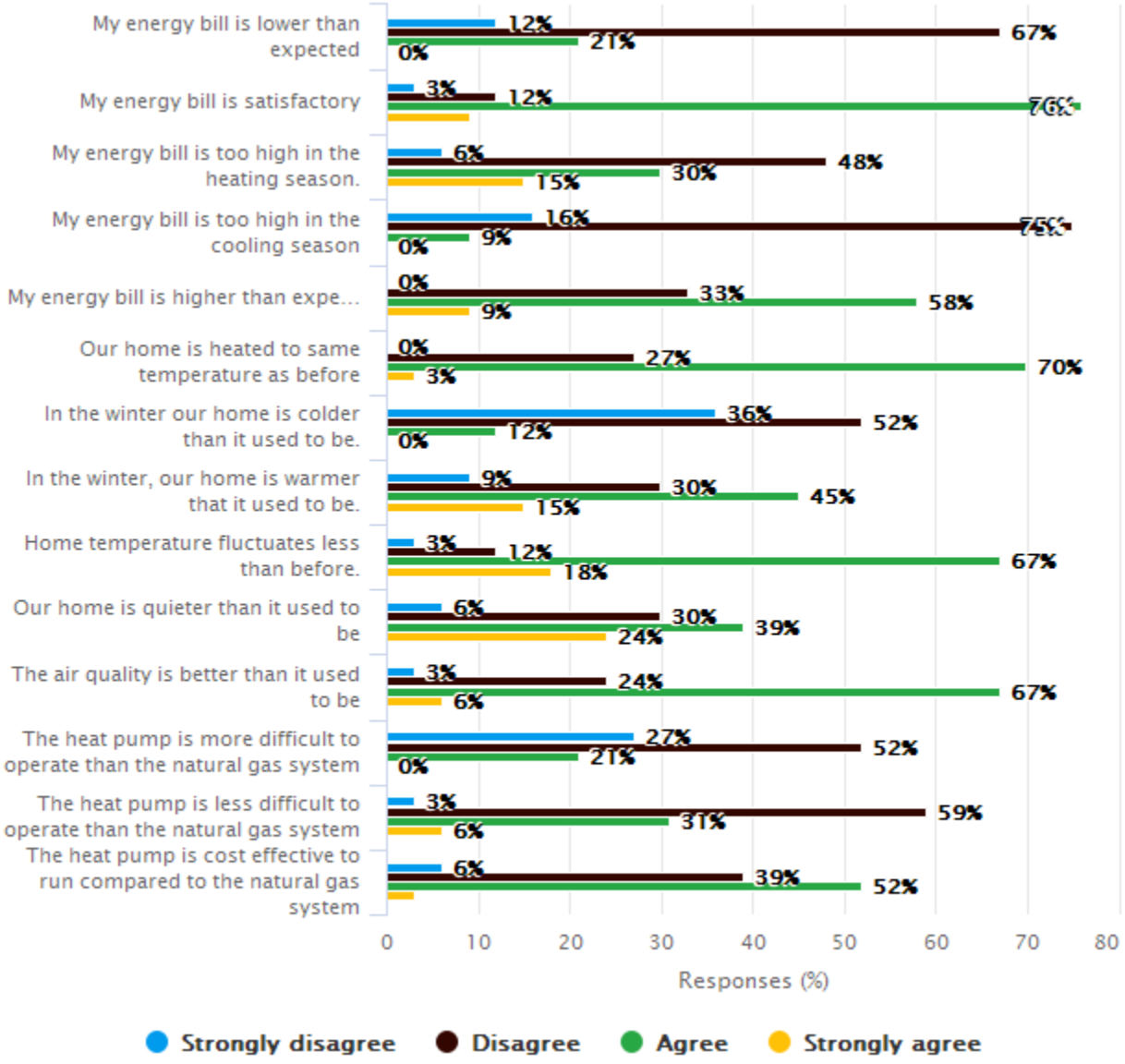

Consider your utility bills after the installation of your heat pump when answering these questions




Before the heat pump installation, I was concerned about carbon tax impacts on my natural gas bills

| | % | |
|---|---|---|
| **Strongly disagree** | 27.27% | |
| **Disagree** | 48.48% | |
| **Agree** | 21.21% | |
| **Strongly agree** | 3.03% | |

Consider the period after the installation of your heat pump. How much do you agree with the following statements?



Consider the future of your home and heat pump. How much do you agree with the following statements?