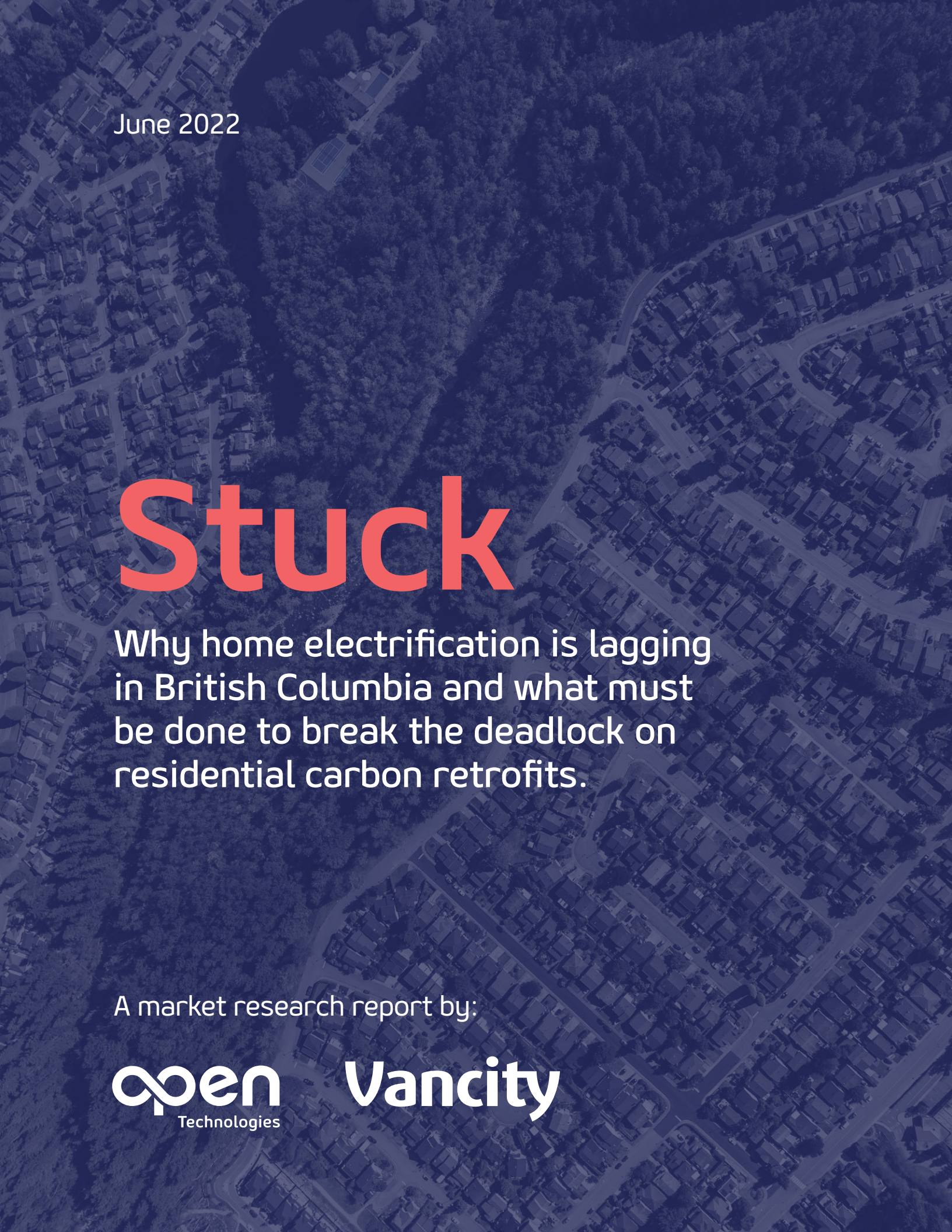

June 2022

Stuck

Why home electrification is lagging in British Columbia and what must be done to break the deadlock on residential carbon retrofits.

A market research report by:

Open Technologies

Vancity

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Though OPEN and Vancity offer different products and services for different markets, both our organizations are committed to reducing the climate impact of our built environment.

OPEN is a software company helping the people that shape our cities to make pro-climate decisions with confidence.

Vancity works to deliver on its vision of a transformed economy that protects the earth and guarantees equity for all. Canada's largest credit union is committed to supporting its members and communities through the transition to a clean and fair economy.

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ABOUT THIS DOCUMENT

This report sheds light on the factors that enable or discourage British Columbia homeowners who seek to transition away from natural gas-fired space and water heating in favour of clean electric alternatives, and what can, and must, be done to reduce the climate impact of the province's ground-oriented housing.

Our inquiries focused on owners of ground-oriented homes in southwestern British Columbia, such as single family detached houses, row houses, duplexes, and triplexes. Broadly, this document is based on the findings of a trio of public-opinion studies:

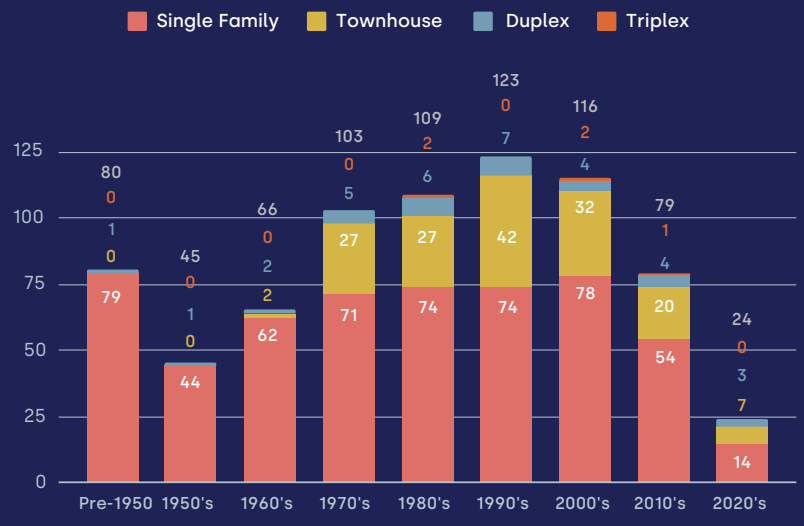
- a quantitative survey of 750 homeowners in southwest British Columbia (with a parallel study of an additional 135 Vancity members) to understand the space and water heating equipment in their homes by type, fuel type, and age, and the key motivational drivers or barriers to change;
- focus groups with homeowners who had recently completed or canceled a renovation or retrofit project, to understand motivation and experience of people going through these processes; and
- in-depth interviews with a dozen homeowners who had recently completed or canceled a renovation or retrofit, again to understand their motivation and experiences.

In our quantitative survey, most of the homes in our data set are single-family-detached houses of various vintages, with a sizable minority of attached home types built since the 1970s. Roughly 90 per cent of the homes in the survey set are located in the Lower Mainland, with the remaining 10 per cent on southern Vancouver Island. About 74 per cent of the respondents report they primarily use natural gas for space heating, which is consistent with other data sources for those housing types and geographies.

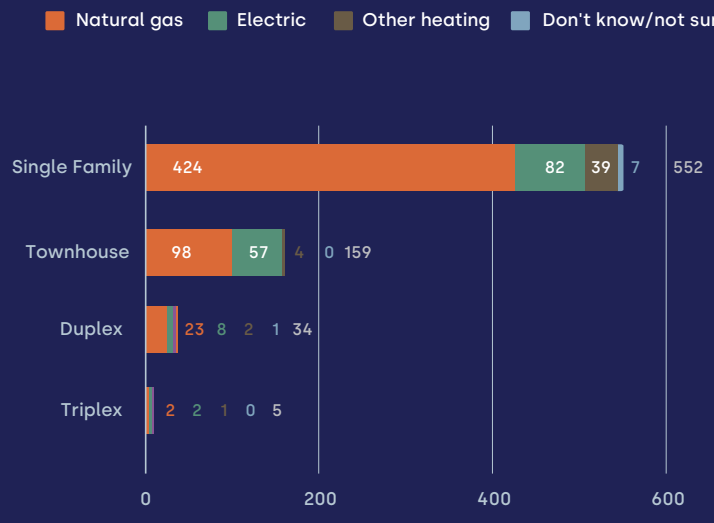
In the course of our research, we explored a range of possible factors to determine which were most powerful in driving homeowners' decisions to take on home improvement projects that would result in a climate benefit. This included analyzing a range of characteristics about their homes plus details about their own motivations and personal backgrounds. (For methodologies, see Appendix 1.)

The provincial government will soon be opening consultations on a proposed scheme to give local governments tools to regulate carbon pollution from homes and other existing buildings. We hope this report and its recommendations will provide useful context for those discussions, and will also prove helpful to policy makers, demand-side-management program leaders, and others interested in increasing the pace and scale of home electrification.

Distribution of homes in dataset by vintage and type



Distribution of homes in dataset by space heating fuel and type of home



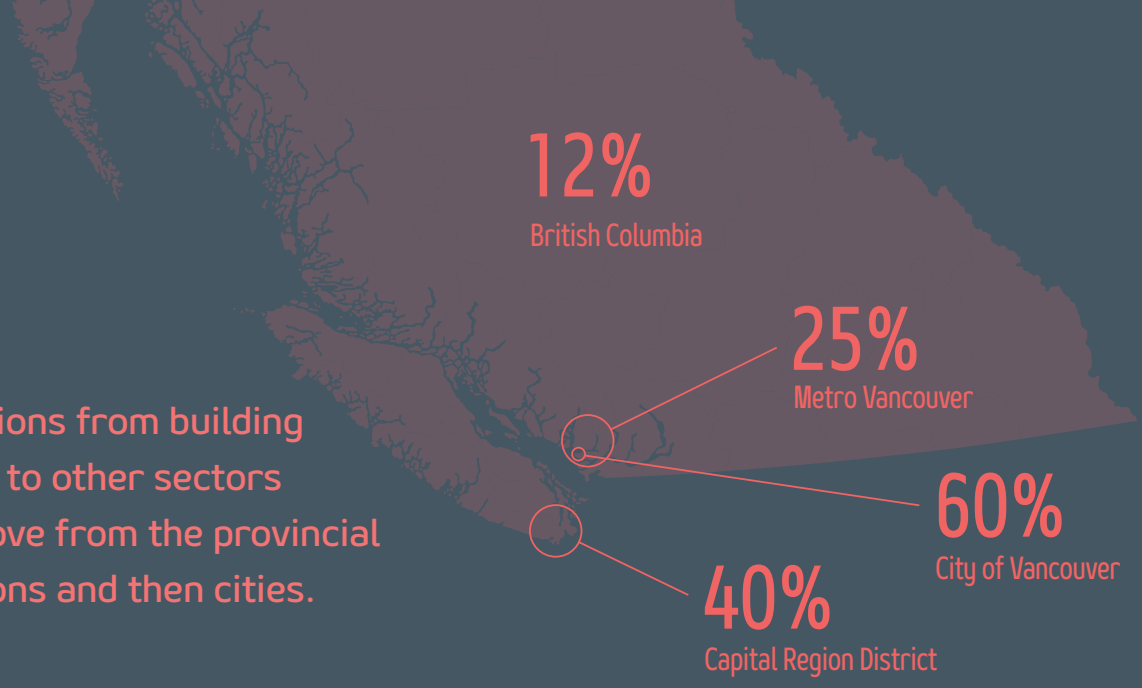
Too many British Columbia homes are producing too much carbon pollution

The day-to-day operation of ground-oriented homes and other buildings contributes about 12 per cent of British Columbia's overall carbon emissions, and their share of total emissions relative to other sectors increases dramatically for urban areas of the province. For example, in Metro Vancouver buildings contribute 25 per cent of the region's emissions and, in the City of Vancouver, their share of all carbon emissions rises to almost 60 percent.[1]

Homes and other buildings produce the bulk of this pollution when they burn fossil fuels—chiefly natural gas—in furnaces, fireplaces, boilers, domestic hot water heaters, and, to a lesser degree, kitchen appliances. Meanwhile, numerous viable electric alternatives are becoming available, powered by a British Columbia electrical grid that is low carbon intensity today and—under the province's *Roadmap to 2030* plan—on a path to zero carbon by the end of this decade.[2]

Though many housing-retrofit discussions and assessments focus solely on improving **energy** efficiency through right-sizing heating equipment and/or envelope improvements, this study focuses on the measures that will drive the greatest positive climate outcome—specifically the replacement of natural-gas fueled space and water heating equipment with efficient electric alternatives. When coupled with energy conservation measures such as improving a home's envelope, we use the term "residential carbon retrofit" to describe this process.

Just shy of one million British Columbia households currently subscribe to natural gas service, and just over half (54 per cent) of all homes rely upon gas as their primary heating fuel.[3,4] For the ground-oriented homes on the south coast of the province that are the focus of this study, this share of gas-primary households rises to approximately 74 per cent of the total.



The share of emissions from building operations relative to other sectors increases as we move from the provincial scale down to regions and then cities.

The Province of British Columbia has pledged to reduce emissions from the operation of buildings and communities by 59 to 64 per cent below 2018 levels by the end of this decade. It is also drafting proposed rules that would give local governments the option to regulate carbon pollution from existing buildings. Already, the regional and local governments in our study area have established emissions reduction targets for 2030 and beyond:

- Metro Vancouver's Climate 2050 Roadmap for Buildings calls for a buildings emission reduction of 35 per cent by 2030 (relative to 2010 baseline), and a net zero building stock by 2050.[5]
- The cities of Vancouver[6] and Victoria[7], and the District of Saanich[8] have all set operating emissions reductions targets of 50 per cent (relative to 2007 baseline) by 2030, on the path to net zero by 2050 or earlier.

If British Columbia is to meet its climate goals, governments must either incentivize or require many more homeowners to replace their gas space and hot water heaters with electric alternatives. Energy efficiency upgrades alone will be insufficient to meet the targets, although many residences will also need envelope improvements to ensure a comfortable and cost-effective homeowner experience and to reduce the peak load burden on the electricity grid.

These targets will need to account for existing homes as well as those built between now and 2030. As of January 2022, the City of Vancouver began effectively requiring all new homes to install high-efficiency electric space heating systems. Metro Vancouver and other jurisdictions have similar requirements that will not take effect until 2030; a great many new homes will be built by then, many of which will be gas-primary if left to follow the status quo (as described in "Where we are today," below).

In short, ***to meet the provincial, regional, and local climate targets for 2030 and 2050 we must decarbonize our homes.*** **And that means quickly replacing the gas furnaces, boilers, and water heaters that currently dominate the landscape, while also ensuring that new homes are electrified from the start.**

As we will show in this report, the homeowner journey from gas to electricity is rife with structural challenges. We will highlight those actions that show some signs of working, and others that do not, and recommend a path forward.

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1. While our research and this report focus on operational greenhouse gas emissions, embodied emissions—those generated by building material manufacturing, transportation, and construction—are also significant and typically underreported.

2. In its CleanBC Roadmap to 2030 plan, the Province of British Columbia committed to a "100% Clean Electricity Delivery Standard for the BC Hydro grid."

3. "Annual Information Form For the Year Ended December 31, 2021," FortisBC, March 18, 2022.

4. Natural Resources Canada, National Energy Use Database, Residential Sector—British Columbia, "Table 5: Space Heating Secondary Energy Use and GHG Emissions by Energy Source." Retrieved from https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_bc.cfm

5. Metro Vancouver. "Climate 2050 Roadmap—Buildings: A Pathway to Zero Emissions and Resilient Buildings." October 2021. Retrieved from http://www.metrovancouver.org/services/air-quality/climate-action/climate2050/Climate2050Docs/Climate2050BuildingsRoadmap_Final_October2021.pdf

6. City of Vancouver. "Climate Emergency Action Plan—How We Build and Renovate." 2021. Retrieved from https://vancouver.ca/green-vancouver/how-we-build-and-renovate.aspx

7. City of Victoria. "2018 Climate Leadership Plan." Retrieved from http://victoria.ca/climateaction.

8. District of Saanich. "2020 Climate Plan: 100% Renewable and Resilient Saanich." January 2020." Retrieved from https://www.saanich.ca/EN/main/community/sustainable-saanich/saanich-climate-plan.html

THE ACTION WE NEED

To hit our 2030 emissions reduction targets, we must rapidly electrify hundreds of thousands of ground-oriented homes currently equipped with natural gas space heating, water heating, or both.

Critically, almost two thirds of this gas-powered space heating equipment is aging into retirement by 2030. This represents either a huge electrification opportunity or a massive blow, should those homeowners recommit to gas, effectively locking in another generation of carbon emissions.

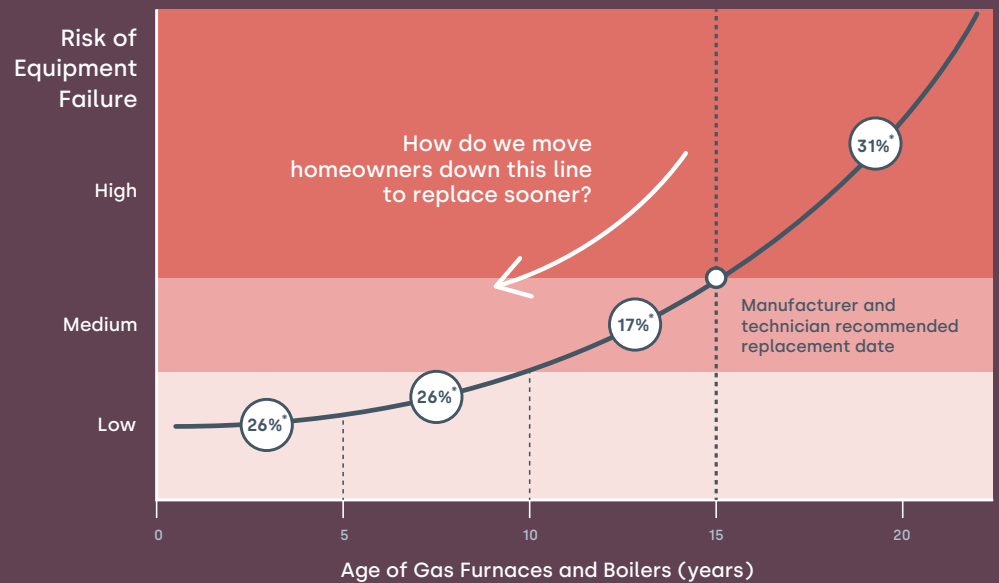
To halve buildings-based emissions by 2030, the province needs to electrify the primary space and water heating systems of at least five per cent of all B.C. households (the equivalent of seven per cent of today's existing, gas-burning homes) each year, while also taking steps to reduce emissions from kitchen appliances and secondary heating systems and ensuring that all newly built homes run zero-emissions heating and hot water systems.

Unfortunately, even as the technical solutions mature and the imperative for strong climate action grows more urgent each day, very few homeowners are pursuing carbon retrofits or replacing their space heating equipment within the 15-year period that most manufacturers and service technicians recommend.

In our study set, homeowners are currently replacing just four to five per cent of their furnaces each year, representing an average replacement cycle of 20 years. Twenty-nine per cent are already older than 15 years and in the "high risk of failure" category; another 34 per cent will reach that point by 2030. The story for gas boilers is even more significant, with 38 per cent older than 15 years today and another 30 per cent reaching the age of retirement by 2030.

Back from the brink

To successfully electrify, policy makers must incentivize or require homeowners to replace gas space heating equipment before it fails.



* proportion of furnaces and boilers in the age category of the study set

We outline the implications of this delayed replacement in the "Home Decarbonization Gap" section below. In the vast majority of those cases, homeowners are replacing old gas equipment with new which, of course, locks in another generation of greenhouse gas emissions.

In other words, the coming eight years present policy makers with an opportunity and imperative to dramatically increase both the rate at which homeowners replace heat and hot water equipment and the percentage of those who electrify. Particularly for furnace replacements, our research focused on air source heat pumps as the primary, most efficient alternative.

The quantitative and qualitative research that we and our partners conducted over the past several months unpacks several of the reasons why so few homeowners take on carbon retrofits and equipment replacement. We first outline the nature of the inertia in the sections that follow.

What is the Home Decarbonization Gap?

The home decarbonization gap is the delta between the current rate of conversion of household natural gas equipment to electric alternatives, such as replacing gas furnaces with electric heat pumps, and the rate that is needed to meet British Columbia's climate targets.

4-5%

Share of natural-gas-heated British Columbia homes that currently replace their furnace each year, most with another gas furnace

DECARBONIZATION GAP

7%

Share of natural-gas-heated British Columbia homes that must be replaced annually to keep pace with the 2030 CleanBC targets

Share of all British Columbia homes that use gas for space heating, water heating, or both — **74%**

Share of equipment that will be in the "high risk" of failure category and up for replacement by 2030 — **64%** (8% per year)

Share of the above that need to be near-zero emissions, electric heating systems — **100%**

Share of newly built homes that need to have near-zero emissions, electric heating systems — **100%**

The challenge of converting existing homes to electric heat pumps is real and critical

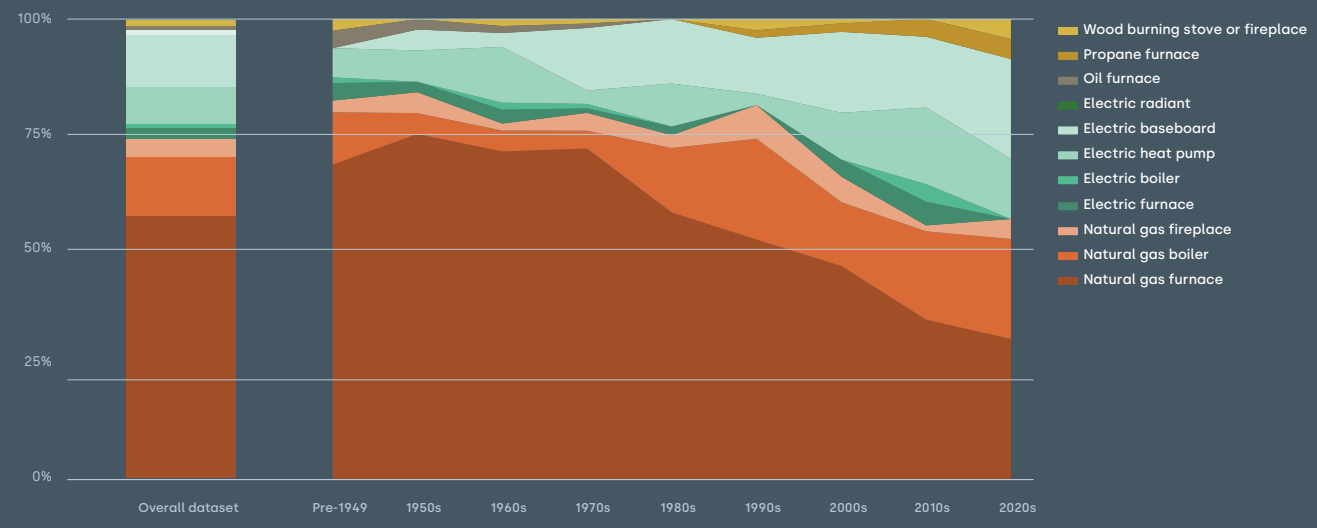
Natural gas furnaces, boilers, and/or hot water heaters serve a large majority of the ground-oriented homes in our studied audience, although this market dominance wanes in favour of electrical systems in homes built since the start of the millennium. Over the course of decades, home space heating systems have shifted from natural gas furnaces, to gas boilers, to fewer of both; that said, gas still maintains a slight market-share advantage over electric-primary systems.

Our research strongly suggests that heat pump adoption—approximately 11 per cent of our study set, with eight percent relying upon heat pumps for their primary space heating—has followed this broader trend toward building new homes with electric heat. While the distribution of electric heat pumps across our home age categories indicates some level of fuel conversion in older homes, 46 per cent of the installed base of heat pumps in our study set are in homes built since 2000.

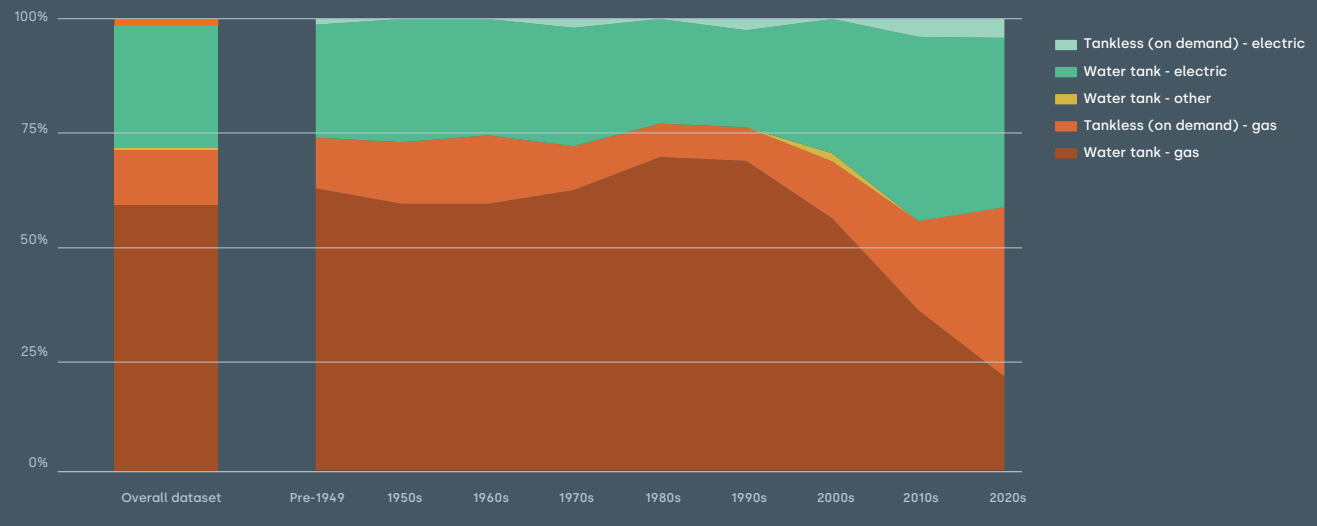
In focus groups, owners of older homes reported encountering multiple technical and logistical hurdles in their efforts to convert to heat pumps. In short, the challenge of converting existing homes to electric heat pumps is real and critical, particularly for those looking to go fully electric (i.e. without retaining a gas furnace as back-up).

Similar patterns apply to analysis of domestic hot water systems by vintage of home. Gas-fuelled systems have also declined in homes built since the 1980s, though—at 71 per cent market share—they still dominate. Our small sample of homes built in the current decade could suggest a resurgence of market share driven by the popularity of gas-fired tankless water heaters, although we would need to conduct further sampling to confirm this.

We asked: "In which decade was your home built, and how is it primarily heated?"



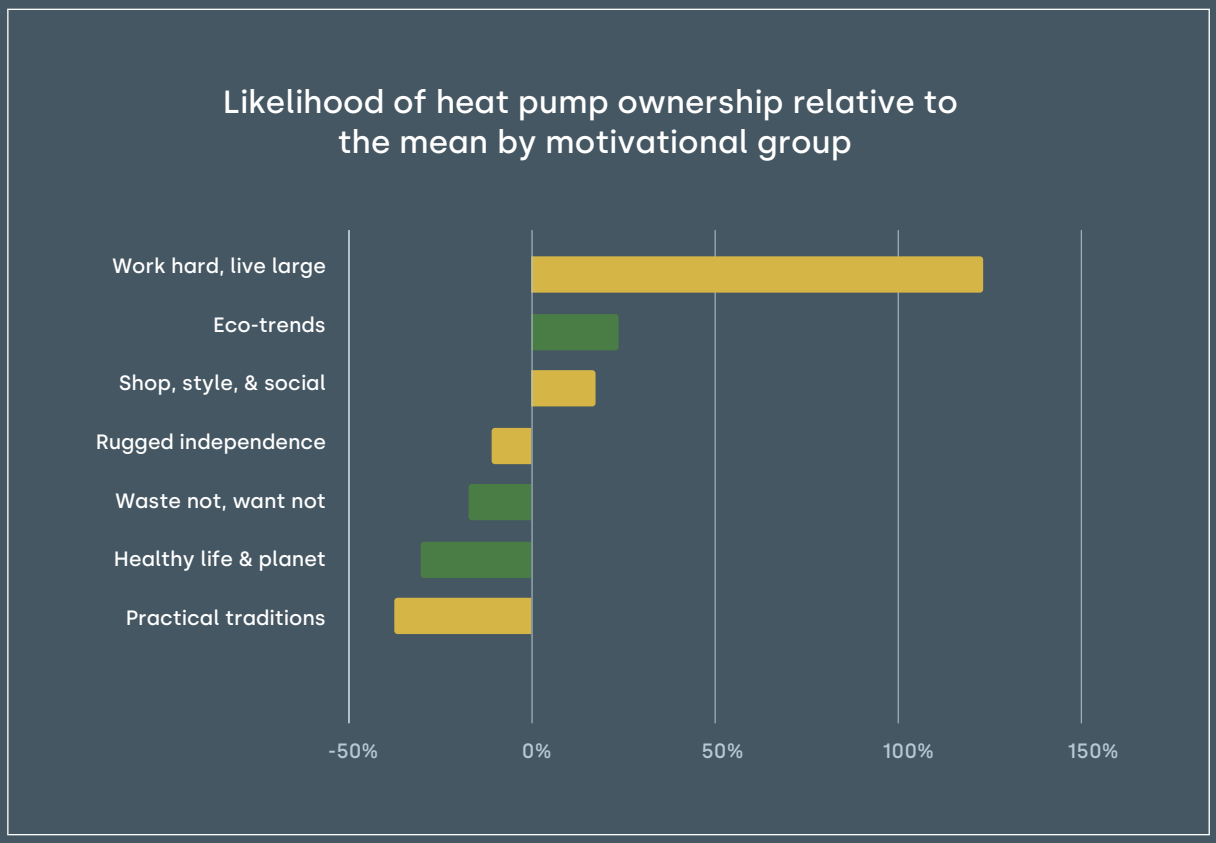
We asked: "In which decade was your home built, and how do you heat your hot water?"



There is a typical heat-pump owner, and it's not who you think

Given the inherently complex carbon retrofit process, we looked for leverage points and lessons learned in areas where heat pump installations are already seeing traction. Demographically, we found few discernable differences between homeowners who run electric heat pumps and those who use natural gas. Self-reported incomes and ethnicities revealed no discernable preference for one energy source over another. That said, a psychographic assessment told a different story.

Vancouver think tank OneEarth developed the Lighter Living Motivations framework to help understand how attitudes and values inform consumer decisions to choose more sustainable products and services in the marketplace.[9] Using screener questions, we assigned each of our survey respondents to one of the framework's seven psychographic groupings, as shown in the chart below.



9. OneEarth developed the Lighter Living Motivations framework in partnership with the Share Reuse Repair Initiative and with funding support from Vancity. Learn more via www.oneearthweb.org/motivations.

Unexpectedly, the results reveal a negative correlation between heat pump ownership and prioritizing healthy planet and sustainable lifestyles in purchasing decisions. The motivational groupings most likely to factor those choices—depicted with green bars in the chart above—are actually less likely to own a heat pump than the average British Columbian. Conversely, the "Work Hard, Live Large" consumer—who is least motivated by climate and environment concerns and instead prioritizes personal comfort, convenience, luxury, and performance—is more than twice as likely to own a heat pump.

This may be explained by the strong positive correlation we found between heat pumps and the type of home that those in this psychographic segment are more likely to occupy. With respect to the physical characteristics, locations, and age of homes already running heat pumps, our research finds these homes are generally:

- single family detached (89 per cent) versus other housing typologies—suggesting more options for siting outdoor units relative to attached homes with shared walls and less outdoor space;
- located on southern Vancouver Island or suburban areas of the Lower Mainland; and
- newer than the dataset as a whole, with more than 45 per cent constructed after 2000.

This reflects the significant growth of new detached-style housing in areas such as the Fraser Valley in recent decades, and underscores that it is much easier to incorporate a heat pump into a new home—ideally one with abundant outdoor space—than it is to retrofit it into an existing natural-gas heated home. These are also homes that are far more likely to include mechanical cooling; as outlined below, heat pumps already represent over one third of the air conditioners in our study group.

This reinforces other findings in this report that structural market factors are more important drivers of heat pump adoption than sustainability considerations. Notwithstanding the challenges that homeowners (and contractors) face in decarbonizing existing homes versus new ones, the fact remains that the vast majority of our 2030 housing stock already exists. Carbon retrofits of existing homes are therefore critical to reaching our interim and net zero targets, and policy makers must overcome the barriers that stand in our way.

Systemic conditions conspire to maintain the status quo

While an enormous opportunity exists to decrease British Columbia's emissions via residential carbon retrofits, homeowners face profound challenges in the current market context. While both governments and climate-action advocates often present this as a relatively simple "capital problem" that can be solved with the provision of more low cost financing, the challenge is far more nuanced. Broadly, we attribute lack of decarbonization activity in ground-oriented homes to a systems problem rooted in imperfect information, motivation, and economic disincentives impacting both homeowners and contractors.

Before we present our specific findings, we sketch out here the three factors that together conspire to maintain the status quo.

1. Broadly distributed emissions with a huge collective impact

Close to one million British Columbia homes subscribe to natural gas service, and the gas distribution network reaches almost all of the province's larger population centres. Each individual home furnace, boiler, hot water heater, and associated ductwork and/or piping has its own unique characteristics and setup and, like internal-combustion vehicles, each house represents a very small sliver of the overall problem. Homeowners may be reluctant to connect their own household heat and hot water equipment to a global challenge.

Heating a typical single-family home entirely with natural gas can emit 4.9 tonnes of carbon dioxide equivalent ($tCO2_e$) each year.[10] That's about the same climate impact as driving a fossil fuel vehicle 19,574 kilometres—three times the driving distance between Vancouver and Halifax, Nova Scotia.[11] And, every year, approximately 10,000 new homes connect to the gas network.[12] Residential natural gas space and water heating equipment contributes a large slice of the province's overall greenhouse gas emissions inventory, and it is growing steadily as the pace of new home construction and gas hook-ups currently exceeds that of electrification.

10. Statistics Canada. "Household energy consumption, by type of dwelling, Canada and provinces." 2019 data. Retrieved from https://open.canada.ca/data/en/dataset/1890bdcf-37ff-40e4-8890-bbbc8c55115f.

11. See Appendix 1: Methodology for calculations.

12. FortisBC. "Annual Information Form For the Year Ended December 31, 2021." March 2022.

2. Low motivation to change

Most homeowners are just looking for reliable, affordable heat. Natural gas furnaces, boilers, and water heaters pump out lots of warmth, cheaply. The equipment is simple and durable, and fairly inexpensive. A burned-out piece of equipment can be replaced with a new one in a matter of hours with a single phone call or email. Further, in existing and older homes, gas heat is substantially cheaper than electricity, month-to-month. If we overlook the climate impacts of natural gas—and our research shows that environment and climate are not currently dominant drivers for most British Columbia homeowners—the status quo makes a lot of sense.

3. High barriers to action

Our interviews and focus groups revealed that, due to a range of technical and industry complications, even the most motivated homeowners face barriers to a successful carbon retrofit. To electrify a gas-heated home via a heat pump, for example, some of the common challenges conveyed by owners of older homes included the following:

- Particularly for cold weather heat pump models, several homeowners were told by service providers that their existing ducts were ill-suited to handle the additional air volume required to move a unit of heat during a cold snap (relative to a furnace), and many older homes lack space to change this ductwork.
- To employ electric resistance heaters as back-up (in lieu of retaining their gas furnace for secondary use), homeowners may face the additional cost of upgrading their electrical panel.
- A candidate homeowner might not have an ideal location for an outside compressor unit.
- Many homeowners are negatively impacted by the high cost of real estate and are struggling to manage regular household operating budgets, let alone setting aside a budget (and time) for asset management and planning.

Furthermore, as detailed below, just finding a knowledgeable contractor that will take a project on, tackle its complexities, and see it through is a critical barrier. At the time of this report (June 2022), Vancouver residents who attempt to find a contractor via the province's approved heat-pump contractor search tool would find just five qualified companies. Only one of the installers on the "pending approval" list serves the city. That said, as we note in our "Recommendations" section, these numbers are about to increase dramatically in response to a clear regulatory signal from the provincial government.

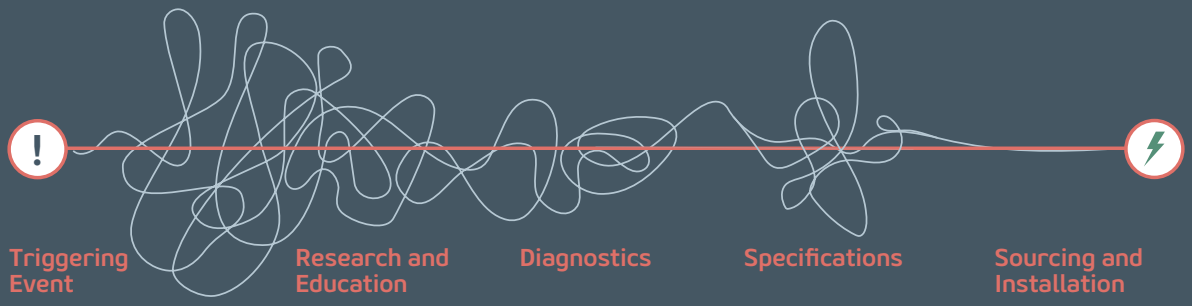
In summary, British Columbia homeowners currently consider electrifying their heating and hot water systems as a classic "high effort / low reward" proposition. As a result, very few such conversions actually occur.

Our research aimed to better understand the drivers behind the decisions that homeowners make as they move through the carbon retrofit process from the first triggering event or idea to the completion of an equipment replacement and/or home energy efficiency project.

We sought to map the key phases in that journey—with an emphasis on electrifying a home's space and water heating equipment—so that we could identify the key friction points and structural flaws in the process where homeowners lose momentum, and define potential leverage points in addressing them. We share the key phases in the following "Homeowner Journey" graphics.

In an ideal world, a homeowner would progress through these stages empowered by knowledge and resources, and with the time needed to resolve the issues that inevitably arise.

Homeowner journey: Proactive conversion from natural gas furnace to electric heat pump



Triggering Event

This could be an equipment failure, a home renovation, or a proactive replacement for homeowners who may be concerned with climate impacts.

Research and Education

The homeowner investigates the costs and benefits of electrification, including rebates.

Diagnostics

The homeowner seeks help to determine which retrofit options are viable for their home.

Specifications

The homeowner seeks proposed specifications from industry experts and suppliers on the needed key actions (eg. energy conservation measures) and equipment make and model.

Sourcing and Installation

Contractor(s) implement the energy conservation measures and source, install, and commission the new equipment.

Typical elapsed time: weeks to months

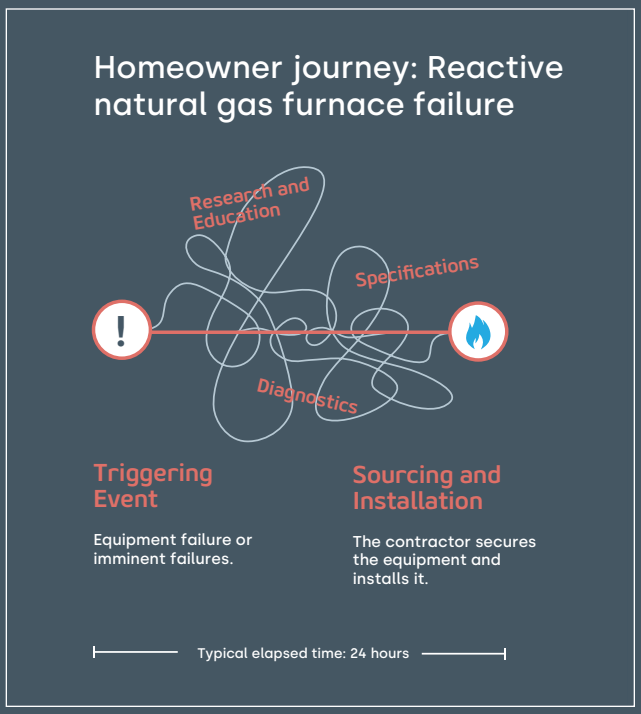
But our quantitative and qualitative research shows clearly that external motivations and triggers are by far the dominant drivers of carbon retrofit activity. Further, every step of the homeowner experience is fraught with resistance and barriers.

Retrofit triggers: What gets the ball rolling?

Equipment replacement

Our research on the installed base of space or water heating equipment in our region demonstrates that most homeowners wait for an external trigger before acting to replace or change their setup.

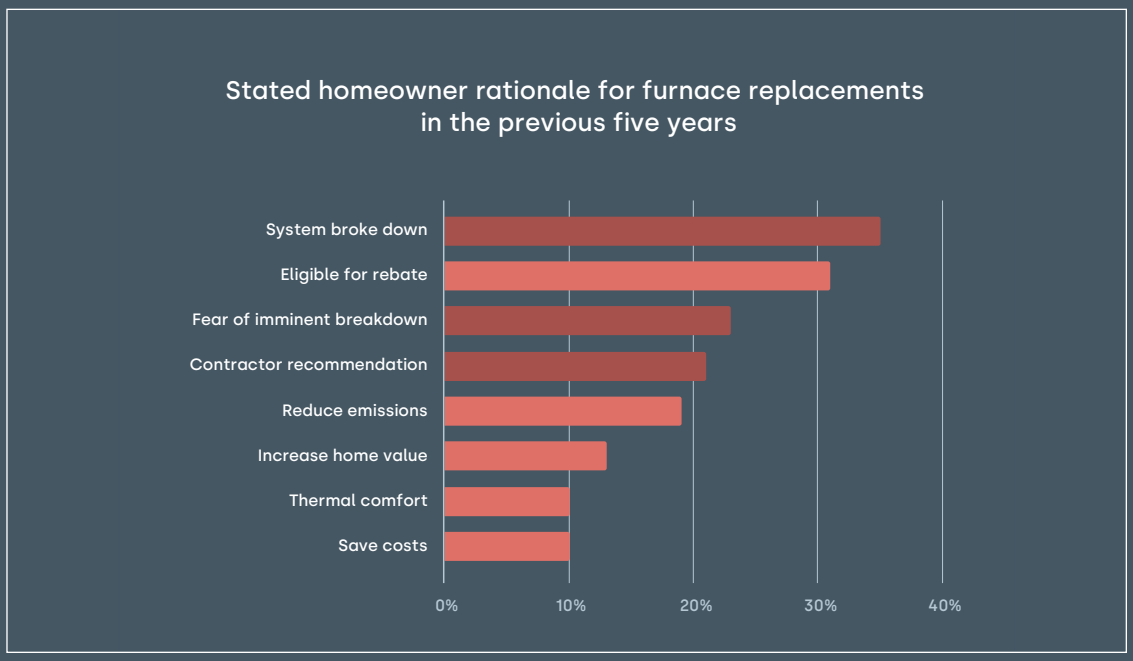
Actual or imminent equipment failure proved a far more common replacement trigger than any of the other reported factors, such as a desire to get better quality of heat, save costs, or reduce environmental or climate impact. In this context, the user journey from initial trigger to implementation is very different from the idealized pathway.



The adjacent sequence typically occurs in the middle of winter, when the homeowner is most reliant on the heating system and has limited leverage in a replacement transaction. The homeowners who said they'd gone through such a heating emergency reported that they felt a sense of helplessness in the process. With no time to collect information and educate themselves about alternative heating options—or even collect multiple quotes for a status-quo option—most homeowners end up with a new gas-powered furnace or boiler within 24 hours.

While several respondents conveyed that they would have liked to have explored different options, the urgency to get the heat flowing was incompatible with the time required to diagnose the various ways that a home's broader systems (e.g. electrical, ductwork, furnace room layout, etc.) might be adapted to allow for a change to a heat pump or equivalent. Climate advocates repeatedly stress the imperative to communicate the idea of "the house as a system," but in a heating emergency this level of consideration literally goes out the window.

From our interviews and focus groups, two overarching drivers contributed to homeowners ending up in this situation.



First, homeowners hesitate to decommission functioning gas equipment. Many focus group and interview participants—whether motivated explicitly by financial responsibility or environmental impact—emphatically and rhetorically asked us, "Why put a perfectly good machine in the landfill?"

Second, the vast majority of the homeowners we interviewed do not have a clear asset management plan for their home, nor do they carry a formal repair and maintenance budget. The financial impact of this unexpected expenditure can be significant, which further erodes motivation to pay more upfront for a more sustainable heating system, even if doing so will save operating costs down the road. In the meantime, the heating equipment industry is optimized to provide homeowners with emergency furnace replacements on cold winter evenings, albeit at a cost. Many of our focus group and interview respondents reported—with considerable frustration—paying an "emergency fee" of up to $6,000 for this after-hours rapid response.

So while one could view the homeowner's orientation toward proactive furnace replacement as a game of chicken, more often than not they lose the game when they find out their equipment could not make it through "one more winter."

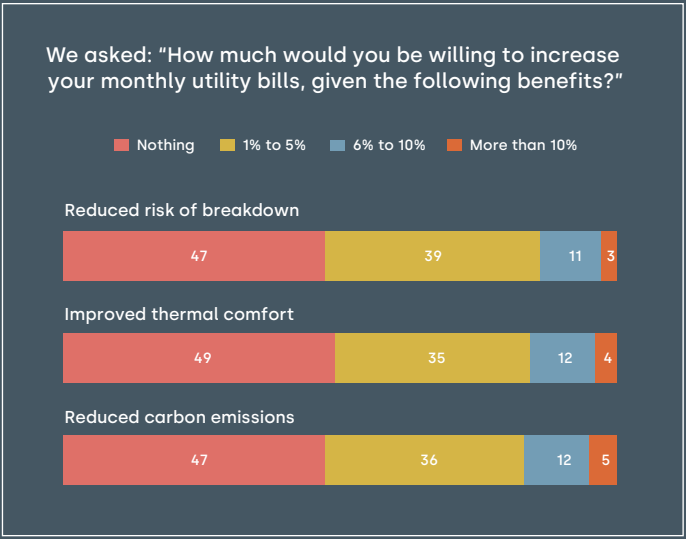
Energy Conservation Measures

The same trend toward external drivers governing homeowner action emerged for the energy efficiency portion of carbon retrofits as well. Our qualitative research into the drivers of proactive energy conservation measures revealed that, while some were triggered by an emergency response such as loss of function and damage as a result of fire or flooding, the external triggers were typically more nuanced.

We queried homeowners on the primary drivers and triggers of their home improvement projects, to understand their experience broadly and to determine the relative motivational power of climate and energy performance. Specifically, we tested the following drivers:

- improved thermal comfort in the home
- home asset value appreciation
- preventive maintenance
- energy cost savings
- environmental and climate performance

Generally, we found cost saving to be a relatively weak driver for home improvement; just 12 per cent of survey respondents indicated that they were motivated by the prospect of lower utility bills.



Our willingness-to-pay analysis also signalled that general thermal comfort and environmental benefit were modest drivers of home investment—although stronger than preventive maintenance, interestingly—with about 11 or 12 per cent expressing a willingness to pay "somewhat more" (a six to 10 per cent premium) and three to five per cent saying they would to pay "materially more" (a premium of more than 10 per cent) to increase those benefits.[13]

Instead, by far the most common driver of home improvement projects was a homeowner's desire to increase their home's *functionality.*

Specifically, the homeowner's need to modify their residence in light of high real estate prices that discouraged them from moving up to a bigger home proved the most common driver of these projects. Several interview and focus group participants told us that their home improvement projects were ultimately triggered by factors that changed how they used their home, namely:

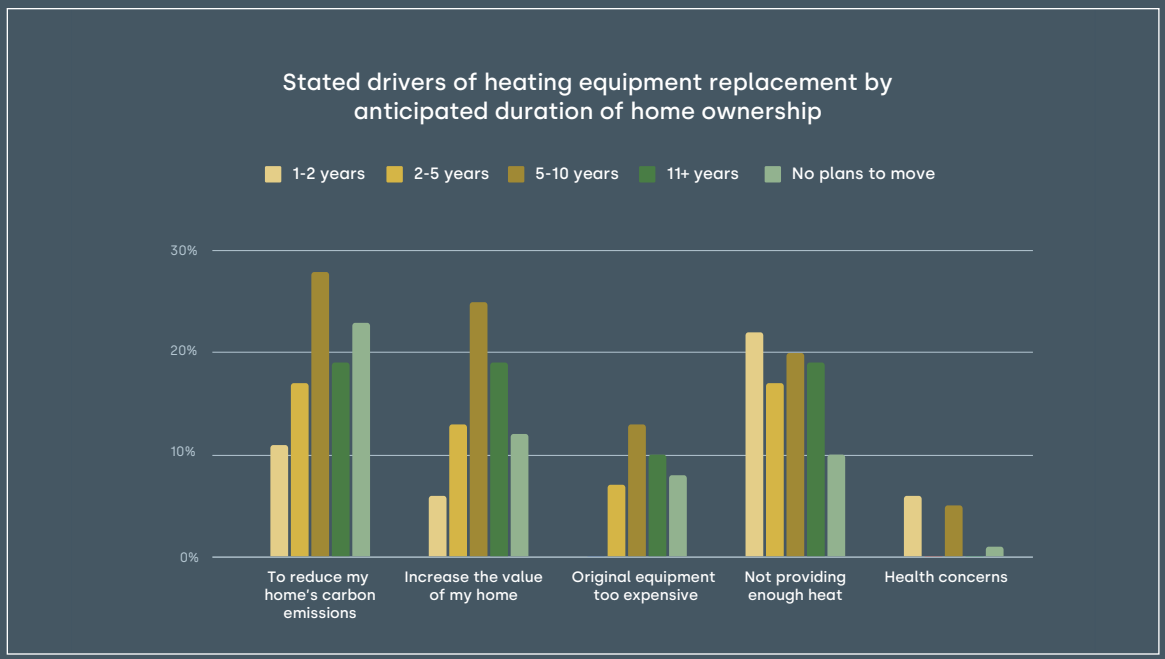
- requirements for additional sleeping and play space as families grow
- requirements for home office and other work space driven by COVID-19 and more generalized shifts in the workforce

13. While over one third of respondents indicated a willingness to pay "slightly more" (one to five per cent) for each of the benefits, we discounted those responses as likely candidates for the "intention-action gap." This is a well-documented social science phenomenon in which survey respondents consistently overstate their willingness to pay for more sustainable choices. More often than not, their support for cleaner—but costlier—options fades when they are actually asked to sign on the line.

So instead of moving up, these homeowners are adding on to, or reconfiguring, their current residence. And where the reported project scope included equipment replacement or heat retention, it tended to be less about overall thermal comfort for the home and more about a need to deliver or retain heat (or prevent overheating) in reclaimed attic or garage space.

After emergency replacement, the next most common time to replace heating equipment is during a broader home improvement or retrofit project. With respect to the value of investing in new heating systems, the market conditions described above also factor into homeowner motivations. We found clearly that homeowners tend to view investments in heating equipment replacement in general, and electrification in particular, as a longer-term investment in their home's comfort and asset value as opposed to something that would help them to sell their home—for a better price—in the near future. Some replacement drivers—such as increasing heating capacity or health concerns—were more dominant for homeowners expecting to sell their home in the next few years. Conversely, the likelihood of replacing equipment to reduce carbon emissions or utility and maintenance costs increases—often dramatically—amongst those homeowners intending to occupy their present home indefinitely.

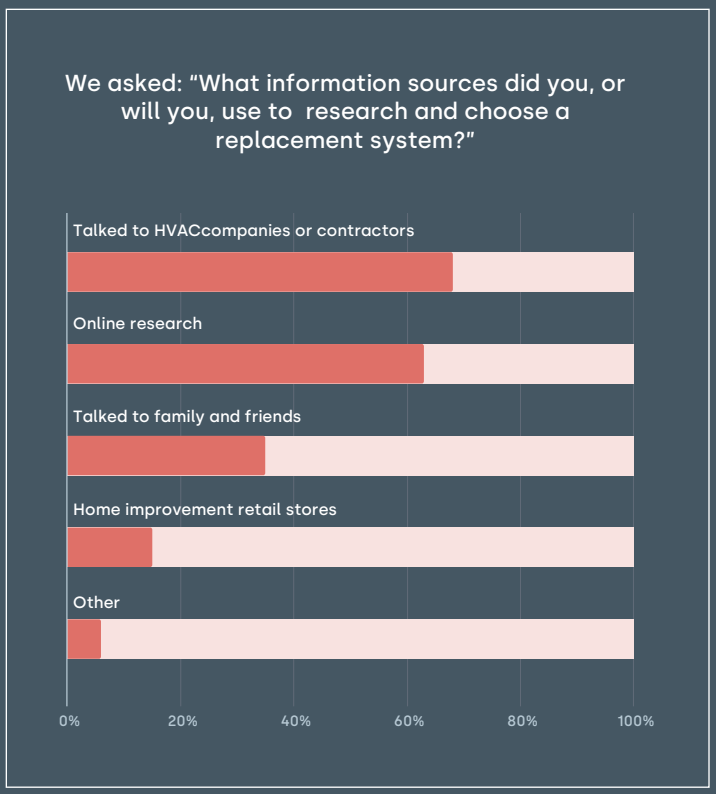
Right or wrong, many homeowners clearly signaled their belief that the market would not reward their investment in an efficient and climate friendly heating system, but several were willing to make this investment if they intended to stay in their home for a decade or more.[14]



14. These findings also suggest that the province's CleanBC Roadmap to 2030 proposal to require home energy labels at time of sale may not engage those members of the population that—at least in the present market context—are most motivated to use that information. Nor did we find strong evidence that energy costs are a material factor in home asset choices. That said, there may be other reasons to trigger mainstream home energy labeling, and it remains to be seen how homebuyers would respond to better, widespread availability of comparative home energy performance data in their overall purchase decisions (especially if governments concurrently introduce home energy performance standards or equipment replacement requirements).

The long journey from trigger to installation

As noted in the adjacent chart, contractors serve as the primary source of information and education for homeowners undertaking a retrofit journey. And in focus group conversations, they proved a topic of spirited discussion.



Many homeowners rated their renovation or retrofit experience as frustrating and the results less than satisfactory. They also reported:

- feeling alone in the information collection process, and struggling with the dissonance and confusion of different prescriptions from different contractors;
- having a very low response rate from contractors, particularly those with time sensitive, smaller, and/or more complex projects;
- feeling disempowered because they were relying very heavily on the one or two contractors that would take the job—despite reservations about the suitability of the recommended solution, or the quality of the contractor installing it; and
- feeling that they were just getting the solution that the contractor could offer, instead of the right one for them and their home.

In short, many would-be residential carbon retrofit projects stall, lose ambition, or never get off the ground because contractors either do not call homeowners back, ghost them part-way through the process, or talk them into the conventional options that will keep the heat flowing but not address climate impact.

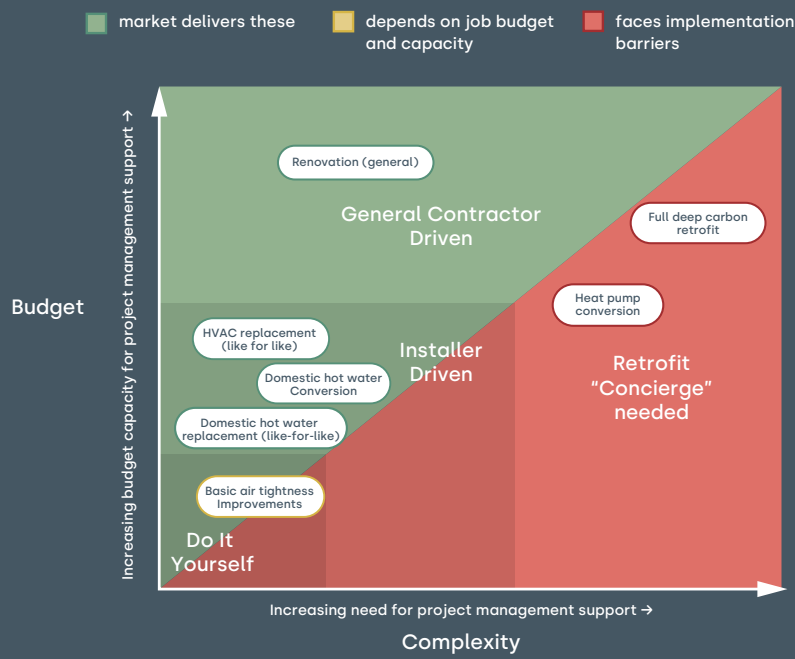
This is likely a function of many considerations, including the scarcity of qualified contractors for carbon retrofits, the homeowners' primary reliance upon them from start to finish, and the poor business case for contractors that this entails. In short, there are too few qualified contractors in the carbon retrofit space, and homeowners rely upon them too heavily throughout the journey from broad information collection to specification and installation. (See: "Unpacking the homeowner mindset," page 16.

On the flip side, our participants reinforced that contractors were more responsive and more likely to follow through when the revenue from a prospective project outweighed its complexity. Homeowners with larger, well resourced projects reported much higher satisfaction and attention—particularly those that involved a general contractor playing a continuous, coordinating role.

All of this points to the need for both a sharp increase in industry capacity, a system that makes smaller projects more attractive to contractors, and additional and more objective sources of information and support for homeowners. As noted in our "Recommendations" section, below, these findings strongly reinforce the concept of a "retrofit concierge" as a way to introduce continuous homeowner support and/or project management throughout the homeowner journey, from (ideally proactive) trigger, through education, diagnostics, specification, sourcing, and installation.

In the absence of such solutions, projects of relatively high complexity but without the overall project budget to support outside coordination either get simplified to conventional projects (i.e. like-for-like replacements with little carbon performance improvement) or run out of momentum entirely. We capture this in the diagram below.

The critical support gap (the case for a retrofit "concierge")



The green area of the diagram depicts relatively straightforward home maintenance and improvement jobs that tend to get done without issue. In contrast, the red area highlights more complex projects that are less appealing to many contractors because the job's complexity currently outweighs the business case for taking them on. Based upon the input of the homeowners who participated in our research, carbon retrofit projects require a new form of homeowner and industry support to become viable.

At the meter, natural gas is cheaper than electricity

As a result of BC Hydro's tiered residential rate structure, British Columbia homeowners who choose to electrify will likely end up paying more month-to-month for electricity than they did for natural gas. While homeowners are not particularly concerned with their current utility bills, they clearly aren't thrilled about the marginal cost difference between gas heat and electricity heat.

Knowing this, we asked homeowners if they would be willing to pay a small premium for their heating and cooling bills, even if doing so would mean improved comfort or an opportunity to shrink their home's carbon footprint. As noted in the diagram on page 19, while a sizable minority of roughly 17 per cent said they would, the majority politely declined. This underscores that relying on voluntary measures to drive decarbonization will only get governments so far, and additional regulation is required to transform these outcomes.

Affordability pressures are hindering pace and scale of retrofits

Setting aside the monthly cost differential issue, affordability challenges are impacting the overall pace and scale of residential carbon retrofits. Many households in our study group are grappling with high mortgage costs and not carrying a contingency budget for home maintenance and improvements. A residential carbon retrofit is far down the list of homeowner priorities compared with increasing the functionality of their current space—even with the incentives currently available. With the dramatic rise in inflation since the interview period, the financial headwinds for proactive replacements and retrofits are likely even stronger.

As such, for home improvement projects that are happening anyway, using rebates and other subsidies to reduce the marginal cost of decarbonization and energy efficiency is a necessary first step. But to boost the total number of projects, and overcome the financial barriers to taking on any non-emergency home improvement work, financial and other support needs to go much deeper.

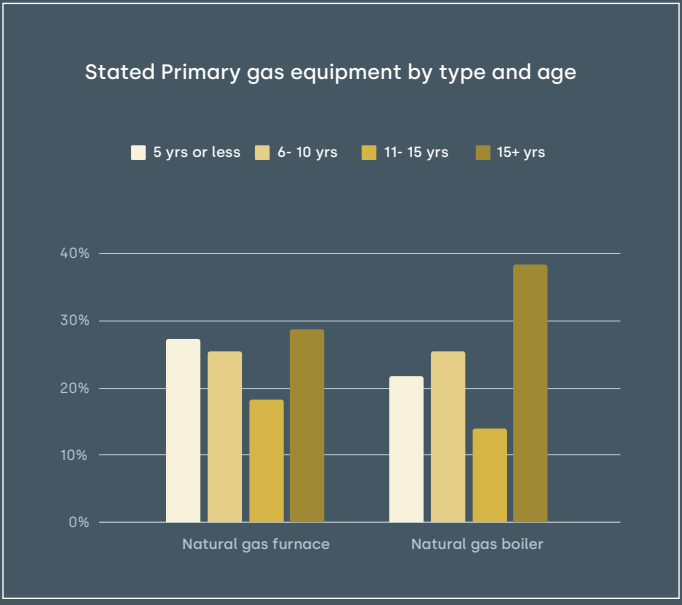
Homeowners conflate "energy efficient" with "low carbon"

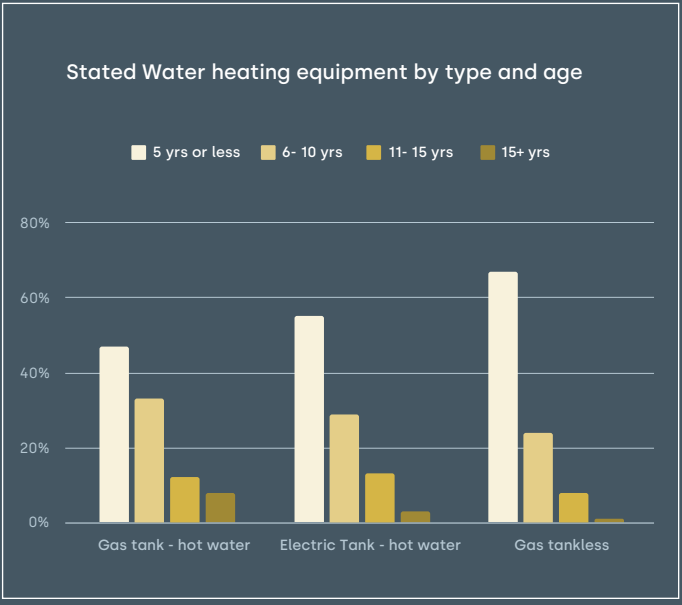
Our focus group discussions revealed that homeowners are largely unaware of the difference between energy efficiency performance and emissions performance. That is to say, while many understood natural gas to be a fossil fuel, contractors convinced them that a new furnace would nonetheless be an environmentally friendly replacement for their old one, because modern gas equipment is exceptionally energy efficient. Governments and program managers should address this in any homeowner education or outreach materials to ensure homeowners are making fully informed choices in the market.

British Columbia can meet its 2030 climate goal by incentivizing or requiring the replacement of gas equipment that is already on its last legs.

Approximately 14 per cent of survey respondents indicated that they had replaced a primary space heating system in the last two to three years, or roughly five per cent per year on average. We can validate this through the age distribution of the equipment in our dataset: 29 per cent of natural gas furnaces and 38 per cent of gas boilers are at least 15 years old. Another 18 per cent of furnaces and 15 per cent of boilers are currently between 11 and 15 years old and headed into the "high risk" (15+ years old) category.

We note that British Columbia can get close to its 50 per cent replacement target by 2030 just by swapping out the natural gas equipment that is at high risk of failure anyway, and overcoming homeowners' objections to decommissioning old but (presently) functional equipment.





Homeowners may nonetheless need a push

Despite the fact that more than a third of operating natural gas space heating systems are living on borrowed time, only about half this number (18 per cent) of homeowners indicated that they are considering replacing their primary home heating system within the next two to three years.

Given that home heating equipment of any kind represents a major household spend, and especially considering recent inflationary pressures on household budgets, we can safely conclude that many homeowners won't replace their operating equipment before it burns out without additional motivation to do so.

A renovation boom opens a window for carbon retrofits

Our research reveals that energy efficiency measures and equipment replacements often get "pulled along" in broader renovation projects which are ultimately governed by home functionality and enjoyment. Decarbonization alone is rarely a primary driver.

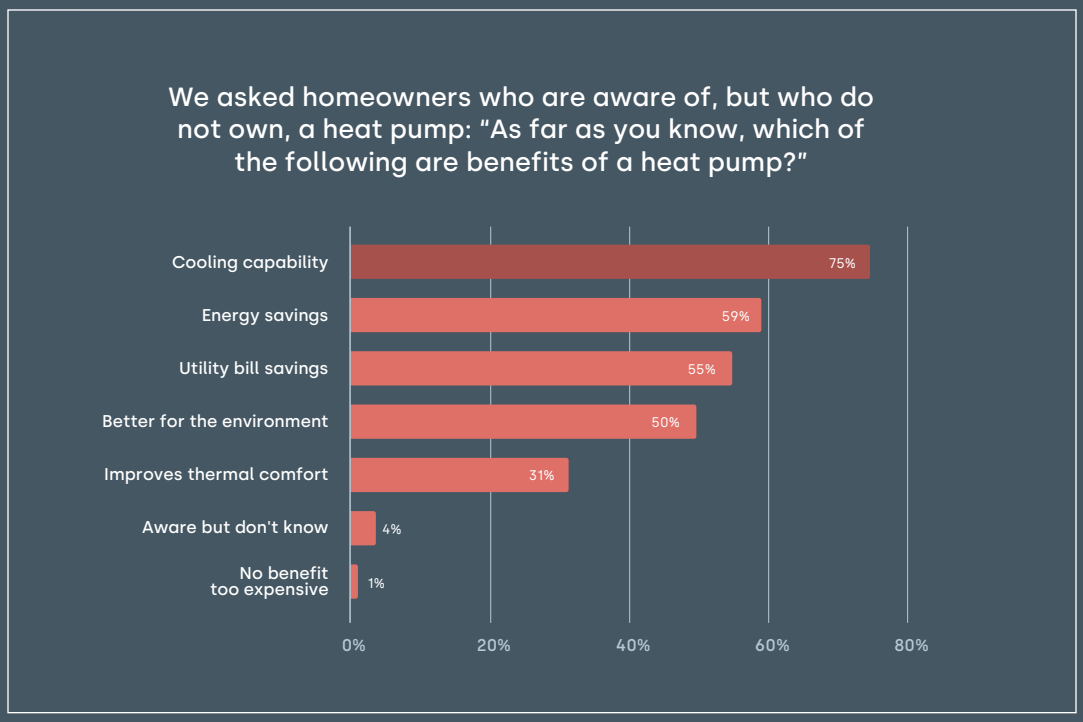
We have also seen that, since 2020, homeowners in southwestern British Columbia have begun investing in their existing residences in far greater numbers, driven by changing usage patterns and family conditions, historically high property values, low interest rates, or some combination of the above. This presents a key opportunity to reach homeowners during an active stage of home improvement and drive incentives (and possibly requirements offset with incentives) to homeowners through the permit process.

Some homeowners aren't sold on a heat pump, and here's why

Of those homeowners in our study who do not presently own an electric heat pump, 30 per cent are considering investing in one in the next five years. Of the 53 per cent who reported no plans to purchase a heat pump, two reasons dominated the list. First, the respondents considered the equipment too expensive, and second, they were uncertain if their home could accommodate a heat pump. Other rationale included overall unfamiliarity, cost of operation, and potential noise concerns.

Homeowners are getting the memo on heat pump cooling capability

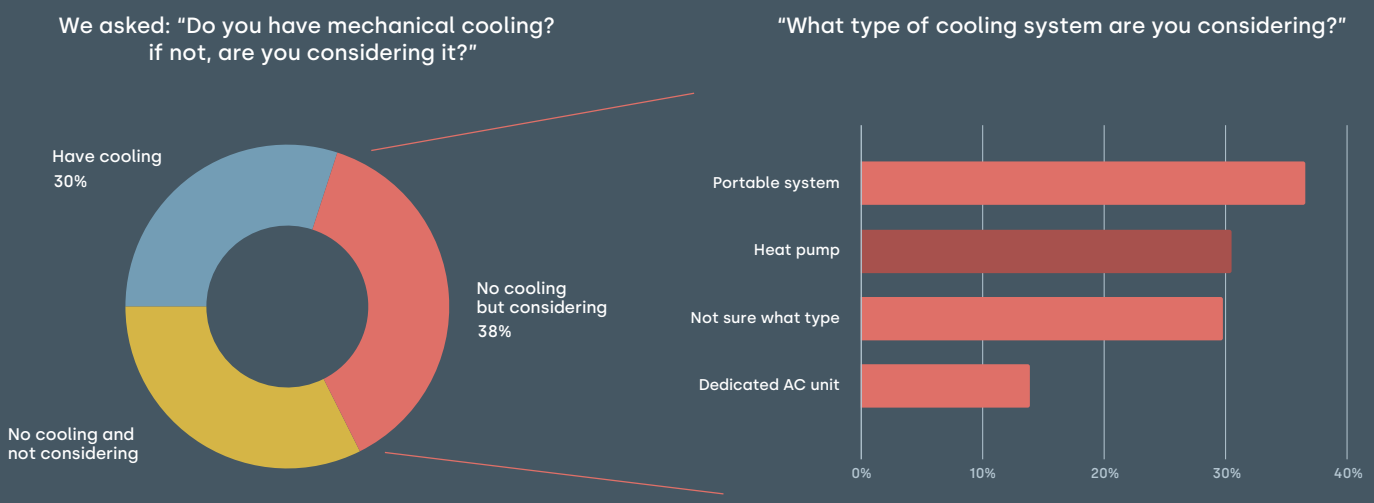
Due to our study area's historically temperate climate, active cooling systems remain fairly uncommon. Overall, just 30 per cent of southwestern British Columbia homeowners reported having a household cooling system. However, another third stated that they intend to install one in the coming three years. This latter number is significant, because if all of these homeowners followed through and did so, the total number of such systems would effectively double the installed base. We conducted our survey work in the winter, several months after the June 2021 heat dome event. Insofar as major heat events trigger shifts in buyer intentions, this suggests a shift that is persistent, beyond the immediate experience or memory of living in considerable discomfort.



The incidence of existing cooling systems varies throughout our study area, with the highest concentration located in the Fraser Valley (48 per cent), followed by Victoria (41 per cent), and the Lower Mainland (26 per cent). Larger and newer homes are more likely to feature built-in cooling, while owners of smaller homes generally rely on portable units.

Unsurprisingly, all heat-pump owners use the systems for both cooling and heating.

Amongst homeowners who do not have a heat pump but expressed awareness of the technology (almost all survey respondents), an overwhelming majority (75 per cent) understand that the equipment can cool their home as well as heat it. This is consistent with the overarching homeowner orientation of prioritizing functionality when making home and equipment performance decisions (over cost, asset value, or environmental factors, for example).



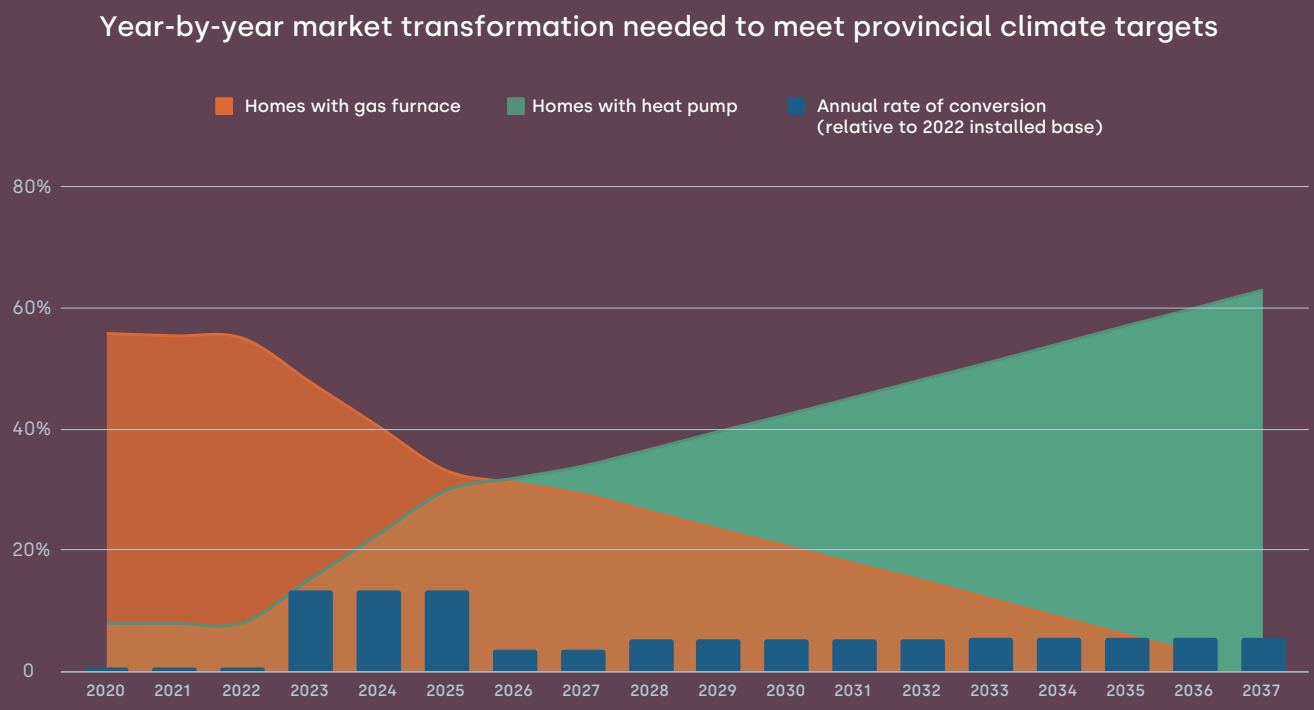
This also suggests that the message about the full benefit of the equipment is reaching its audience, contrary to the perception of some advocates who believe the term "heat pump" may lead homeowners to conclude that the systems can only provide indoor warmth. Whether this "conventional wisdom" was always incorrect or this is a recent change as a result of marketing campaigns and market maturity, southwestern British Columbia homeowners are now aware of and motivated by the technology's cooling capability.

In fact, half of the respondents who lack a cooling system are considering getting one, with 30 per cent of this group indicating their preference for a heat pump over other air conditioning options (and another 30 per cent not knowing where to start). Most who expressed interest in active cooling currently run natural gas heating systems, and most have larger single-family homes. Therefore the subset of those considering a heat pump for its cooling capabilities are also strong candidates for successful installation (and furnace replacement) based upon home type.

Profound structural barriers are keeping the pace of home electrification to a slow trickle.

When it comes to home electrification, the central finding of our research is that carbon retrofitting—specifically, electrifying—a home is challenging and requires planning, but most homeowners are reactive rather than proactive. Approximately 60 per cent of heating equipment replacements occur following a furnace or boiler failure, or when a homeowner comes to believe that burn-out is imminent. This tends to result in quick, like-for-like installations that lock in fossil fuel combustion for another generation.

As a result, we call upon policy makers, program designers, and others with a systems-level scope to take the following key actions to transform the home energy equipment marketplace in a way that is beneficial for homeowners, industry participants, and our shared climate imperatives.



To reach our provincial, regional, and local government emissions reduction targets, we need to rapidly decarbonize our residential building stock, starting immediately. As this diagram shows, the pace of gas-fired equipment replacement must at least double. And instead of 99 per cent of these replacements resulting in another gas system, we need all of them to be high efficiency electric alternatives.

1. Send the market a strong signal to decommission old gas-fired heating equipment in favour of heat pumps and other high efficient, electric alternatives

Provincial, regional, and local governments must send a clear signal to the market that residential natural gas will sunset, while providing homeowners with more information and more choices and improving the business case for contractors to pursue residential carbon retrofits. As indicated by the sluggish pace of equipment replacement today, a time of replacement policy is a necessary, but wholly insufficient, step.

Governments also need to provide a regulatory mechanism to incentivize or require homeowners to replace equipment that is 15+ years old and thus at high risk of failure. The province can remove 63 per cent of existing furnaces and 68 per cent of existing boilers by 2030 just by removing this vintage equipment from the market.

2. Address electrification affordability

As noted throughout this document, in order to meet the decarbonization gap, we don't just need to change the type of equipment replacements, we also need to increase the pace of replacements. And that means—among other things—making home-performance investments more affordable.

This report has presented a range of findings for why only four to five per cent of the province's gas-primary homes replace their equipment each year. A critical one, which emerged throughout our research, is the cost of capital upgrades to households that are already grappling with inflation and high real estate prices, and usually lack an asset-management budget.

Our interviews and focus groups consistently revealed that while homeowners—particularly city dwellers—already have access to various forms of relatively cheap financing, they are strongly averse to taking on debt for home improvements in general, and energy and carbon improvements in particular. For homeowners to proactively remove equipment that is 15+ years old—or engage positively with electrification requirements—policy makers must tackle the complexities of the retrofit process, and also reduce the financial burden of these projects on households.

Our quantitative research demonstrates that rebates help encourage homeowners to choose more energy and carbon efficient options for a given improvement project. But we urge policy makers and program designers to go beyond just targeting cost parity with conventional replacement and retrofit projects that are happening anyway, and to stimulate new retrofit projects that homeowners would otherwise consider too costly.

In short, while finding innovative ways of delivering low cost financing to households is likely to add value, it does not address the fact that—for the vast majority of homeowners we spoke with, and especially for lower income households—the critical affordability gap is not between loans at zero per cent interest or market rate. Aversion to taking on additional, repayable debt is high, period; and the argument for utility cost savings alone justifying these investments is (quite rightly) seen as weak.

We thus encourage policy-makers and finance providers to promote investment mechanisms that do not add significantly to the operating expense burden of homeowners. There are a range of candidate approaches, including patient capital models linked to home equity, third-party financing models, or simply offering a deeper subsidy to stimulate the decarbonization of the province's housing stock. As an example of the latter approach, the CleanBC Income Qualified program offers a good starting point in helping lower income homeowners make these investments in the health of their home and our collective climate.[15] The Atlantic provinces have long managed extensive and successful heat-pump retrofit programs for low-income households that previously ran on heating oil.[16] We urge British Columbia decision makers to access their expertise.

3. Develop a home electrification concierge service

The homeowner retrofit journey is currently fragmented and overwhelming, particularly for relatively small but highly complex jobs that don't financially justify a general contractor in a coordinating role. In our focus group discussions, homeowners repeatedly and emphatically expressed interest in a "carbon retrofit concierge" who could assist them through the electrification process. When asked what services such a service might provide, they indicated general education, a home-specific diagnosis and prescription, followed by sourcing of solutions. At present these services are either jumbled together, disconnected, or simply unavailable.

The current approach relies heavily on homeowners to navigate a complex system and assemble the puzzle pieces. Taken from the industry perspective, contractors tell us that they invest a tremendous amount of time supporting homeowners through the education process, only to find that few move quickly forward with the project once its complexity comes into focus. This takes them away from their core work of doing viable installations, and makes the business case for electrifying older homes more challenging relative to traditional like-for-like gas replacements.

This "trusted concierge" would play a similar role that a general contractor would on a larger project, ensuring trades show up, specifying and sourcing equipment, and ensuring that installation and set-up is successful.[17]

4. Accelerate contractor accreditation process and provide consumer transparency

Homeowners expressed strong demand for heat-pump-installer accreditation and access to third-party customer ratings. As noted earlier in this report, they also shared deep frustration with their efforts to even find a knowledgeable contractor willing to take on an electrification project, tackle its complexities, and see it through to completion.

Fortunately, at least on the latter front, help appears to be on the way. In British Columbia, the Home Performance Contractor Network (HPCN) qualifies residential heat-pump installers. While its ranks of certified contractors were thin when we began producing this report—its database listed just five installers serving the City of Vancouver—their numbers are about to swell.

As of July 1, under provincial government regulations, homeowners who wish to receive a rebate from select programs must use an HPCN member for the installation. As we finalized this report, with that deadline approaching, the network confirmed that 70 heat pump contractors are now qualified members with nearly 500 more working to complete its accreditation process. This rush of contractors to qualify for the program underscores how a clear signal from the province can drive market transformation.

An opportunity now remains to incorporate third-party reviews on the HPCN database of approved space- and water-heating contractors—as consumers have come to expect such reviews for numerous other trade and professional services.

5. Continue to highlight the cooling advantage that heat pumps offer

Our research noted a significant new demand for mechanical cooling, and many now understand that a heat pump can cool a home. This represents a large opportunity to promote heat pump adoption. The message that heat pumps can provide cooling is reaching homeowners, and is the lead driver of interest in electrification.

6. Boost awareness of the climate impact of gas water heaters

While fewer than 22 per cent of survey respondents cited concern over greenhouse gas emissions as even a secondary consideration for why they may wish to replace their space heating equipment, the proportion for domestic hot water equipment is even lower. Just four per cent of respondents cited climate as a consideration.

While gas water heating contributes a smaller portion of a household's gas consumption than space heating – roughly 35 per cent in the case of a typical gas-heated tank—this is still material, and arguably much easier to change than a heat pump conversion.[18] At the very least, overcoming this apparent knowledge gap may prove a leverage point in any campaign or program targeting residential decarbonization.

7. Reassure homeowners that gas equipment will be recycled

Whether the stated reasons were cost, financial waste, or environmental ("perfectly good appliance ending up in the landfill"), our focus group and interview participants stated clearly, consistently, and fervently that they did not want to decommission and dispose of operating natural gas equipment. This suggests that any program that aims to accelerate the removal of still-functioning residential space or water heating equipment should address operational versus embodied impact of gas equipment and messaging on end-of-life stewardship.

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15. BC Hydro has been reportedly looking at different ways to increase heat pump supports for low-income households but as of the publication of this report, has yet to release any implementation details or a timeline for roll-out.

16. In particular, Efficiency Nova Scotia.

17. At the time of this report production, we identified one retrofit concierge service in the market; it is only available to homeowners in Squamish and Whistler.

18. Natural Resources Canada, National Energy Use Database, Table 2: "Secondary Energy Use and GHG Emissions by End-Use, Residential Sector, British Columbia." 2018 Data.

"A massive scale-up of residential carbon retrofits will be essential if British Columbia is to realize its 2030 climate target and 2050 net zero targets."

Even with existing supports, residential carbon retrofits are inherently complicated and expensive projects, and energy cost savings alone are a weak driver to justify them. Our research shows that homeowners have little motivation to take them on—particularly when they have "perfectly good heating equipment" that they believe will get them through another winter, and when they have other spending priorities.

And yet a massive scale-up of residential carbon retrofits will be essential if British Columbia is to realize its 2030 climate target and 2050 net zero target. This is a classic systems-level challenge requiring systems-level solutions. And the central finding of this research project is that these are challenges of information, motivation, and incentive for both homeowners and industry participants alike.

These challenges are rooted in the structure of the retrofit industry, and cannot be solved simply with new, cheaper forms of debt financing. Homeowners in southwestern B.C. already have abundant access to cheap, real-estate-backed debt. They also consistently shared their aversion to going (even further) into the red to achieve energy or carbon savings. So the financial hurdle is not simply between providing repayable debt at zero per cent interest or market rates. We must instead be willing to incentivize the proactive replacement of gas-fired systems, reduce the overall burden of complexity on homeowners, and drive down costs through market efficiencies, rebates and other incentives, and then creative, patient forms of capital.

In short, we won't have a capital problem unless we first successfully address the structural problems.

The Province of British Columbia will soon be opening consultations on a scheme that will allow local governments to regulate carbon pollution from existing buildings. This is an encouraging development, as to date governments have relied on education campaigns and voluntary incentive programs to do the heavy lifting of residential electrification. While rebates, energy labeling, and education campaigns are certainly helpful, the buck must not stop there. Profound inertia of the current gas-focused model, the complexity of required changes, cost differentials, and industry pushback render such initiatives inadequate to meaningfully accelerate residential carbon retrofits.

In short, the research summarized and analyzed in this report points to an imperative for policy leadership. To reach our provincial, regional, and local government emissions reduction targets, we need to rapidly decarbonize our residential building stock. This means increasing both the ***pace*** and ***nature*** of heat and hot water system replacements across the province. The pace of gas-fired equipment replacement must at least double. And instead of 99 per cent of these replacements resulting in another gas system, we need 100 per cent to be high efficiency electric alternatives.

Policy makers must quickly phase out gas-primary space and water heating systems. To reach the 2030 targets, this "simply" requires replacing the 61 per cent of gas-fired furnaces and 68 per cent of gas-fired boilers that are already approaching the end of their service life. This is a tremendous opportunity, and homeowners and the retrofit sector require clear leadership and guidance to make it happen.

Residential carbon retrofits require a multi-layered policy response, including new regulation, to send a strong signal to the market and supplement the current voluntary-focused approach. This should include a clear signal from the provincial government that residential natural gas will eventually be phased out. It requires political courage and a funding commitment many orders of magnitude larger than current allocations.

In the absence of clear and aggressive new regulation, coupled with strategic and major program support for the industry transition, residential carbon retrofits will continue to stumble along as exceptions to the rule, and the province will not likely meet its climate targets. The deck is presently stacked against even the most motivated of British Columbia homeowners, and only a significant regulatory intervention will unleash carbon retrofits at the needed scope, scale, and speed.

"Only a significant regulatory intervention will unleash carbon retrofits at the needed scope, scale, and speed."

APPENDIX 1: RESEARCH METHODOLOGIES

This report is based on the findings from three separate public opinion research projects. We summarize their methodologies here.

Focus groups

We hosted three 90-minute focus group discussions with four people per group, and paid each participant a $150 stipend. Our enquiries sought to understand the barriers that homeowners face in renovating their homes and the factors that motivate them to undertake a reno project. To ensure an unbiased communication of motivations and drivers, the research team did not name OPEN Technologies as the sponsor of the research nor communicate that energy and carbon savings were at the root of our research interests. We configured the groups to ensure cultural, generational, and economic diversity, and hosted the conversations in July and August 2021.

Online surveys

The surveys consisted of 750 surveys (n=750)—plus an additional 125 Vancity members in a parallel survey—with owners of ground-oriented homes in British Columbia's Lower Mainland, Fraser Valley, and southern Vancouver Island. We conducted them in December 2021 and January 2022 in a bid to better understand the installed base of space and domestic hot water heaters by type, energy source, and age, as well as the motivational drivers affecting their likelihood to change. We screened for homeowners who have direct control over the use and selection of their heating equipment.

Twenty seven per cent of our survey respondents reported owning an attached-style home such as a townhome, duplex, or triplex, while 74 percent reported owning a single-family-detached house.

In-depth interviews

We also conducted extended interviews with a sample of a dozen homeowners who had recently undertaken or attempted a renovation or retrofit project. We conducted these interviews to better understand the journey from triggering event to project completion, and the experiences and emotions that this process evoked. We used these findings to define the stages of the homeowner retrofit journey, and to add additional insights and nuance to our quantitative findings.

As with the focus groups, the research team did not introduce OPEN Technologies as the research sponsor or communicate that energy and carbon savings were at the root of the research interests.

Greenhouse Gas Equivalencies Calculation

According to Statistics Canada, the average B.C. home that heats its space and water with natural gas emits 4.9 tonnes of $CO2_e$ per year. According to the United States EPA Greenhouse Gas Equivalencies calculator, this quantity of emissions is equivalent to that produced by a typical gasoline passenger vehicle driving 12,163 miles, which is 19,574 kilometers. The driving distance from Vancouver, British Columbia to Halifax, Nova Scotia is 5,791 kilometers. Therefore, one would need to drive the distance between Halifax and Vancouver three times.

APPENDIX 2: ABOUT OPEN TECHNOLOGIES

OPEN Technologies develops data-driven software tools to help the people that shape our cities to make pro-climate decisions with confidence. This includes a range of tools to reduce the market friction that often hinders regulatory innovation by various levels of government. Our core focus is the aggregation of attribute and energy data from thousands of buildings or homes, to help governments and capital providers direct resources to their greatest impact.

Visit us at opentech.eco/#services for more information.

Our work includes, but is not limited to:

GRID Benchmarking and Disclosure Platform – Since 2019, cities and provinces across Canada have used GRID to ensure a consistent, rigorous framework for running energy and carbon benchmark programs. The data insights that GRID provides help to drive resources to where they can achieve the greatest climate benefit, whether for an individual property or for thousands of buildings at a time through smart policy and capital deployments.

Green building product market analytics – The trend toward higher performance standards for new or existing buildings changes the market for building components, products, and equipment. We built Shift to help industry participants, capital providers, and policy makers to see and interact with market forecast information for key product categories as performance and building standards change.

Model-driven decision making tools for design optimization and/or retrofit planning – As jurisdictions introduce higher performance standards for new buildings, builders and designers seek insight on the most cost effective path to a target performance level; meanwhile homeowners and property-owners seek information to help them respond to retrofit programs. OPEN has a number of tools to support both design optimization and retrofit project selection.

Custom projects – OPEN's expertise as a web-tool developer with strong data management and data visualization/interaction skills leads to us being engaged for custom projects by a range of partners across the green building spectrum.

June 2022