Deep Emissions Retrofits

Decarbonization via Building Electrification

EXECUTIVE SUMMARY

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This project was conducted under the mentorship of Zero Emissions Building Exchange (ZEBx) staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of Zero Emissions Building Exchange (ZEBx) or the University of British Columbia.

Territory Acknowledgement

The author acknowledges that the work for this project took place on the unceded ancestral lands of the xwməθkwəy̓əm (Musqueam), Skwxwú7mesh (Squamish), Stó:lō and Səl̓ílwətaʔ/Selilwitulh (Tsleil- Waututh) Nations.

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Introduction

The objective of the project was to develop articles on advancing deep emissions retrofits by analyzing four retrofit cases- three Part 9 detached home retrofits & a limited scope, domestic hot water retrofit on a Part 3 commercial building. Each article dealt with a case with different design challenges, aiming for differing levels of performance, and provides guidelines, opportunities, and barriers towards adoption of high-performance design strategies in the lower mainland region. As per Vancouver's Climate Emergency Action Plan[1] (CEAP), space heating and domestic hot water needs have been identified as the two largest contributors to overall building GHG emissions, and these articles provide details and insights into the challenges and benefits of adopting electric equipment, leading to healthier, decarbonized buildings. The articles would be further developed by ZEBx, incorporating new information from the construction and occupancy phase for some projects, and will be promoted on the ZEBx website as "Deep Emission Retrofit Dialogue Series", launching in Fall 2021. To achieve the city's climate goals, these articles would serve as educational material, encouraging and supporting the industry professionals and homeowners in the British Columbia to opt for electrical heating and hot water equipment to utilize British Columbia's green, hydroelectric power source.

Background

In November 2020, Vancouver city council passed the Climate Emergency Action Plan (CEAP), which shows how an estimated 54% of all Vancouver's carbon pollution can be attributed to natural gas use in buildings and tackles it by dedicating one component of the plan to target the operational carbon emissions in Vancouver's buildings. The plan, in conjunction with the BC Energy Step Code[2], which sets the energy performance targets for all new buildings towards net zero operational emissions by 2032, serve as a practical roadmap to successfully combat the climate crisis, helping the province of British Colombia to emerge as a leader in sustainability. ZEBx is dedicated to support the industry through this transition, acting as a catalyst that transforms the entire design and construction value chain towards cost-effective, attractive, zero emission buildings. By providing these articles to newcomers and veterans of the industry alike, it helps create guidelines and best practices.

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[1] Vancouver, C. of. (2020). *Climate emergency action plan*. City of Vancouver. https://vancouver.ca/green-vancouver/vancouvers-climate-emergency.aspx.

[2] How the bc energy step code works: Energy step code. Energy Step Code | Government of British Columbia. (2021, January 21). https://energystepcode.ca/how-it-works/.

Methodology

The articles were drafted by primarily utilizing the information collected by ZEBx under the ZEBx's Near Zero program. The information was collected through 3 separate questionnaires – Design, Construction & Occupancy, as well as individual interviews and email correspondence with the project teams. As each questionnaire pertains to a particular phase of the retrofit project, not all questionnaires were available for analysis during the drafting of these articles, since many of the projects are still active and at varying levels of completion. The scholar, under the mentorship of ZEBx employees, derived key themes from the collected information which highlighted interesting design decisions and unique constraints and converted them to initial article drafts. As more information becomes available over time, these draft articles would be further developed by ZEBx to launch in their newsletters.

Summary

In the first article, the project team was hired to do a CHBA net-zero energy retrofit[3] on a "Vancouver Special", located in a residential neighborhood in East Vancouver. The existing house showed great promise for a high-performance net zero emission retrofit, particularly due to a simple form and a roof which receives unobstructed sunlight throughout the day, The design of the retrofit was geared towards providing a consolidated, multi-generational living experience, and so the retrofit design paid special attention towards factors such as thermal comfort, indoor air quality and noise reduction to provide a high quality of living for the occupants. By retaining and incorporating the house's structural elements back into the retrofit design, improving the existing envelope using high performing windows and insulation, adding a high-efficiency HVAC system, and achieving building electrification through heat pump and solar power, the project aims to reduce both embodied and operational GHG emissions. The design estimated the building performance to be compliant with Step 5 of the BC Energy Step Code, future-proofing the value of the house by complying with future building code demands.

In the second article, the project started off as a simple renovation for an existing house, located on a quiet spur road in northern Squamish. The existing home was originally built in 1981 and had undergone at least two prior major addition/renovation cycles before the current one. As the design phase continued, the owner learnt more about the concept of high-performance housing & construction, and the project scope morphed into a full high-performance retrofit over time,

[3] Association, C. H. B. (n.d.). Canadian home Builders' association. Net Zero Renovations- About PACE. https://www.chba.ca/CHBA/Housing_in_Canada/Net_Zero_Energy_Program/Net_Zero_Renovations.aspx.

eventually receiving the Built Green Canada Platinum Status[4]. The existing structural components of the house were retained, and the rest of the building was stripped to the studs from the interior, reusing material when possible, leading to a substantial reduction of embodied emissions over a new construction. To achieve thermal comfort and airtightness, the design aimed to achieve a highly insulated building envelope using high performance glazing, minimizing air leakage through blower door testing and aerosolized sealants. Using a heat recovery ventilator, the team achieved high interior air quality with minimal increase in the energy use, aiming for a building performance compliant with Step 4 of the BC Energy Step Code.

The third article discussed a retrofit project on a pre-1940s single family house, located in Kitsilano, possessing character merits with heritage value to the city[5]. The existing house had its rear unit facing south with no shading, resulting in overheating in the summer, and had poor air quality as typical of a design of its time. The retrofit strategy centered around providing high levels of thermal comfort and indoor air quality using the most sustainable approach, and so the project aimed to achieve the EnerPHit certification[6], awarded by the Passivhaus Institute. Under the guidance of a Passive House Certifier, the retrofit design retained the existing structure, massively improved the envelope of the house, decommissioned the central gas and wood burning fireplaces, and used passive cooling strategies with limited electrical heating equipment to significantly reduce emissions over a new construction. The retrofit design faced two distinct set of challenges as they aimed to achieve the stringent performance targets set by the EnerPHit standard while dealing with the added deconstruction and material reuse requirements of a character merit house, serving as a great example of the complexities when retrofitting older houses.

The final article was a limited scope, domestic hot water retrofit on a 26-story commercial building, originally built in 1968, looking to replace its aging, natural gas powered, domestic hot water heating system. The hot water system contained three domestic hot water loops, where the lower loop services floors 1 to floor 10, upper Loop services floor 11 to floor 26 and the final loop exclusively serves the showers for change rooms in the building. The retrofit focused on replacing the riser piping and heating equipment for the upper and lower loops, replacing the existing single gas-fired boiler with air source heat pumps to make use of the British Columbia's

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[4] Renovations. (n.d.). https://www.builtgreencanada.ca/renovations.

[5] Vancouver, C. of. (n.d.). *Character home retention incentives program*. City of Vancouver. https://vancouver.ca/home-property-development/character-home-zoning-review.aspx.

[6] Institute, P. H. (n.d.). *Passive house INSTITUTE*. Passivhaus Institut. https://passiv.de/en/03_certification/02_certification_buildings/04_enerphit/04_enerphit.htm.

low-carbon hydroelectricity system, effectively removing all carbon emissions from the hot water heating system of the building. The retrofit was done over the course of a few weekends, and the entire system was replaced without any disturbance to the regular building operations. Impressed by the GHG reductions of this limited scope retrofit, the building is now considering a full scope energy retrofit of the whole building.

Conclusions

Each article details a unique retrofit case and discusses key themes to educate the reader about the possibilities, challenges, and necessity of adopting high performing design strategies and equipment to achieve the performance targets required to successfully combat the climate crisis. The articles will be launched with the ZEBx newsletters and published on the ZEBx website, and would help educate homeowners, industry professionals and newcomers about high performance retrofits by analyzing different retrofit cases, each with their own constraints and challenges, and provide best practices and guidelines to achieve the required building performance targets. By creating awareness about the barriers and opportunities of deep emissions retrofits, the articles aim to act as a catalyst towards achieving a greener, decarbonized city.