INVESTIGATING ENERGY EFFICIENCY REQUIREMENTS ASSOCIATED WITH AFFORDABLE HOUSING FUNDING PROGRAMS

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Executive Summary

Federal funding programs for affordable housing projects, typically administered by Canada Mortgage and Housing Corporation and the Federation of Canadian Municipalities, almost always outline high energy efficiency as one of their environmental objectives. Thus, housing providers who are seeking to secure funding from these organisations must pledge to create energy efficient buildings. However, it is still not entirely clear to all what is meant by "an energy efficient building".

One way to address this lack of clarity is by critically examining the specific energy efficiency targets that are required to be met by any new build project that seeks to be eligible for funding from these sources. This report presents an investigation and analysis of the energy efficiency requirements of three funding programs that target affordable housing projects: the National Housing Co-Investment Fund, the Rental Construction Financing Initiative, and the Federation of Canadian Municipalities' Green Municipal Fund. Further, this research details some requirements for energy models and discusses reasons why funders have stipulated conducting an energy modelling study prior to construction as a prerequisite for eligibility.

Firstly, the report contains a review of literature that discusses increased energy consumption in the building sector, and the efforts to incentivise the achievement of higher energy efficiency standards through programs such as Passive House and LEED.

It then presents a discussion based on interviews that were conducted with six professionals from various backgrounds in the sector. These six individuals each represented a different actor or stakeholder in the affordable housing field: financers, policy makers, architects, energy consultants, housing developers and operators. This diversity allowed for the examination of a wide range of perspectives and the comparison of experiences. The interviews provided insights into how these specific energy efficiency and energy modeling requirements were developed. They also revealed barriers to achieving these higher performance standards and the associated challenges such as inhibited innovation and additional costs, as well as funders' expectations of and recommendations for their applicants.

In addition to these interviews, this paper features an example of an affordable housing project that is currently under construction in Ottawa, Ontario. This project has been successful in securing funding from two of the above mentioned programs and various others as well.

Across the board, professionals acknowledge that requirements on high energy efficiency impose additional upfront costs on housing providers. However, these costs are relatively minor and are paid back in the long term through savings in operational costs. Meeting, and indeed exceeding, the environmental targets set by CMHC and FCM for new builds has been proven to be feasible and beneficial to the providers as well as the tenants of affordable housing in the long run.

On the other hand, seemingly unavoidable are the design challenges of enhanced energy efficiency that are experienced by buildings of increased height or in different climates. These challenges could be mitigated by hiring experienced contractors and consultants, following an Integrated Design Process in the early feasibility stages, and using appropriate rightly sized equipment during implementation. Additionally, tenants should be encouraged to be more conscious of their energy consumption practices, and housing providers should remain rooted in their mission to commit to providing good quality, affordable housing for everyone.

Résumé Exécutif

Les programmes fédéraux de financement des projets de logements abordables, généralement administrés par la Société canadienne d'hypothèques et de logement et la Fédération canadienne des municipalités, font presque toujours de la haute efficacité énergétique l'un de leurs objectifs environnementaux. Ainsi, les fournisseurs de logements qui cherchent à obtenir un financement de ces organisations doivent s'engager à créer des bâtiments à haut rendement énergétique. Cependant, tout le monde ne sait pas encore très bien ce que l'on entend par "bâtiment économe en énergie".

Une façon de remédier à ce manque de clarté est d'examiner de manière critique les objectifs spécifiques d'efficacité énergétique qui doivent être atteints par tout nouveau projet de construction qui cherche à être éligible à un financement de ces sources. Ce rapport présente une enquête et une analyse des exigences en matière d'efficacité énergétique de trois programmes de financement qui ciblent les projets de logement abordable : le Fonds national de co-investissement pour le logement, l'Initiative de financement de la construction de logements locatifs et le Fonds municipal vert de la Fédération canadienne des municipalités. De plus, cette recherche détaille certaines exigences relatives aux modèles énergétiques et examine les raisons pour lesquelles les bailleurs de fonds ont stipulé que la réalisation d'une étude de modélisation énergétique avant la construction était une condition préalable à l'admissibilité.

Tout d'abord, le rapport contient une revue de la littérature qui traite de l'augmentation de la consommation d'énergie dans le secteur du bâtiment et des efforts visant à encourager l'atteinte de normes d'efficacité énergétique plus élevées par le biais de programmes tels que Passive House et LEED.

Il présente ensuite une discussion basée sur des entretiens menés avec six professionnels de différents horizons dans le secteur. Ces six personnes représentaient chacune un acteur ou une partie prenante différente dans le domaine du logement abordable : financeurs, décideurs politiques, architectes, consultants en énergie, promoteurs et exploitants de logements. Cette diversité a permis d'examiner un large éventail de perspectives et de comparer les expériences. Les entretiens ont permis de comprendre comment ces exigences spécifiques en matière d'efficacité énergétique et de modélisation énergétique ont été élaborées. Ils ont également révélé

les obstacles à la réalisation de ces normes de performance plus élevées et les défis qui y sont associés, tels que l'inhibition de l'innovation et les coûts supplémentaires, ainsi que les attentes et les recommandations des bailleurs de fonds à l'égard de leurs candidats.

En plus de ces entretiens, ce document présente l'exemple d'un projet de logements abordables actuellement en construction à Ottawa, en Ontario. Ce projet a réussi à obtenir du financement de deux des programmes susmentionnés et de divers autres programmes également.

Dans l'ensemble, les professionnels reconnaissent que les exigences en matière de haute efficacité énergétique imposent des coûts initiaux supplémentaires aux fournisseurs de logements. Cependant, ces coûts sont relativement mineurs et sont remboursés à long terme par les économies réalisées sur les coûts opérationnels. Il a été prouvé que le respect, voire le dépassement, des objectifs environnementaux fixés par la SCHL et la FCM pour les nouvelles constructions est possible et bénéfique à long terme pour les fournisseurs et les locataires de logements abordables.

D'un autre côté, les défis de conception liés à l'amélioration de l'efficacité énergétique auxquels sont confrontés les bâtiments de plus grande hauteur ou situés dans des climats différents semblent inévitables. Ces défis pourraient être atténués en engageant des entrepreneurs et des consultants expérimentés, en suivant un processus de conception intégrée dès les premières étapes de faisabilité et en utilisant des équipements appropriés et de taille adéquate lors de la mise en œuvre. En outre, les locataires devraient être encouragés à être plus conscients de leurs pratiques de consommation d'énergie, et les fournisseurs de logements devraient rester ancrés dans leur mission d'engagement à fournir des logements de bonne qualité et abordables pour tous.

1. Introduction

For the purposes of this report, I examined the energy efficiency targets set by selected affordable housing funding programs as requirements for proposed projects. The research mainly explored energy efficiency targets set by three programs; two under the Canada Mortgage and Housing Corporation (CMHC) and one under the Federation of Canadian Municipalities (FCM). These are (a) the National Housing Co-Investment Fund (NHCF), (b) the Rental Construction Funding Initiative (RCFI), and (c) the Green Municipal Fund (GMF) by FCM, more specifically the Sustainable Affordable Housing (SAH) Initiative. I investigated the rationale behind energy efficiency modelling requirement for new builds as well as design challenges and steps that can be implemented to secure funding that is tied to energy goals.

The Canada Mortgage and Housing Corporation (CMHC) is one of the biggest support providers for Canadians in housing need. The CMHC has been investing in a greener housing sector by enabling and empowering housing owners and operators. Similarly, and also backed by federal financial support is the Federation of Canadian Municipalities' Green Municipal Fund (FCM GMF). While the FCM is a nationwide advocacy group, federal dollars are funneled through their GMF which then dispensed towards sustainable affordable housing in Canada. Both funders continue to demonstrate considerable effort directed towards supporting projects that aid in making the housing sector more environmentally sustainable and affordable.

Another player in the process of planning for and obtaining government funding is the affordable housing developer. For the purposes of this research, I will draw on my internship experience at Ottawa's affordable housing developing non-profit, Cahdco. Cahdco (found at Cahdco.org) is a sister organization to Centretown Citizens Ottawa Corporation (CCOC). Both corporations have a substantial relationship with the CMHC and an impressive network of consultants and clients.

Financing from CMHC and FCM is highly desired by affordable housing projects due to their low mortgage interest rates, their high grant percentages, and their favorable terms for affordable housing providers. Simultaneously these factors also make these funding opportunities highly competitive as they draw from a limited budget dedicated to housing. Thus, they set rather stringent and ambitious targets for affordability, energy efficiency, and accessibility for their applicants. The affordable and non-profit housing sector, particularly when compared to the for-

profit sector, faces significant barriers to limited funding opportunities. And so, it is important to understand what sort of project these financers are willing to support and what steps can be taken by housing providers to meet the financers expectations without compromising their own mission of affordability.

The aim of this study is to critically evaluate efficiency (EE) requirements set by different national housing funding programs, and to explore the means by which successful projects have managed to meet these requirements in the past. While I primarily investigated the energy efficiency requirements set by CMHC NHCF, RCFI, and the FCM GMF, the research also explored the relationship between affordability and energy efficiency and the trade offs that housing developers are often obligated to make, particularly from the perspective of the affordable housing providers who are often at the forefront of sustainability. Additionally, this study looks at a remarkable example project of affordable housing development in Ontario.

In this research, the first critical step is to review the relevant literature and policies related to energy efficiency in Canada, and more specifically in Ontario. Findings from the literature review were helpful to was inform a list of potential interviewees and interview questions. The next step is to undertake interviews. Interviewees were chosen from the affordable housing arena through CCOC connections: housing operators, non-profit developers, architects, national funding providers, municipal authorities on energy efficiency. Interview questions were generated from the research findings and designed to draw from the knowledge of the interviewee. The interviews were recorded given consent of the interviewee. The results were compiled and transcribed for the final step. Alongside this literature review and interviewing process, an examination of an Ottawa based project was conducted to provide an example of a successful applicant .

The final step was to construct a coherent narrative from the research findings and interviews to provide a comprehensive picture of the current landscape. Visual aids were constructed to illustrate or simplify findings, key findings were discussed and emerging points were generated, and the lessons learned were synthesized for the benefit of the affordable housing sector.

By eliciting and representing multiple perspectives, this research may allow the different points of view espoused by isolated professionals who have engaged in varying facets of the issue, and have been impacted differently, to compile their findings and lessons learned through their

experiences when building and operating housing projects that have received funding under the CO-I, RCFI, and GMF programs. Furthermore, the documentation and dissemination of this research could potentially be beneficial for the housing sector as a whole, including private developers and for-profit housing operators who are inclined to adhere to the EE requirements attached to NHCF, RCFI, or GMF. Moreover, this research provides insight into the challenges of navigating varying energy efficiency requirements entailed by different funding programs. It also provides considerable insight into steps that should be taken in order to meet those requirements, as demonstrated by previously successful recipients of the financial support. This will ultimately be useful to housing developers, providers, engineers, architects, and researchers.

2. Methodology and Ethics

The research attempts to answer the question "what are energy efficiency requirements for new builds set by the National Housing Co-Investment Fund, the Rental Construction Funding Initiative, and the Green Municipal Fund?". It explores the conception of these requirements and the rationale behind the metrics set by each organization to measure energy performance. It also sheds some light on why funders require energy modelling studies to be conducted by certified professionals at the application stage.

While the primary objective of this research was to investigate and clearly outline the energy efficiency requirements for new builds as prescribed by these funding programs, it also aims to provide a better understanding of how these requirements were conceived and what steps can be taken to meet or exceed them. As well, it looks at barriers to energy efficiency, and how high energy efficiency can be reconciled with affordability.

In order to answer the research questions, the methods that were employed include a literature review and several Interviews followed by a brief analysis of an example project.

2.1 Methods

2.1.1 Literature Review

The materials reviewed as part of this research were mainly found online. As the two most relevant entities for this investigation are CMHC and FCM, their respective websites https://www.cmhc-schl.gc.ca/ and https://fcm.ca/ supplied good points of reference. Upon initial examination I determined that these websites contained a wealth of knowledge that would be beyond sufficient, however in order to introduce different perspectives I also referred to the National Energy Code of Canada for Buildings (National Research Council of Canada and Canadian Commission on Building and Fire Codes, 2017) , the British Columbia Building Code (National Research Council of Canada and BC Office of Housing and Construction Standards , 2018, BC Step Code), Ontario's building code (Ministry of Municipal Affairs & Housing, 2012, Ontario Building Code) , and publications by non profit housing organizations in Canada. In addition to these, I turned towards resources from non Canadian organizations such as the European Commission (European Commission, 2011, Energy performance of buildings). Lastly, a number of scholarly articles and reports were consulted for the purposes of this research.

2.1.2 Interviews

A number of participants from various backgrounds were interviewed. The participant population was intentionally selected to represent various actors in the affordable housing sector. They were asked to shed some light on what the energy efficiency requirements exactly meant in practical terms, elaborate on the process of selecting these metrics as minimum requirements, and share their most important lessons they'd like to impart on affordable housing providers to help reach and exceed these requirements. The interviewees were asked to discuss potential barriers to energy efficiency and how such barriers could be overcome. These professionals operate from different provinces of Canada and they fall into one or more of the following categories:

a) Affordable housing developers:

These individuals have familiarity with the funding programs in general and expertise in a specific area of inquiry relevant to the research. Developers are useful participants as they assemble the views from many parties while prioritising the financial viability of the project. They are professionals and thus can give a professional viewpoint, which is useful to weigh and balance the viewpoints of other stakeholders who may be less beholden to that ethos.

b) Affordable housing providers:

Considering that the bulk of their financing comes from NHS funding programs that stipulate their projects meet a certain level of energy efficiency, affordable housing providers are greatly affected by the topic in question. Providers often work in proximity with building staff and tenants and can therefore offer insight on how the pursuit of energy efficiency requirements may affect individual units, rent levels, and tenants satisfaction and wellbeing. As housing providers are very familiar with the long term costs associated with building operations, their contribution will be invaluable.

c) Funding agencies and advocacy groups:

Interviewees in this group were mainly from CMHC or FCM. Their rather extensive knowledge in affordable housing funding programs added further richness to the research. These interviewees were involved in the conception of the three funding programs that are in question and operate on a federal level. They aided significantly not only with answering the research

question but also formulating the problem and informing interview questions. They also offered some perspectives on what steps are taken by successful applicants.

d) Architects, engineers, and energy consultants:

Consultants with professional backgrounds helped bring a technical perspective to the research. Architects and energy consultants are knowledgeable about the topic of energy modeling, energy generation, building envelope design for energy efficiency, and mechanical/electrical aspects of new builds. Their input shone light on currently existing limitations as well as opportunities for innovation based on to their firsthand experiences.

The project selected to be the example project for this report was CCOC's 159 Forward Ave Family Shelter. This is a project that is currently underway in Ottawa. It is now in the construction phase and has been successful in meeting and exceeding energy efficiency requirements set by CMHC and FCM. Consequentially, CCOC was able to secure funding from both financers for this building and even includes the City of Ottawa as one of the financial partners. This is a multi-unit residential building that has faced design challenges but was able to overcome them through innovation and collaboration between the project manager, the architect, the construction manager, the city, and the federal government (CMHC & FCM). The discussion in the final segment of this section was based on information gathered from Cahdco's website and planning documents such as the site plan control application and the planning rationale that have been made publicly available through the City of Ottawa.

2.2 Limitations

Although energy efficiency is not the only measure of environmental sustainability for buildings, and in fact some government lenders set requirements on both energy performance and greenhouse gas emissions, this report will focus solely on requirements set for energy efficiency as an energy savings focused metric that is more tied to affordability and a variable that is *easier* to measure as opposed to reductions in GHG emissions. An aspect that has not been thoroughly examined in this report is the source of energy and how different energy sources have significantly different impacts on the environment. For instance, a total energy use intensity (TEUI) of 80 kWh/m^2in Quebec does not require or produce an equivalent amount of GHGs as a TEUI of kWh/m^2in Alberta.

2.3 Research Ethics

2.3.1 Recruitment

Participants were contacted by way of email, with a formal letter attached. The email served as a quick introduction and broad overview of the project's intent, as well as the reason for contact. Attached in Appendix 1 is the general contact email letter that was shared with and signed by the participants. The formal letter was more detailed, outlining the specifics of the research as it relates to the participant, but also to the objectives of the project. The participants did not receive any compensation

2.3.2 Consent Process

Free and informed consent was attained in written format. The attached document described the content, risk, and benefit of the study for the participant, but did not coerce the participant to participate. It is written in lay language. It describes what the participant is expected to do (participate in an interview no longer than one hour). The attached document was forwarded in an email to the participant well in advance of the interview. This ensured that consent is not rushed. Appendix 2 shows the consent form that was shared with and signed by the participants. The document forwarded via email (consent form) did not bind the participants participation, and participants were clearly informed that they could withdraw at any time. This is to satisfy the condition of ongoing consent. Alternatively, the participant may choose to refuse to answer certain question but continue with the rest of the study if they wish. The participants were not pressured to consent, and that is made clear in the document. Finally, the document assured the participant the maintenance of their full legal rights at all times throughout the study.

2.3.3 Risk/ Benefit Assessment

Both the probability and magnitude of potential risks resulting from this study is minimal. Participants were not asked to do or say things that they would not say in their daily jobs or lives. The interviews were used as a tool to coherently summarize the actors' experience with this subject, not as a way to unearth some hidden truth of motivation that may expose them to harm. The only conceivable harm to the participants is political, though that is both unlikely, minimal, and entirely within the participant's control. The participant is not being asked to put themselves in harm's way. Additionally, risk relating to the researcher is extremely low.

2.3.4 Confidentiality & Data Security

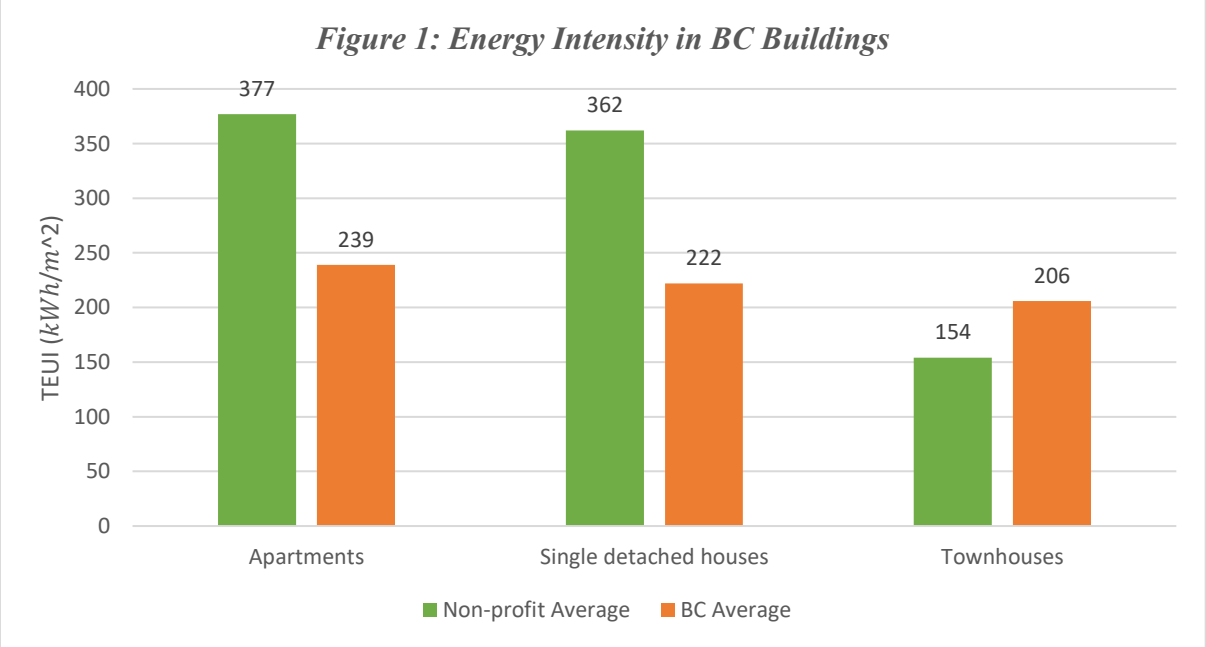
Although participants remained anonymous to one another during the interview process and they their identities are not disclosed in this report. Anonymity will be maintained by using student email for recruitment and placing contact information on a separate sheet as the consent form.

Additionally, the participants were selected, contacted, and described in a way that ensures the identification of one in no way jeopardizes the right of another to remain anonymous. During the research, when questions are asked pertaining to this, fellow participants will be referred to by loose titles or affiliations (never both) so as that the title could refer to multiple people, and not obviously to one person.

The research has been approved by the Research Ethics Board in June 2022 and the certificate of ethics approval is attached in Appendix 4.

3. Literature Review

Buildings use 30–40% of all energy resources (UN Environment Programme, 2011). In European countries, domestic emissions account for roughly one sixth of emissions, often only surpassed by the transportation sector (European Commission, 2011, Energy performance of buildings: Commission refers Spain to Court). In the Canadian context, and more specifically in British Columbia's, building account for over 60% of all energy consumed in the province (Light House Sustainable Building Centre, 2014). Interestingly, not all building types consume energy in the same way. In BC, although residential buildings vastly outnumber commercial and industrial buildings, residential buildings consume 31% of all energy in the province, whereas 34% goes towards commercial, and industrial buildings combined (Light House Sustainable Building Centre, 2014) . Similarly, shown in Figure 1 is how apartment buildings and single detached homes are consuming more energy when compared to townhouses, and how the annual total energy use intensity in the average BC Non profit apartment building is significantly higher than that of the city average (BC Non-Profit Housing Association, 2010, based on an Asset Management survey of 1000 buildings).



Source: BC Non-Profit Housing Association, based on 2010 Asset Management survey of 1000 buildings

This happens to be in accordance with Stephen et al.'s findings that state that an urban apartment has significantly lower energy consumption than a suburban or detached passive house (Stephan, Crawford, and de Myttenaere 2013). These statistics and many others demonstrate that building energy consumption varies greatly not only depending on building size, but also building use, type, and ownership.

In order to address this observable increase in energy use, in Canada as well as in some countries of Europe a series of subsidy systems have been set up by governments to encourage building developers to create structures that achieve high energy performance levels. These green policies have led to owners and developers of newly constructed or renovated buildings to eagerly pursue significant enhancement to their energy efficiency. Some might go as far as obtaining energy efficiency or "Green building" certifications as a tool to verify their building has been built with various sustainability related key performance measures in mind.

A study showed that reduction in energy consumption positively correlates with a growth in total return on buildings and boosts rental price (Cajias and Piazolo, 2012; Taruttis and Weber, 2022). Add to that energy savings that positively impact household savings, quality of life, and many other aspects that may not be so easy to measure. Highly energy efficient properties have attracted a price premium in the house rental and sales market as they involve reduced energy costs, directly reflected in the properties' energy bills. These energy related upgrades are not easily accessible to lower-income homeowners or market renters, who cannot reasonably be expected to pay the up-front costs required to access later rebates or to take on additional debts to do so. Still, it is often the case that property owners do not undertake energy-efficient renovation, mainly due to a lack of knowledge of the resulting benefits, a lack of access to technical resources, or a lack of financial support that helps offset the increased upfront costs.

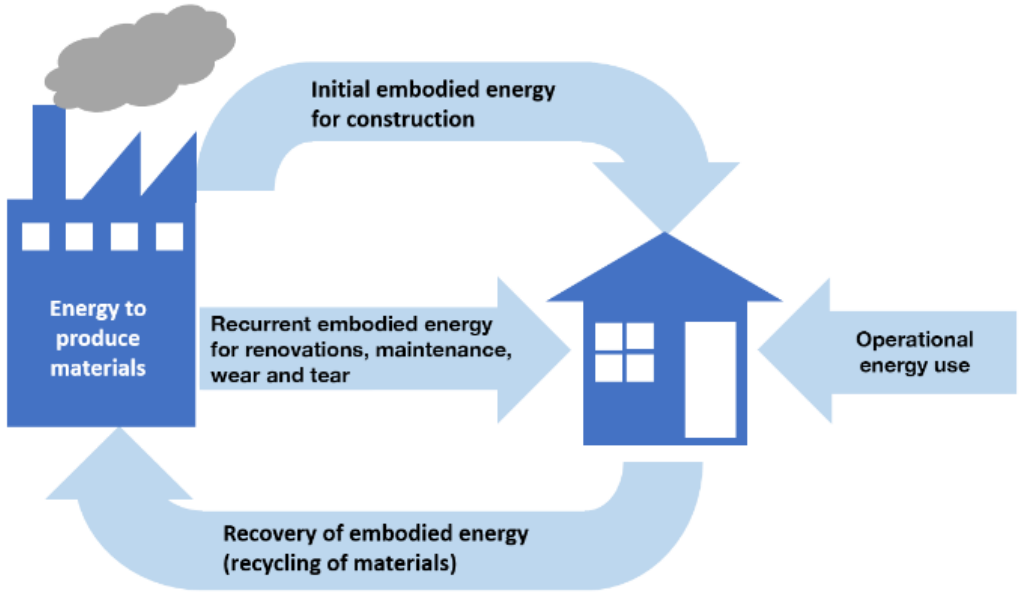
Much of the literature examines energy efficiency certification programs such as LEED and Passive House as tools used to enforce regulations that are inflexible for many purposes, potentially encourage innovation (Gann, Wang, and Hawkins, 1998), and impose unnecessary costs.

Many regulatory or standardising programs examine building energy use by focusing solely on the energy consumed during operation. They do not account for the amount of energy needed to erect a building, which is therefore embodied in the construction, or the energy spent toward

"end-of-life-decommissioning" that takes place when the building in longer in use. The expression "Embodied Energy" refers to the energy load directly and indirectly required to produce goods and services, including the energy used to create, harvest, and transport the raw materials during production as well as the energy used to destroy and dispose of waste materials after demolition (see Figure 2). In the construction industry, the definition involves "the whole amount of energy used for mining raw materials, to transform them into semi-finished or ready-to-use goods through specific manufacturing processes, and to transport the products to the building sites" (Copiello, 2017, p1069) .

Hence, programs such as Passive House are often criticized because they do not wholistically consider the embodied energy of the material to be used in construction, nor do they take into account a cradle to grave approach (Copiello, 2017). A recent analysis performed on a passive house assesses that the embodied energy exceeds the operating energy, with the former being from 2 to 3.5 times higher than the latter (Stephan, Crawford, and de Myttenaere, 2013). Thus, programs such as this could be viewed as non beneficial as the upfront costs associated with construction materials and their embodied energy could potentially match or exceed the long term savings attained through reduced operating energy levels.

Figure 2: Embodied Energy of a Building



Source: Murray Hal, 2020. "Australia's Guide to Environmentally Sustainable Homes- Embodied Energy" https://www.yourhome.gov.au/materials/embodied-energy

Alongside the additional costs of building higher performance projects, the development team may face various other design challenges. For example, it can be difficult to design for higher multi-level buildings as they maintain the same roof area as a smaller building but consume far more energy. Thus, design challenges such as energy consumption and means of energy generation in higher buildings and in northern climates are discussed in this report.

Evidently, a new direction is being taken in the building code and performance regulation arenas. There is a noticeable emerging preference for ’performance’ rather than ’prescriptive’ regulations that mandate attributes such as weight, dimensional, material and production specifications for building components. In contrast, newer performance-based regulations require that only certain performance criteria be met, such as overall strength or level of insulation. Similarly, as it pertains to the pathways detailed by authorities to meet energy efficiency requirements, applicants are free to pursue either the recommended route or a more innovative one, as long as they reach the mandatory performance levels.

Often the most common means of achieving environmental sustainability on a building level are by reducing energy consumption and GHG emissions. The two financing authorities discussed in this report, CMHC and FCM, provide specific guidelines around their requirements for each of those two items, in addition to an energy model that presents the comparison of energy consumption and GHG emission reduction performance between the base case and the project to be built. Furthermore, CMHC and FCM set affordability thresholds as well as energy performance thresholds. Both programs often hint at or state an outright correlation between energy savings and affordability, a relationship that is explored in this report.

3.1 Affordable Housing in Canada

CMHC determines whether a household is in “core housing need” using the following definition: “A household is in core housing need if its housing does not meet one or more standards for housing adequacy (repair), suitability (crowding), or affordability and if it would have to spend 30 per cent or more of its before-tax income to pay the median rent (including utilities) of appropriately sized alternative local market housing.” (Statistics Canada, 2016, Dictionary, Census of Population,) According to the 2018 progress report for the City of Ottawa 10-Year Housing and Homelessness Plan, “42% of renters spend more than 30% of their pre-tax income

for local housing that is adequate, affordable, and suitable" (City of Ottawa, 2019, 2018 Progress Report, p.4).

Apart from rent affordability, there is a surprising number of people who are living in affordable or subsidized housing that are in energy poverty. These are tenants who have utility bills that are high. This is a problematic phenomenon in a sector that cares about affordability. Incorporating energy efficiency measures into the building is a way to drive affordability for the tenants, especially if they are going to be paying for utilities on top of the monthly rent. Utilities can be remarkably lower in an efficient building. On the other hand, if utilities are to be covered by the provider, there will be operating savings which could then go into new capital projects or into delivering lower rents in some of their existing units.

3.2 The Federation of Canadian Municipalities' (FCM) Green Municipal Fund (GMF)

Through GMF's Sustainable Affordable Housing (SAH) initiative, funded by the Government of Canada, FCM supports local affordable housing providers – including municipal housing corporations, not-for-profit housing providers and housing co-operatives – to retrofit existing affordable housing units or construct new, energy efficient buildings that emit lower greenhouse gases.

In its 2019 budget, the Government allocated $950 million to the Federation of Canadian Municipalities' Green Municipal Fund (GMF) to support energy efficiency in affordable, social, and market housing units. Over the last two decades, GMF has provided over $15.1 million in grants and $55.7 million in loans for projects related to energy efficiency and renewable energy in existing buildings. (Environment and Climate Change Canada, 2020, Canada's Strengthened Climate Plan)

SAH's Planning Grant is designed to assist Canadian housing providers in initiating more sustainable affordable housing projects in their communities. The ultimate goal of this grant is to help housing providers successfully develop outputs that support projects that apply for additional sources of funding for further development of energy efficient affordable housing projects, such as SAH's study grant or CMHC's Seed Funding.

The FCM's objective is to incentivize actors in the affordable housing sector to work towards a triple bottom line of environmental, social, and economic benefits. In practical terms, this

translates to widely affordable, completely accessible, net zero energy & emissions buildings. Going beyond meeting the minimum energy efficiency requirements and achieving net zero can be done in a variety of ways, mainly by designing a high performance building envelope and using renewables to reduce energy consumption and GHG emissions. FCM demonstrates commitment to supporting affordable housing and believes that setting ambitious environmental targets will ultimately result in or contribute to deep affordability. Note that a net zero energy buildings are those that can offset their energy consumption. Net zero energy building is a high-performance building that is designed, constructed, and operated to require a greatly reduced quantity of energy to operate; it is a building that meets its energy needs through sources of energy that do not produce greenhouse gases or in a manner that will result in no net emissions of greenhouse gases (Kibert and Fard, 2012).

Over the years, the Green Municipal Fund has been a particularly strong supporter of retrofit projects, especially as the National Housing Strategy revitalization programs have grown less popular. For new construction projects that are aiming to produce an energy conscious building, the FCM through their Green Municipal Fund's (GMF) Sustainable Affordable Housing (SAH) initiative offers various funding opportunities for different stages to take the project from studies to planning to capital construction. In order to be eligible, applicants must meet the affordability and energy efficiency criteria detailed below as well as other accessibility related requirements. For-profit developers are not eligible for GMF. With only $300 million in budget, FCM sought to focus on the non-profit and municipal housing sector. One of the primary objectives of the green municipal fund is to strive for affordability to the greatest extent.

Energy Efficiency

- Retrofits: Save at least 25% of current energy consumption
- Newbuilds: Net zero energy (ready) or 80 kWh/m^2

Affordability

- Rents for at least 30% of the units are less than 80% of the local median market rent

The FCM's grants and loans that are offered through the Sustainable Affordable Housing Initiative (SAH) are all tied to energy reductions (FCM, 2021, Sustainable Affordable Housing: Application Guide). Their measure for energy performance is total energy use intensity

(kilowatt-hours per square meter) and their requirement to qualify for GMF funding planning grant is for buildings *in most regions* to target a net annual total energy use intensity (TEUI) of less than 80 kWh/m^2 at project completion. This is an energy savings focused metric and therefore is more tied to affordability, assuming that energy savings positively correlates to cost savings which then helps lower rent or utility costs for tenants. This number also aligns with the passive house standard (a standard which was originally developed for colder climates) which entails a maximum total energy use intensity of 120 kWh/m^2yearly for homes (Alajmi et al., 2018).

Table 1: The Green Municipal Fund Funding Offers at Various Stages

Project Stage	**Funding Offer**
Planning	• Grant up to $25,000 • Up to 80% of eligible costs
Study	• Grant up to $175,000 • Up to 50% of eligible costs
Pilot Project	• Up to $500,000 • Up to 80% of eligible costs
Capital: Retrofit *(Minimum 25% energy improvement)*	• Financing up to $10 million • Up to 80% of eligible total project costs • Grant based on energy performance • Grants are 25% to 50% of GMF funded amount
Capital: New Build *(NZE/ NZER)*	• Financing up to $10 million • Up to %20 of eligible total project costs • Grants are 50% of GMF funded amount

Source: FCM. 2021.Sustainable Affordable Housing: Application Guide. 5.

3.3 The National Housing Co-Investment Fund (NHCF)

In 2017, CMHC released their National Housing Strategy (NHS) to set guidelines for long-term development of new housing as well as the preservation and improvement of existing housing in

Canada. The NHS's stated priority areas for action include housing those who are in need, and indeed housing everyone, sustaining social housing, and promoting sustainability in housing and communities(CMHC, 2018, National Housing Strategy Progress) . As of March 31, 2021, the government has committed $19.6 billion under the NHS, supporting the creation of 75,600 new housing units and 189,400 repaired housing units (Cahdco, 2020, Canada's National Housing Strategy: Progress to Date) and several funding initiatives have been established under this national strategy. Of particular relevance to affordable unit construction are SEED Funding, Co-Investment (NHCF) Program, Rental Construction Funding Initiative (RCFI), Affordable Housing Innovation Fund (AHIF), and many more. The NHS allocates the biggest portion of funding towards forgivable loans to the Co-Investment fund, promising $13 billion in low cost repayable loans and forgivable contributions over 10 years. As of December 2021, over $1 billion have been committed in forgivable loans/contributions and over $2 billion in repayable loans under the NHCF alone to support the construction of close to 12,400 new units, of which over 8,600 are affordable, and the repair/renewal of over 65,900 units (CMHC, 2020, National Housing Strategy Progress Report,). The objective of the NHCF is to support the creation of housing, but more specifically affordable housing. Tables 3 and 4 demonstrate how NHCF provides Non profits/ Co-ops and Indigenous organisations with more support in the form of forgivable and repayable loans.

Table 2: New Construction- Forgivable Loans

Prioritization percentage score	*Non profits/ Co-ops and Indigenous organisations*	*Provincial, Territorial & Municipal Governments*	*Private Sector*
Less than 50	Up to 5%	Up to 5%	Up to 2.5%
50-74	Up to 10%	Up to 7.5%	Up to 5%
75-94	Up to 15%	Up to 10%	Up to 7.5%
95+	Up to 30%	Up to 20%	Up to 10%

Source: CMHC. 2020. National Housing Co-Investment Fund- Funding Eligibility. 2.

Table 3: New Construction- Repayable Loans

Non profits/ Co-ops and Indigenous organisations	*Provincial, Territorial & Municipal Governments*	*Private Sector*
Up to 95%	Up to 75%	Up to 75%

Source: CMHC. 2020. National Housing Co-Investment Fund- Funding Eligibility.2

The focus of the Co-Investment Fund is to develop "*energy-efficient, accessible, and socially inclusive housing"* (CMHC, 2022, National Housing Co-Investment Fund: New Construction). The NHCF offers low-cost loans for affordable housing projects, and to access these loans, groups must meet certain terms, particularly as it relates to affordability, sustainability, and accessibility. In addition to this, a project must demonstrate its viability to receive funding from other sources; as well having multiple financial partners is encouraged. Below are some of the affordability criteria for the NHCF

Energy Efficiency

The NHS details minimum environmental requirements for new builds as follows: Applicants must demonstrate that their project(s) are designed to achieve a minimum 25% decrease in energy consumption and greenhouse gas (GHG) emissions outlined in the requirements of the 2015 National Energy Code for Buildings (NECB) or the 2015 National Building Code (NBC) ("base case"), or a 15% decrease relative to the 2017 National Energy Code for Buildings. (CMHC, 2020, Minimum Environmental & Accessibility Requirements New Construction)

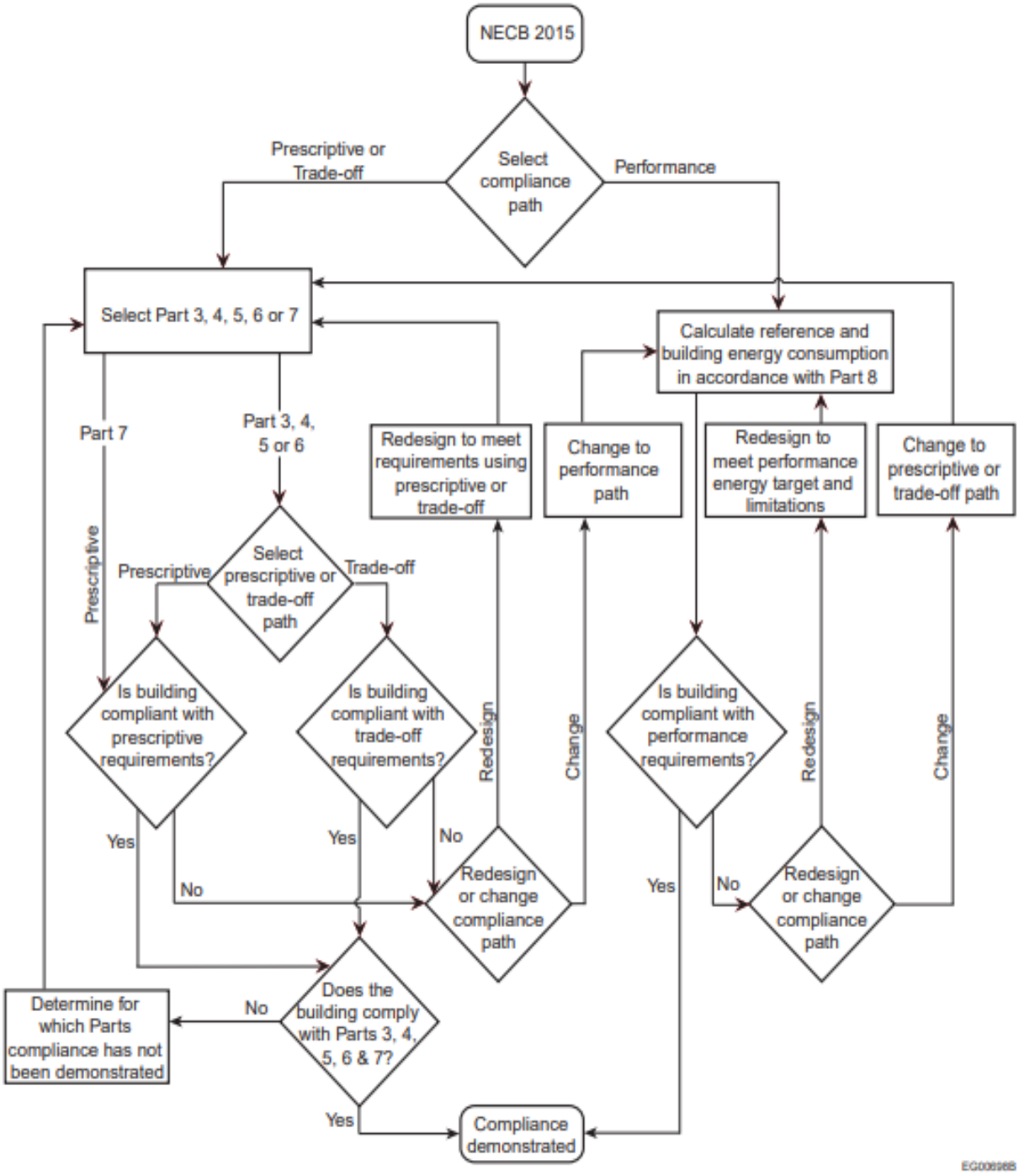
It is also important to note that CMHC explicitly states on their website that they "will prioritize applications that exceed the minimum requirements. Applicants should ensure that they clearly state if their projects will exceed the minimum requirements and by how much (e.g. " ... will exceed 2015 NECB by 40%")." (CMHC, 2020, Minimum Environmental & Accessibility Requirements New Construction).

Affordability

In order for the project to be considered for this fund, rent for at least 30% of units must be below 80% of Median Market Rate. CMHC only considers Median Market Rent (MMR) at the neighbourhood level (municipal MMR if no neighbourhood level data is available), found on their Housing Market Information Portal. Lowering rent rates beyond just below 80% MMR would be viewed favorably by CMHC; the lower the rents the more an application will be prioritised (CMHC, 2020, National Housing Co-Investment Fund Application Guide for Financial Viability Workbook - New Construction) Affordability must be maintained for a minimum of 20 years.

The NECB elaborates on a variety of compliance options between performance, perspective, and trade-off and lays out a detailed decision flow chart (shown in Figure 3) to aid in the selection of a compliance path. The following figure shows the decision flow chart for code compliance in the National Energy Code 2015.

Figure 3: Compliance Options



Source: [National Energy Code of Canada for Buildings 2017](), Division B 1-9 (National Research Council of Canada and Canadian Commission on Building and Fire Codes, 2017)

Table 4 compares the three available compliance options: the prescriptive pathway, the performance pathway, and the trade-off pathway. The table makes use of the details provided in the 2015 National Energy Code of Canada for Buildings to summarize the differences in the required level of compliance in each pathway, the allotted room for flexibility and the means of proving compliance.

Table 4: Compliance options for building envelope design according to National Energy Code of Canada for Buildings 2015.

	Prescriptive Path	*Trade-off Path*	*Performance Path*
Limited to Specific instructions	Yes, the Code dictates minimum thermal characteristics for envelope elements and energy efficiency measures that can be stated as specific instructions.	Presents a way to make small adjustments to the characteristics of the building without having to follow the whole-building performance route.	Although it is subject to certain limitations, this path is more focused on outcome rather than process.
Flexibility in requirement application	No, must apply to the requirements of the Code	Yes, some. For example, the trade-off paths allow Code users to vary the thermal characteristics of one or more components of the building envelope and/or vary the fenestration and door	Yes. Very flexible. the building could, for example, be designed with any thermal characteristics desired provided that it would not have a calculated energy consumption under standardized conditions that is greater than it would have

		area from that permitted in the Code.	been had the building been designed in strict conformity with the prescriptive requirements, all other aspects of the building (those that are not the object of a requirement in the Code) remaining the same in both cases
Room for Innovation	Little to none	Yes, some	Yes
Proof of compliance	Adherence to Code	Demonstrate that the resultant building envelope will not transfer more energy than it would if all its components complied with that Section.	Two energy analyses: one on the building as if it met the prescriptive requirements, which gives the "target" performance, and the other on the actual design for which a building permit is requested.

Source: National Energy Code of Canada for Buildings 2017, (National Research Council of Canada and Canadian Commission on Building and Fire Codes, 2017)

3.4 Rental Construction Financing Initiative (RCFI)

Similar to the Co-investment fund, and also under the NHS is the Rental Construction Financing Initiative (RCFI). As of December 31, 2020, the RCFI has committed close to $8.4 billion in financing to support the construction of over 24,900 units, of which over 15,900 will be affordable. This initiative is accessible to any project that aims to respond to a need for rental supply. Eligible applicants include municipal governments, municipally owned corporations, cooperatives, and not for profit as well as for profit developers.

This program offers financing in the form of low interest repayable loans without the contribution component. That is to say, all funding secured through this stream is to be paid back with interest at the end of the agreed upon amortization period. These loans are often coupled

with a CMHC backed mortgage loan insurance that guarantees that the borrower does not pay the premium.

Energy Efficiency

Project must exceed the energy consumption requirements stated in the current model building codes by a minimum of 15%.

Affordability

At least 20% of units must have rents below 30% of the median total income of all families for the area, and the total residential rental income must be at least 10% below its gross achievable residential income. Affordability must be maintained for a minimum of 10 years (CMHC, 2020, Rental Construction Financing Initiative).

Here is a table to summarize the energy efficiency requirements of each of the programs.

Table 5: Summary Comparison between GMF, NHCF, and RCFI

Program	*EE Requirements*
FCM GMF *Planning* *Studies* *Capital* *Pilot*	• The project must be working towards net-zero energy (NZE) or net-zero energy ready (NZER). • Net annual total energy use intensity (TEUI) of less than 80 kWh/m^2. • Northern applicants may target a net annual TEUI of up to 120 kWh/m^2.
NHCF	A minimum 25% decrease in energy consumption outlined in the requirements of the 2015 National Energy Code for Buildings (NECB) or the 2015 National Building Code (NBC) ("base case"), or a 15% decrease relative to the 2017 National Energy Code for Buildings.

RCFI	Projects must be a minimum of 15% more efficient in energy consumption and GHG emissions than current model building codes: • Low-rise multi-unit buildings under Part 9 of the National Building code must demonstrate a minimum 15% improvement over the 2015 NBC. • All other multi-unit buildings under Part 3 must demonstrate a minimum 15% improvement over 2015 NECB. Starting November 1, 2022, all buildings under Part 3 must demonstrate a minimum 15% improvement over 2017 NECB. RCFI will accept modeling against 2017 NECB immediately.

All of these financing programs require – or at the very least emphasize- that the proposed project have approval under another affordable housing program or initiative from any government level, such as capital grants, municipal concessions or expedited planning process (CMHC, 2020, Rental Construction Financing Initiative). Obtaining the support of partners is essential, and so oftentimes affordable housing projects would aim to simultaneously fulfil the minimum requirements of all of the discussed programs in order to attain as much financial support as possible from various sources. That is what is referred to as “Stacking”.

The research topic at hand is a complex one. Requirements set on the energy efficiency of newly constructed residential buildings are effectively in place to help the sector reach not only socio-economic goals but also environmental targets. There is a great emphasis however that these environmental targets be not pursued at the expense of affordability. Funders recognise this as one of the trade offs that may be made and propose guidelines for producing highly energy efficient, affordable buildings while also leaving room for innovative performance based approaches.

4. Results and Discussion

This section looks at energy efficiency and funding tied to energy efficiency from different angles and through different perspectives. The following discussion is based on interviews I've conducted with various professionals in the field: a researcher from CMHC, a Program Designer of the GMF Sustainable Affordable Housing Initiative, an architect and certified energy modeler, an engineer who is specialised in energy, and an energy policy consultant. This diverse group provided insights into what the energy efficiency requirements actually mean, the rationale behind them, ways to meet those targets, and whether those requirements inhibit innovation and burden affordable housing providers with additional costs.

4.1 Breaking Down the Requirements

CMHC's elaboration on their stipulated requirements is that they, as financial supporters, are asking applicants to achieve a 25% reduction in the total annual energy consumption of the proposed building. CMHC funds are relative to what they otherwise might have built by only meeting code. So essentially, CMHC is trying to encourage a 25% performance increase over what would otherwise be delivered under just typical market conditions without CMHC being involved. The CMHC as a federal department has a requirement to support federal efforts on the carbon reduction front and then move towards a near net zero at 2030 and net zero in 2050.

Essentially CMHC is stating their minimum requirements in the building code and then asking applicants to go above and beyond code. This is being done in the hope to not only make buildings more energy efficient, sustainable, and affordable to operate, but also to influence practice writ large. Beyond the funded buildings, if designers and contractors in the field become accustomed to delivering higher performing buildings, perhaps the program will ripple over and have a broader effect across the affordable housing sector and the overall housing sector. CMHC views these requirements as a nudge in the right direction towards near Net Zero and net zero buildings.

FCM on the other hand references back to the beginning of the GMF SAH program in 2019. The federal government provided the Green Municipal Fund $950 million for three new streams of programming, focusing specifically on energy efficiency in buildings. And one of those streams was for sustainable, affordable housing. FCM had $300 million specifically to direct towards

sustainable affordable housing. They designed the program with a team of consultants and an advisory group made up of 14 experts who are working actively in the sector across the country. This, they found to be incredibly helpful.

Notably, FCM also had the great advantage of designing their program in the context of the National Housing Strategy (NHS), which at the time had already been released and implemented for years. Thus the FCM sought to provide funding that would be supplementary to CMHC'S funding from NHS programs, thus creating harmony between opportunities from the two entities by focusing on energy outcomes and GHG reductions, as well as attempting to determine how to make the biggest impact with their relatively limited budget of $300 million (as compared to the NHS $70 billion allocation). It is also important to note that FCM has received a great uptake from retrofit projects as these revitalization projects were prior to the FCM programs slightly overlooked by the NHS programs at the time. On the other hand, there has always been a lot of money available for new builds.

FCM recognises through their research that to build to Net Zero Energy standards it can typically result in anywhere between 5 to 15% increase in capital costs. To counter this, FCM offers monetary contribution to cover 20% of the eligible costs of a project up to $10 million in the form of 50% grant and 50% loan. And so, effectively their funding will cover any additional cost to build to that higher standard.

As for the northern energy performance requirements, FCM's in-house energy specialist looked at the BC Step Code and other data for northern climate areas to determine what TEUI Target number would be appropriate. Additionally, the program design team had some conversations with the government around even the direction of the NECB. Furthermore, it was already a year into the program operating that the special considerations for northern projects were introduced. This gave them the advantage of assessing the application data that they had compiled over that span. Now they are able to compare how current applicants are doing against this and for the most part, projects prove to be more ambitious and end up exceeding the minimum. In case when they fail to meet the minimum, conversations are had with those applicants to see what could be done. And so, FCM strives to be fair and these numbers were adopted for being reasonable based on the applications that FCM had received, including northern applications as well.

FCM wanted to make sure that they were stimulating and targeting projects that are going to have ambitious energy goals. They considered the Passive House standard as something to strive for and the highest realistically achievable limit.

A target like 80 kilowatt hours per square meter per year is quite significant and in the range that could be satisfied by a solar electric installation on the roof of the building. If one takes a typical footprint of a small residential building, that is up to four storeys, and provided that other conditions for efficiency are met, the TUIE could be brought into the range of between 70 and 90 kilowatt hours per square meter, which, depending on the location, could actually have all its energy generated with the photovoltaic electricity. So 80 $kWh/m^2$is a magic number.

From the get-go, FCM had $300 million to allocate to all sustainable affordable housing projects, new and old, under this funding stream, but not all of that is allocated out the door immediately. And since there is only so much funding that can be disbursed on an annual basis, FCM was intentional about proportionately covering both retrofits and new construction, all while recognizing that there was much greater need and limited funding on the retrofit side. So FCM tried to ensure that whatever limited funding that was dedicated to new construction projects was targeting those high impact projects.

So, unlike the NHCF 25% decrease in energy consumption minimum requirement, the GMF SAH aimed towards something that was quite ambitious, like a net zero energy ready (up to 80% energy reductions) or NetZero energy designation. FCM specified annual energy intensity as their measure while also trying to align with the new National Building Code 2020 which now is in tiered levels, “A new compliance path with 4 energy performance tiers is introduced to provide a framework for achieving higher levels of energy efficiency in buildings.” (Government of Canada, 2020)

There were a few things that were considered for applicants from northern regions; extreme climate, short construction season, and variable daylight hours to name some . FCM aimed to provide additional flexibility for Northern developers, recognizing that it may be more challenging and time consuming process to achieve some of these targets given the climate and time constraints. Flexibilities are also extended to increased funding amounts recognizing that labor and material costs are significantly higher compared to the average across Canada.

4.1.1 Rationale Behind Specific Requirements

There are two different types of measures discussed in this report: absolute measures (used by FCM) and relative measures (used by CMHC). Each one of these requires different approaches from the applicants.

The National Housing Co-Investment Fund (NHCF) requires buildings to perform 25% better than the standard prescribed in the 2015 National Energy Code for Buildings or 15% better than the base case in the 2017 National Energy Code for Buildings. These percentages were chosen as a good enough improvement to ask for without representing a barrier to affordability. CMHC aimed to balance the affordability of construction (and ultimately rent and mortgage levels) with a desire to push for higher performance driven by the need to reduce the carbon load in Canada. This is in alignment Canada's plan to reach Net-Zero by 2050. So NHCF's 25% (or 15%) was strictly a line in the sand. Considering that the Rental Construction Financing Initiative predated the NHCF, the RCFI's requirements are lower at 15%, a number that was deemed appropriate at the time of the launching of the program. With each success of the program, CMHC observed that developers were capable of meeting the requirements of the previous program and so they would gradually ramp up the requirements from 10% to 15% to 25%.

For the case of the Co-Investment Fund, the 25% better requirement was based on the experience of what the development community could do when asked and when encouraged to participate. As a baseline, the National Energy Code and the National Building Code of Canada were chosen to ensure capturing both part 3 and part 9 residential buildings. As described by the Ontario building code, part 3 are buildings that are higher than 600 m^2 or over three storeys, multi-unit residential buildings and part 9 are buildings fewer than three storeys. Although CMHC recognized that the National Energy Code and the National Building Code have not been adopted in their entirety in all provinces and territories, the choice of the national metric was in support of the Government of Canada's effort to harmonize codes across Canada. By choosing a common reference point CMHC is also being consistent in how they are asking people to articulate the performance of their building relative to a common baseline.

By comparison, the CMHC numbers in the National Housing Co Investment Fund and the Rental Construction Financing Initiative are essentially legacies of earlier ways of measuring energy efficiency, which was always a relative comparison to a good building as described by the code.

The FCM approach is different entirely. It is about how serious we want to get and how hard we want to push buildings. And the reality is, if one looks at the national inventory reports that are sent to the UN under the climate change agreements, buildings are a small fraction of GHG producers. And so, the level of impact to the planet that FCM is trying to make may not be achievable through regulating/ enhancing buildings only.

Beyond just financing a loan or grant, FCM provides a range of supports to applicants. Affordable housing providers and developers particularly benefit from their capacity building resources and connections with regional energy coaches. FCM provides support that is really necessary from planning all the way through completion.

FCM encourages commissioning and that is considered an eligible cost in their funding stream. As part of the project planning process it is important that the undertaking of new construction building commissioning provides some level of certainty for the affordable housing providers that the building is constructed as per design and that the savings are going to materialize. After development completion and equipment installation and operation, there might be some opportunity to provide additional funding for the recommissioning phases after operations to ensure that things are operating as optimally as they should. So having some recommissioning funding may be beneficial and necessary.

The federal government through the NHS programs dedicates a lot of money and a lot of new builds are generated by the Co-investment fund. So FCM's GMF, as a more recent addition to the field, had much more ambitious requirements than CMHC in order to push people. The GMF has a relatively smaller budget than the NHS programs, but still offers applicants a high grant percentage that would offset building to that higher standard. It is quite a different approach which was contextual and grounded in the sector's needs and the FCM's limited budget.

In terms of the two numbers that were ultimately chosen (80 kWh/m^2 and 120 kWh/m^2), FCM did quite a bit of research, looking at different codes and standards and policies related to buildings such as the British Columbia Step Code. They looked at some of the municipal codes like Toronto Green Standard, and a variety of standards codes such as Passive House and the Canadian Build Green standard. All this review work was done to estimate the direction that the sector was heading and where things were landing, how ambitious some of the existing standards

were, and whether FCM should take the similar approach to the “base case”. Ultimately, they determined that many of the newer and more advanced standards are moving to the TEUI measure as opposed to using NECB as a base case. FCM attempted to incorporate this existing knowledge and future aims while pursuing a simple and flexible approach particularly for northern applicants. An ambitious but reasonable balance of simplicity and fairness was FCM’s formula.

Due to many acknowledged challenges with using the base case approach, the newer codes are moving in the direction of using total energy use intensity or similar metrics. Directionally, the SAH program aims to promote better energy outcomes and also increase the affordable housing sectors capacity and understanding as it relates to energy use for new builds. It was discerned that moving to more ambitious targets but also introducing new concepts and providing opportunities to better the understanding of the energy use in buildings through FCM’s metrics may be more appropriate. FCM emphasized aligning with emerging and anticipated standards, being ahead of the curve as opposed to behind it. So that was why FCM chose the TEUI over the base case approach.

4.1.2 Prescriptive vs Performance Pathways

FCM does not specify a prescriptive pathway to be followed by applicants, instead they intentionally encourage opting for a performance centred approach. This is to recognize that there exist numerous valid approaches. This is also to avoid putting limitations on housing providers and demonstrating that the applicant best knows what works for them and what changes their buildings might experience over time. And so the SAH program design team was intentional about leaving room for flexibility, while also providing guidance and capacity building support.

The prescriptive path is always easier for the designers to follow and easier for the authorities to inspect. That is because the building design is either in accordance with the stated guidelines or it is not. Taking a look at the architectural drawings and design specifications of the proposed building, it is possible to quickly determine whether the suggested pathway has been followed. Actual performance work on the other hand is much more challenging because it takes more time to do a forensic evaluation of an energy model.

There's a real struggle because the program evaluation teams at CMHC do not have energy modelers on staff and cannot interpret the results of the model. There is really no one to give the model a sniff test.

Whether an applicant decides to follow a prescriptive or performance pathway may greatly depend on the level of resources available to the applicant organization. So for example, an organization that is large in size and has enough capacity to employ a certified energy expert will likely consider the building specifications and deliberate which methods and technologies to apply in order to reach a high performance design that meets the requirements without necessarily following the recommended instructions. They are able to go through the energy modeling process to prove that the desired standards are met. Choosing the performance based path also offers a bit of flexibility in not being restricted to following typically rigorous procedures and venturing out to ultimately produce an innovative design with potentially lower costs attached to it.

On the other hand, a prescriptive path is more ideal for smaller housing providers and applicants with limited capacity and resources. The need for creativity is eliminated. All that must be done is referring to the stipulated requirements and determining what the tried and true approach has been. Through this pathway, the applicant would simply request from their architect to meet, for example, a Passive House standard or whatever it takes to meet the design intent of the funding opportunity they are pursuing. This is less experimental and so it simplifies the applicant's as well as the architect's job, and it guarantees with a greater level of certainty that funding will be secured. Although this may be a less efficient way to go about this process, it saves small providers resources that they might need to allocate elsewhere.

At the same time, there is an observable move towards the performance pathway. Although the prescriptive pathway is very clearly laid out and easier to follow, it does not require ingenuity. The preference shift of the market towards the performance path is driven by the belief that it is innovation that is going to get us to our long term goals of NZE by 2050. Hence, it is imperative to ensure the competency of the engineers, designers, modelers, and contractors who are hired to develop housing projects. In this regard, rural areas, may not be as equipped as some of the more urban centers.

CMHC has considered an absolute measure in the form of an energy utilization Index (EUI) Approach. EUI is a key energy metric that calculates energy per square foot per year. This is a measure that captures the total energy use per year and standardises it against building height (Energy Star, 2017). However, the problem with that is that there was not good or sufficient information on the climate conditions, location by location and there are rather arbitrary lines or isotherms of climates between the major weather centers. So one could end up in a situation where the EUI is more demanding because one is simply 5 kilometers to the east, west, north, or south. So the EUI approach was not adopted and instead using a percentage was deemed more appropriate as ultimately the goal would be to simply perform better than code. Taking a relative approach to existing code meant that the program design team would avoid needing to come up with a grid of the EUIs all across the country or EUI requirements based on climate. CMHC currently does not have the inputs necessary to obtain the resolution to do a good enough job at taking the EUI approach.

In the case of energy modelling, a relative measure requires energy models to provide a comparative energy target. Usually, the conflict is all around the reference building. This is a flawed approached in that an error could be made with the assumptions but will not be caught in the energy models overall because the reference building and the proposed building are modelled in the same way. That produces a TEUI that is much higher than one would expect for building zone of those characteristics. It's much higher on the code side as well as much higher on the proposed building side. But because it does not materially change the relationship between the proposed and the reference buildings, it is ignored. It would become evident however if for example a project that was simulated for CMHC that has been tested a number of ways and is doing what it is supposed to, but its TEUI is much, much higher than these targets from FCM which are really trying to describe the same building. Simply put, if a project meets the CMHC NHCF minimum energy requirements, then it should also automatically meet the FCM requirements. The two requirements although portrayed differently ultimately translate into the same performance level and the same reductions in energy efficiency. Thus if a building meets the CMHC requirements but does not meet the FCM requirements then there is a significant chance of error when designing and modeling for CMHC minimum requirements.

4.1.3 Concerns of Inhibiting Innovation

Criticism as it relates to the National Housing strategy programs confining their applicant to requirements that other developers on the market do not have to adhere to is that these inevitably add to the upfront project cost. FCM SAH program factors in the need to help offset those costs. Admittedly, the sector recognizes that FCM is specifically trying to push beyond the status quo by having more ambitious targets.

The SAH team does not believe that their program would inhibit innovation in any way because the program does not prescribe a fixed pathway, but only requires applicants to meet the minimum targets. There is also the argument that innovation is only good to a certain point, beyond which certainty becomes more valuable. At some stage, most projects need to ascertain a level of confidence related to the operating costs and all other aspects that affect their ability to deliver affordable rents. Undeniably, there is something to be said for following successfully proven models such as, the Passive House model. Perhaps that is where FCM's pilot offer would come in. This is in the form of a significant grant up to $500,000 that is primarily instated to push innovation. That is also where built-up knowledge from well positioned organizations comes in, those that have been able to learn, innovate and share back into the sector.

Similarly, CMHC insists that NHS programs do not stifle innovation. In fact by encouraging applicants to exceed minimum targets, innovation has to be applied. CMHC is not requiring applicants to go beyond the targets without offering a reward in return. So one might say that CMHC is paying for the 25% better than national code achievement. Essentially CMHC expects the applicant to work out the cost of "building better", and then CMHC will cover it in the form of a loan or a contribution agreement. If anything, these requirements push developers to creatively find most cost effective solutions to meet targets.

Additionally, there is an observed correlation between improvement of energy performance and reduced operation cost in the buildings (Young, 2008) and ultimately affordability through lower rents. The increased capital costs are often balanced out by monthly savings on utility bills (Zalejska-Jonsson, Lind, and Hintze 2012), both in the common areas and the residential units. CMHC was intentional about setting energy efficiency targets for buildings and not only greenhouse gas emissions targets as to not mimic government policy that is often focused on reducing GHGs. Using the abundant data on existing buildings, CMHC is currently doing

research on whether or not the minimum requirements on energy and carbon were a barrier to energy affordability.

Affordable housing providers who are committed to keeping buildings for a long time have less difficulty finding capital funding than they do operational funding. So, they possess a built-in interest in high performance building and low operating costs. And in that case, there is no conflict between innovation and affordability. But there is still a high pressure on the construction budget because they do not want to do things frivolously.

What has become clear over time is that one of the solutions that delivers high performance buildings is using off the shelf equipment. For example, cold climate heat pumps have emerged in the market recently and they have made a quite a big difference. And as they improve, the need for a second backup system is reduced. That is significant, but that is an innovation that has been 20 years in the making. In this context, and as far as high energy performance buildings go, the opportunity for innovation presents itself in the way the design team works together to make sure that all the systems that use energy are no bigger than they need to be. Ensuring that the equipment installed in the building are right sized is by far more critical than hunting for the latest, most novel technologies or equipment on the market.

Keeping in mind that these requirements are relatively new to the vast majority of professionals in the field, not many consultants or contractors possess great experience with designing or building to these standards. Most people perceive high energy performing equipment to be more expensive and challenging to implement, and it is no surprise that many smaller providers or less experienced architects and construction teams stay away from them. It is only recently that sustainability has become a priority in building development, whereas previously the main priority was to keep costs low. Hence, it is now recommended to prioritize energy efficiency considerations in the very early stages of project feasibility.

Then there are also the issues of operation, maintenance and repair of the equipment that is installed in the building. Affordable housing owners are aware that they will need to manage this equipment for decades to come and so there should be a very straightforward way of operating and managing these systems.

From the onset, housing providers must consider the total cost of building ownership. This is by examining the operational cost of these buildings over the next 60 years. When that projection is done, any capital investment in year 1 (or year 0 during construction) in energy efficiency pays dividends for the next 60 years, easily making the business case to support incorporating high building efficiency measures. When one looks at it on that long term, it always pays itself back.

In the short term however the housing provider will almost certainly end up with a higher capital cost. Affordable housing providers, and especially those who operate on a smaller scale, may find it extremely challenging to raise additional funds to justify for example a geothermal system rather than typical low cost boilers. That is why during the project feasibility and design stages incorporating energy saving equipment that incur higher capital costs can be daunting to them. Therefore, it is impractical for the provider to consider the long term benefit unless the funder is also considering the increased costs attached to enhanced efficiency and supplying additional funding or more flexible conditions to reflect that.

Because FCM's budget towards the Green Municipal Fund (GMF) is limited, there is a greater emphasis on supporting innovative projects that have the potential to scale. FCM recognises that the need is much greater than available funding, and when designing a program it is necessary to be descriptive and prescriptive with regard to the overall aims, while also allowing for maximum flexibility.

FCM was constrained not only because of their own design and their internal policies and practices, but also, they were guided by the federal funding agreement and therefore have to abide by some of their prescriptive requirements. In the labour market, the challenge is that not all professionals are comfortable in that space; engineers, designers, and those who are doing the construction. That is a real barrier for some housing providers; to procure skilled labour at a reasonable rate, as a result of which they may add a risk premium on top of that too.

4.1.4 Exceeding Minimum Requirements

NHCF, RCFI, and GMF all offer incentives for applicants who exceed the minimum energy efficiency requirements. These incentives are in the form of bigger loans, bigger contributions, higher contribution to loan ratio, better terms or interest rates, etc. Encouraging building better than the minimum standard code also helps prepare the market (the developers as well as the

designers, engineers, and contractors) for future code changes that are going to become more and more stringent over time.

For FCM'S GMF, only for retrofits projects do energy outcomes correlate to more favourable terms or grant to loan ratio, that is to say for example, 25% reduction in energy use secures 25% of the asked amount as a grant and so on. That is in place to incentivize more ambitious energy reductions in retrofit projects. More and more retrofits are exceeding the minimum so that they can secure the highest grant percentage of 50%. For new builds on the other hand, as long as the project meets the minimum requirement, it automatically qualifies for a 50/50 Grant/loan. The terms are 10, 20, or 30 years, depending on the project's needs, rather than its performance.

As for CMHC's programs, applicants who exceed minimum requirements earn better terms and conditions on their loans and grants tier structure on the CMHC website. The conditions and terms will be very situational because it depends on the building and the energy savings. By and large most NHFC funded projects well exceed the minimum requirements. Upon completion and after some time of operation, these buildings have shown to not only exceed by a small safety margin, but rather they are performing 30% or 35% better than the base case when the minimum requirement is to go up to 25% .

4.2 Design Challenges

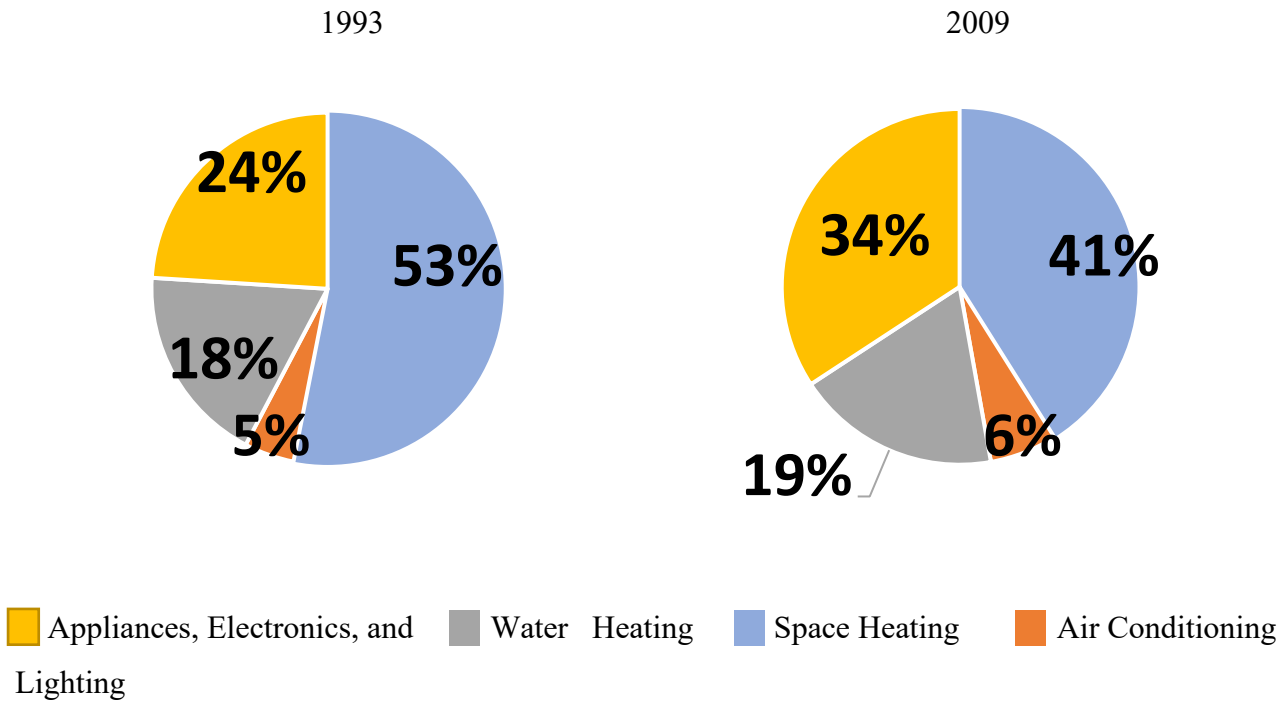
Densification is generally encouraged in urban planning, but the more people there are on a piece of land or the more intensity of use there is on a property, the greater the need for energy overall. That quickly outstrips the ability of the building to collect energy with an array on the roof. Although systems are improving so it is generally possible to generate a significant amount of energy with wall mounted arrays, many projects are not located quite north enough to make that work really well and very quickly. By increasing density, one can outstrip the ability of a building to produce energy, even if it is completely cladded with photovoltaic panels.

Another issue of increased density is achieving a manageable water pressure particularly for higher buildings. For instance, in Ottawa typically the municipal water main pressure can push water up five stories. In that sense, densification may not produce a very good quality of life. Furthermore, units in a residential building may be considered more efficient particularly as

opposed to townhouses in that there is one exterior wall per unit, which is extremely efficient. But energy performance in terms of heating and cooling as well as ventilation is one thing, but with increased density in a given space there are increased plug loads, that is energy towards electronics, appliances, and lighting (Sofos, 2016).

It is the responsibility of the development team to design an efficient building envelope, but residents add a plug load which cannot be anticipated at the design stage. In previous decades, energy spent in residential buildings was predominantly consumed by the HVAC (Heating, Ventilation, and Air Conditioning) systems. Nowadays in higher performance buildings the overall energy consumption has been reduced and so has energy towards aspects such as domestic hot water, heating and the cooling, but the tenants plug load has not shrunk (see Figure 4), it has in fact more than doubled since the 1970s (Center for Sustainable Systems, University of Michigan. 2021). It now represents a greater percentage of the overall energy consumption in that building.

Figure 4: Energy consumption in Homes by End Uses (quadrillion Btu and percent)



Source: U.S. Energy Information Administration, Residential Energy Consumption Survey. Note: Amounts represent the energy consumption in occupied primary housing units.

Another emerging design challenge for high energy performing buildings is reconciling low performing design preferences of the public such as larger windows considering that the best passive house windows for a cold climate in Ottawa are still three times worse in thermal control than the code level wall. So even though these windows are extremely sophisticated, a wall would still be three times better. That is why the code places much emphasis on the fenestration wall ratio. But the industry has developed a taste for using window walls and curtain walls to enclose a building because it allows for rapid construction.

4.2.1 Solutions and Means to Meet the Targets: Energy Generation

Different building types have varying capacities for energy use as well as energy generation. For instance, townhouses can typically produce much more energy than they use. On the other hand, commercial buildings can hardly generate as much energy as they consume. In theory, when energy efficiency measures are operationalised on a neighbourhood scale, buildings in a mixed use community will have an (average) total energy use intensity close to 80 kilowatt hours per square meter per year. Thus, it can be deduced that energy efficiency measure work best when they are applied and measured on a neighbourhood scale.

Energy generation is essential to achieving higher energy efficiency. For northern projects particularly those located in the far north face it is extremely challenging to devise a viable energy generation scheme. They are able to produce a fair amount of energy in the summer on days with more daylight, and far less energy in the winter, as they are able to harness more solar energy on longer sunnier days. This then calls for the installation of dual systems.

Thermal energy ought to start playing a role as well as electrical energy. A solution to bring some projects below the 80 kilowatt hours per a square meter was taking the domestic hot water load, which for residential building can be up to 1/4 of the whole energy profile and moving that on to a renewable source as the solar thermal collector and a storage system would have been able to get rid of that particular load. And one of the difficulties with electrification is when you're adding heating to the electricity load, the peaks get very high and the local utilities get concerned about being able to provide enough electricity for the project.

So far, solar photovoltaics have been the most reliable solution for energy generation in multiunit residential buildings. The only other viable source of renewable energy in residential buildings is wind. Wind power in at the building scale doesn't function very well. Wind power at the building

level does not function very well. Wind power at utility scale uses a turbine that generates one megawatt at the time or more, and typically starts with a hub height of 100 meters. Wind at the building scale is excruciatingly dependent on the adjacent buildings and the height of the buildings. It is not possible to actually generate an adequate amount of energy with a little windmill on a building. A commercial scale turbine field will be needed. Perhaps global advancements in the near future will resolve this issue

4.3 Energy Modelling

As part of the funding application for all of the programs discussed in this report, applicants are required to prepare an energy model. Energy modeling is to be done by qualified, certified experts using particular software and datasets. Essentially, the energy specialist models the proposed building to compare its performance as designed to the performance of the base model. The base case, or in the case of the energy modeling the base model (building), is defined in the National Energy Code for buildings. The energy modelling work for the proposed project is only to be conducted by an appropriately trained and qualified expert who is required to declare their qualification upon application. This serves as insurance for the financers receiving the application, however, this does not necessarily mean that models produced by experts are always accurate and correct. To a degree, there is confusion on the part of program managers who are not familiar with energy modeling and do not understand what the terms mean.

Energy models are necessary to understand and anticipate what the future performance of the building will be and whether that performance falls within the acceptable range set by funders. However, what happens when the building's energy performance as modelled and designed does not match the actual performance as built? In those cases, there will be no claw backs. So if the actual performance of the building does not meet what was anticipated in the design, FCM and CMHC will not compel the proponent to pay back the amounts that were borrowed or granted; instead they will work with the project development team to attempt to understand and rectify the situation.

FCM acknowledges that in order to do the modeling work upfront, resources will be needed. That is why they provide the funding at the planning or study stages. Applicants are asked for reporting for one year of energy or utility data post occupancy. For the GMF SAH programs, the

application review team does their due diligence by examining and verifying the accuracy of the energy modelling reports provided by applicants.

Seeing as how the Green Municipal Fund has only been in effect for a relatively short time, at this point in the program, there are no capital projects that have yet completed construction. And so there is currently no data to indicate how the anticipated results are lining up with the actual results. However, the program design team is aware that often energy modeling reports are ambitious, and that the outcomes of the building process are not entirely predictable. By the same token, the energy experts at FCM account for potential gaps between as designed versus as built cases, and they go as far as to apply significant risk factors to their analysis to eliminate as much uncertainty as possible.

Getting the energy modeling work done up front is important not only to help make funding decisions, but also to prompt the project team to consider overall objectives of the project. Certainly, FCM places emphasis on transparency with applicants, particularly when it comes to their evaluation, monitoring, and auditing procedures.

CMHC describes in great detail how they expect energy models to be executed and by whom. They specify that this is a step to be carried out only by someone with the appropriate experience, training, and certification. Moreover, they are very prescriptive in terms of the specifications of the summary page of the energy analysis report. They require the modeller to also provide their input and output data and very clearly highlight the outcomes of the report. When the application package is received, the evaluation team looks to ensure that all conditions have been fulfilled and the minimum requirements have been met or exceeded, as stated in the report. CMHC relies strictly on the material provided in the application, without necessarily conducting their own analysis to corroborate the submitted materials. Indeed this is a true illustration of good faith in the applicant.

However, there always remains the possibility of a follow up or audit conducted by CMHC to verify that the energy modeler indeed did an honest job to produce a relatively accurate analysis and that there were no errors or omissions. Similar to FCM, CMHC accepts that a lot of assumptions go into energy analysis, and so the energy reports provided at the design stage will never predict with 100% accuracy the building performance when built. In fact, following several energy monitoring processes, CMHC has discovered that all of their residential projects

that have completed construction and been in operation for a year or two perform better or worse than that designed by 10-15%.

And by large, models are overly optimistic in their assumptions; in their estimation of how construction actually goes and how people actually operate the building and adjust their thermostats, leave windows open, run water, etc. The way the building is used and operated can result in deviations from the initial assumptions. In the long run, it could be beneficial for modelers and developers to conduct their own monitoring procedures to learn how to better manage their buildings, and in the case of the models to learn how to tweak their assumptions. Discrepancies could also originate from changes in design, construction code, or materials. In those cases, it is required that if there is a material change to the fabric of the building that would have an impact on energy, then applicants have to resubmit an energy modeling report.

Energy modeling is also stipulated as an early requirement because it acts as an exercise to bring the project design team to consider innovative solutions such as additions of more insulation or better windows, air sealing, heat recovery, energy generation, etc. By these means, and thinking beyond the actual numbers, CMHC is trying to move the sector along in principle and in thinking to go beyond code.

For housing providers, an energy budget is just as important as a financial budget. That is, to specify, at the concept development stages the amount of kilowatts hour per meter squared (or an equivalent) to be spent yearly. This then positions energy efficiency as one of the guiding principles in the design stage at the forefront of decision making discussions. Granted, trade-offs will be made along the way, but setting an energy budget alongside a financial budget will hold the design team accountable. Although this would be an entirely voluntary step, in the future, setting an energy budget may become a compulsory requirement when applying for building permits.

4.3.1 Energy Audits and Monitoring

Although CMHC has not conducted any audits as of yet for any of its completed NCF or RCFI projects, it is still rather active in monitoring the completed projects. CMHC has researchers who are committed to examining the buildings that have been built under the National Housing Strategy and monitoring them for a year or gathering the energy data for a year. There is a preference to monitoring because it gives real time analysis. But reviewing energy bills and

conducting walkthrough audits help to confirm that the building was built in accordance with how it was designed and modeled, all the while maintaining reasonable expectations. This is a research effort to utilize the data and evidence to better understand how NHS programs might be adjusted going forward to reduce the inconsistencies. This then feeds into program evaluation, policy development, and knowledge mobilization products and channels for partners in the affordable housing sector.

4.4 Additional Costs Associated with Increased Energy Efficiency

There is the argument that these very specific energy performance requirements set by FCM or CMHC can impose unnecessary costs on affordable housing projects. From the very early development stages, affordable housing providers are confronted with the question: what targets will we commit to? There ought to be a belief on the part of the operating organization, if it is a new building, to strive to make it the best it can be. Higher performance buildings cost more, but not significantly so. The work done by the interviewed architects firm has premiums between 7 and 10% in construction. Building higher performance buildings requires an expressed commitment to enhanced performance from the beginning and an informed strategy.

It is true that higher performance buildings incur higher capital costs, but these costs pay themselves back in the long run. If the initial reluctance is overcome, and the total cost of building ownership is evaluated, then it becomes clear that in the long term these relatively high upfront cost translate to savings in operating dollars.

When applying for funding from FCM, applicants are asked to identify the energy conservation measures that are being implemented and the cost associated. The payback period is defined as the time after which the cost of implementation is paid back to the housing provider through energy savings made incrementally and over time. Although not all energy efficiency equipment offer a good (short) payback period, many do. There certainly are cost savings to be had from an operational perspective for a number of energy efficiency measures.

4.4.1 Stack-ability

The Green Municipal Fund had the advantage of using the NHS programs as reference points as programs that were in existence long before the GMF was launched. After examining the energy

requirements set by the NHS RCFI, the GMF team decided to aim for even higher objectives. The intent was to design a program that was going to push people to the next level, and that is how their energy performance requirements came to be. This is also reflected in their approach to setting requirements for retrofit projects. The GMF team opted for an identical requirement as the NHCF for energy performance, that is a 25% reduction in energy use. It is also noteworthy that the GMF programs also happen to have the same affordability requirements as the NHCF, thus making it easier for applicants to secure funding from both NHS and GMF programs and to reduce barriers to stack-ability.

At the launch of the GMF programs, their minimum EE requirements looked quite different from what they are today. Requirements in early days were much broader, only asking projects to be designed to a NetZero Energy or NetZero Energy Ready standard. Essentially, the GMF was asking for their applicant buildings to be very efficient. However, that elicited questions from unsure applicants: What meant by an “efficient building”? Buildings can go up to different heights, and offsetting the energy used by a three storey building with a surface area that can allow for solar energy generation on the roof, will not be done in the same way as it would be for a fifteen storey building with a different surface area. Simply stating NZE or NZER was insufficient. That is when the net total energy use intensity requirements were deployed, to provide more clarity.

Applying for funding from the GMF is a competitive process; there is only so much funding that is available on an annual basis. Outside of meeting the minimum criteria, in reality, it takes a great deal of ambition and innovation to make a project stand out. Evidently, that is not always easy for some of the smaller not for profit associations that must compete with larger organizations such as Toronto Community Housing, who have the means and resources. In this sense, all applicants are constrained, but not all are constrained equally. Indeed, many funding opportunities could be made available, but what is equally as important is the availability of the capacity on the applicant organization’s part, to apply for these various programs and the capacity to make these projects happen. The GMF team recognizes the scarcity of capacity and resources as a real issue, and they attempt to address it by creating capacity building tools such as regional energy coaches.

There was a concerted effort to design the GMF SAH programs to be stackable with the Co-Investment Fund. FCM engaged stakeholders to learn about the experience of housing providers who have faced some challenges with the complex application process to the NHCF program. This was done intentionally to make the process of applying to the newer GMF programs as seamless as possible. On the other hand, a concern for CMHC is to make sure that applicants are not stacking money from multiple sources to pay for the same things. It becomes somewhat of an administrative challenge to grasp the contributions of each financing partner and then dissect which portion of the work is being paid for by which partner.

4.5 Affordable Housing at The Forefront of Sustainability

Affordable housing has been known to be at the forefront of sustainability in Canada. In fact the first light steel Passive House construction in North America is Ottawa's Karen's Place. It is a 42-unit social housing project. It was also Canada's first multi-residential social housing project passive house certified and it is also believed to be the world's first cold climate certified large multi-family Passive House (Passive House Institute, 2016).

Figure 5: Karen's Place, Ottawa

Source: Karen's Place formerly Salus Clementine, Ottawa, Ontario Canada , Passive House Institute, 2016

This has been demonstrated for the past 5 to 10 years as so many of the new, leading edge projects have come out of non profits and affordable housing providers. The reason for that is because non-profits own and operate their buildings in perpetuity. For-profit developers on the other hand, solely seek to maximize their profits and minimize their costs even if at the expense of tenants. A private developer may not be as concerned with long term lifespan or performance of building equipment, or the potential future increases of fuel costs.

Thus, a non profit that is building with the intention to hold is obligated to examine the long term as well as the short term total cost of building ownership and operation. As the designers who are involved from the early stages of conception, they are able to make decisions that make and keep these buildings as truly affordable as possible. Therefore energy efficiency and high performance must be built into the design of these buildings.

Seeing as how private developers are not as limited in their funding sources, they are not beholden to receiving support from CMHC or FCM or any other government body that ties their funding to the achievement of minimum environmental requirements. Because private developers do not face the same pressures from financers, they do not have to achieve greater environmental objectives and they can conveniently develop low performing buildings without considering the overall societal costs of doing so. Although capital costs towards energy enhancement are virtually guaranteed to be recouped over the years, because private developers build to sell and rarely retain their buildings, it monetarily serves them to be short-sighted.

It is also important to consider the direction that the Canadian building sector is heading in. The government has committed to reaching net zero emissions by 2050. Taking this into account, allowing the development of inefficient buildings is counter productive. Buildings that do not meet that standard today are guaranteed to spend additional money to retrofit within the next 20-30 years. This will harm the building owner in the long run and the burden of poor energy efficiency will be borne by either the building operator or the tenants whose utility bills will undoubtedly be considerable, in some cases leading to energy poverty. Therefore, building an inefficient building may not affect the building developer in any way, but there is a societal cost to be paid regardless.

It can be said that the affordable housing sector is leading in the sustainability field, however it can be more challenging for a lot of small providers. Social and affordable housing is fortunate

enough to have a long sightedness ingrained in their mission and they possess a long term view of the ownership of their buildings. Their objectives are different from that of a private developer's in that they are motivated by a social purpose. Their broader range of considerations factor in climate issues and the burdens of utility bills.

Moreover, the mission of affordable housing providers aligns well with the stated objectives of NHS programs and FCM SAH initiative. That of the SAH initiative is to "switch to energy-efficient options and lower your energy bills" (FCM, 2021, Sustainable Affordable Housing). Admittedly, some of CMHC's best buildings are out of the affordable housing sector, whether they are public housing, Coops, or non-profits.

4.6 Broader Benefits of Enhanced Building Performance

There are a number of different energy and non energy related benefits associated with committing to a higher performance building. FCM considers a triple bottom line perspective that encapsulates environmental, social, and economic benefits of a project. FCM requires applicants to outline the triple bottom line associated with their project to prompt applicants to consider the benefits of developing their projects from different angles.

From a local economy point of view, many heat pump systems are powered by natural gas that is imported from remote regions, and so has a higher cost. Employing local manufacturers and maintenance workers, paying local companies to extract heat from our own environment rather than the ground somewhere in another country, in another province- these strategies stimulate our local economy and help make it independent and circular.

From an environmental point of view, when it comes to buildings, decisions made today have long standing impacts. Investing in higher performance leads to reduced levels of greenhouse gases that are being emitted into the atmosphere. There are health benefits as well. Whereas in old buildings, air would be continually pumped and then made up for its loss through the building envelope, in newer high performance buildings, fresh air is delivered to every single space with a dedicated duct. So each space is being provided fresh air and the old stale air is being exhausted, addressing smells as well as carbon dioxide. These buildings are highly

insulated, therefore there's less noise intrusion between the units as well as from the outside. Tenants are generally more comfortable in them.

As for further social benefits, emergency response preparedness is a pro of high performing buildings. These buildings tend to be more resilient to extreme weather events so they keep their heat for longer in the winter and they stay cool longer in the summer, and they can operate without power without being too much of a risk for a long period of time.

The focus for environmental outcomes are energy savings and GHG reductions. FCM sees energy efficiency as a way to drive affordability which then would be the biggest economic benefit. Looking at it though a social lens, some might say that affordable housing is as much a social issue as it is an economic issue. Highly efficient buildings deliver better air quality and promote the health and well being of their residents, particularly as more people are spending more time in their homes while working remotely. It is a way to promote the well being of residents, their comfort (quality of life), and pride in their homes.

4.7 Considerations for Applicants

FCM now has successful projects that could be used as case studies. To future applicants, it is important to remember that all stakeholders involved, affordable providers, designers and funders are all working towards common goals for affordable housing, and where possible, efforts should be streamlined, reducing complexity and promoting flexibility on the financers' part. Additionally, FCM offers a multitude of capacity and knowledge building resources. They regularly host webinars and provide helpful materials on their website such as their "project workbook" that helps applicants determine their eligibility, build their application, and anticipate the amount of financial contribution their project may receive .

Although this is somewhat of a given, the SAH team encourages applicants to read the guides provided along with any other support materials. When submitting an application, completing documentation is key. That is how the application review committee evaluates projects on meeting the minimum requirements for sustainability and affordability and examining their level of innovation and ambition.

Following this, applications are evaluated through a relative lens, the expectations for big housing providers are different from expectations for a smaller provider with less experience under their belt. Beyond the project itself, the team that will deliver the project must be strong, experienced, and reliable.

Applicants are advised to develop the project concept with the energy efficiency requirements in mind from the very beginning. The most cost effective way to build for energy efficiency is from the ground up in an integrated way where it is possible to make the trade offs as the buildings are being designed. The more planning/ design room is given to the development team, the easier it gets to meet the minimum requirements and exceed them.

Based on the work that CMHC has done on multi unit residential buildings, it has been proven that more complex systems are especially challenging to deal with after the fact. The more that can be done to achieve energy requirements through passive means- through incorporating systems that do not require much maintenance- the better. High maintenance energy management systems or any overly complex ground source energy system coupled to hot water or solar can become a hinderance. When it comes to multi unit residential buildings, especially in the affordable housing sphere where on site engineers who may not always be available to sit in buildings to keep all systems running, it is better to avoid complex equipment altogether.

It is recommended to conduct integrated design planning charrettes to ensure that the targets are known to all consultants on the team who can then adhere to the requirements and make sure targets are met. Opting for a more integrated, holistic approach that is iterative becomes much more cost effective than a more a linear building practice.

Tenant engagement is also an important factor in meeting energy efficiency goals. It is often overlooked that occupants have a significant impact on energy consumption. Highly energy efficient buildings, buildings that eliminate heat loss and heat gained outside through a better envelope and reduced energy waste in mechanical and electrical systems, are heavily dependent on occupant interactions. When everything else has been designed optimally, the big unknown then is how occupants actually use things. The tenants' role in energy efficiency grows, the more efficient the building. Then it becomes important to devise an occupant engagement strategy that not only makes occupants aware of the objectives of the building but also includes them as a part

of it. Continuous tenant engagement to make sure they are sympathetic, or outright supportive, to the cause as the building moves forward in time is needed.

And finally feedback- ensuring that energy and water use, garbage production, recycling, etc. are measured and monitored plays a big role in detecting issues and correcting them in a timely manner.

4.7.1 Example Project- 159 Forward Avenue

Centretown Citizens Ottawa Corporation is an Ottawa based Canadian non-profit, mission-driven affordable housing provider. CCOC has nearly 50 years of affordable housing operating experience, with over 1,800 units in total that make up the organization's portfolio. CCOC created Cahdco to develop affordable housing and provide development consulting services to non-profit organizations. As such, Cahdco is the project manager for this remarkable project on 159 Forward and CCOC is the owner and future operator.

Figure 6: 159 Forward Ave

Source: http://www.cahdco.org/project/forward-family-shelter/

This new affordable housing project will house mixed-income families. The project, is currently under constructions and happens to be on a site that was previously a dedicated to a family shelter which was shut down in late 2018 (City of Ottawa, 2020, Site Plan Control Application Summary). The project is a four-story, 49-unit residential building located in the well-established neighbourhood of Hintonburg, Ottawa and consisting of 5 studio units, 22 one-bedroom units, 8 two-bedroom unit, and14 three-bedroom unit. Through this mix of unit types, CCOC will be able to accommodate the needs of differently sized families in the community.

To aid the long term financial feasibility of the project and in order to promote diversity of tenants, the units will be rented at varying rates: average market rent, below market rent, and Ontario Disability Support Program (ODSP).

In order to cover the considerable total project cost of $23.8 Million, CCOC had to seek funding from a various sources and this project, by virtue of it's ambitious targets and its anticipated societal impacts, was able to receive great financial support from all levels of government in the forms of loans, grants, and land award through a competitive Request for Proposals.

With the support of the several grants received from city of Ottawa, CMHC, FCM and other funder, 159 Forward will have a reduced impact on the environment through energy-efficient Passive House design, as well as solar photovoltaic (PV) generation on the roof. The building has been designed to Passive House standards to help maximize the building's energy efficiency, sustainability, and resiliency. By striving for and achieving this standard, the project is projected to not only met but exceeded CMHC and FCM minimum requirements for energy efficiency and GHG emissions. Table 6 lists the energy efficiency measures that will be integrated into the building to aid it in reaching the Passive House standard (WSP, 2020).

Table 6: : 159 Forward Sustainability / Energy Efficient Features

Item	Meets of Exceed Ontario Building Code 2012 Requirements
Design	The building will be designed to meet Passive House Standards. It exceeds the energy efficiency requirements of the Ontario Building Code and the National Energy Code for Buildings .
Air Tightness	A thick air-tight envelope will aim to limit the air change rates to 0.6 AC/H. This exceeds minimum requirements for airtightness.
Ventilation	An Energy Recovery Ventilator (ERV) will be used to handle the ventilation. It will help manage both the moisture content and temperature of the air.
Mechanical Systems	Centralized mechanical systems will limit penetrations into the building increasing the integrity of the building's envelop and maximizing air tightness.

Windows, Walls, Roof	The envelope will be designed to maximize R-value, minimize air flow through the envelope, and limit sound penetration. This will limit heating and cooling costs to a quarter of a traditional building.
Appliances	All appliances will be energy Star rated and the building will seek to achieve an EnerGuide rating greater than 80.
Plumbing and Lighting	All plumbing fixtures will conserve water and all lighting will be LED and minimize energy use.

Source: Site Plan Control Application by WSP (CCOC, Action Ottawa Proposal)-

5. Conclusion, Policy Implications and Recommendations

The two National Housing Strategy programs that are being investigated in this report namely the Co-Investment Fund and the Rental Construction Financing Initiative both require new buildings to exhibit a decrease in energy consumption of respectively 25% and 15% below the base case that is presented in the 2015 National Building Energy Code. The Federation of Canadian Municipalities Green Municipal Fund requires new builds at a minimum to not exceed a total annual energy use intensity of 80 kWh/m^2. Both make special considerations for northern housing projects.

The FCM has worked with external experts to develop the GMF financing program and to utilize the TEUI as its measure, setting 80 kWh/m^2.as its prescribed maximum. The program team believes that this is a realistically attainable goal for applicants, that will simultaneously be enough to make an observable difference in the field while leaving room for ambition and innovation in the long term. On the other hand, the NHS programs took an approach that incorporates the existing and regularly updated National Energy Building Code. This is because CMHC has deemed that a favorable strategy would be one that is in alignment with the efforts of the federal government on the building code side of things. Both the FCM and CMHC make allowances for applicants to follow any desired path as long as they can prove that these requirements will be met or better yet, exceeded.

Certainly the challenges that face highly energy efficient housing projects in addition to all the potential financial barriers, are the numerous design issues discussed in this report, particularly challenges that come with building heights, severe climates, and complex building equipment. As a building gets taller, its overall energy used increases with increased number of people living in it. Experts advise that energy generation which is needed for reaching a net zero energy or net zero energy ready standards is the surest way to meet the minimum requirements. This can be done through the installation of photo voltaic panels throughout the building envelope and roof. The use of solar energy could be particularly challenging in northern communities where sunlight is not abundant for most of the year. This research has also revealed that it is recommended to pursue appropriate, uncomplex, rightly sized equipment when designing and planning for energy efficiency.

Furthermore, I have ventured to understand what places affordable housing providers at the forefront of sustainability, particularly when compared to for-profit developers. Firstly, it is embedded in their mission to care for tenants and prioritise affordability. Secondly, affordable housing providers typically build with the intention of holding, not selling. And thus it is ultimately in their interest to produce a building that is going to remain in good condition for as long as possible, all the while keeping the costs (including utility, maintenance, and repair costs) to a minimum. Thirdly, non-profit housing has limited funding opportunities, and in order to secure financing from government, they are required to meet targets set by the funders, whereas private developers may not be inhibited by the same limits as they resort to other financers. Housing providers that are successful are often the ones who consider the total life-cycle cost of building ownership, prioritize energy efficiency in the very early stages of a project, and adopt an integrated design process that involves experienced architects, engineers, and consultants. Mandating more stringent energy efficiency measures comes with an increased upfront project cost. Experts interviewed in this report estimated this premium in capital cost to be up to 10%. That is to say the capital cost of a Net Zero Energy Ready building will be 10% higher than that of a similar building that is not designed to the same NZER standard.

As for the costs associated with conducting energy modelling studies, costs that are greatly felt by housing providers, funders who mandate these studies affirm that they in fact provide the dollars required to get energy modelling work done. For FCM that is through the Planning Grant, and for CMHC that is through SEED Funding. These are funding programs that are available at the early stages of a project when the feasibility work is to be conducted. From the perspective of a non profit housing provider, the costs of meeting those higher performance standards and conducting the required modeling work often end up being operationalised. It is less than ideal for affordable housing projects, which are not inherently geared toward making profit, to incur costs that will later be carried over many years.

Outside of financial challenges associated with designing and building for energy efficiency, there are limits on the capacity and the availability of specialised labour. For example, CMHC when evaluating a project do not have energy modelers on staff and cannot interpret the results of the model provided by the applicant. Further, affordable housing buildings often lack the capacity to hire someone who is familiar with these mechanical, electrical, energy conservation

systems, and that is a gap that that many of the affordable housing providers cannot fill yet. This is perhaps where we look to the housing sector to address these capacity issues by educating, training, and fairly compensating construction managers, sub-contractors and general contractors.

Whereas the FCM has been transparent in communicating how they arrived at their requirement for a Total Energy Use Intensity TEUI of 80 kWh/m^2.for new builds, the same can not be said about CMHC's approach when designing and setting requirements for their National Housing Co-Investment Fund and Rental Construction Financing Initiative. Undoubtedly, the National Building Codes are backed by a great deal of research, but whether CMHC has consulted with anyone to advise their funding programs is unclear. A greater level of transparency between finances and applicants is called for, particularly regarding the issues of application review and evaluation, energy audits and long term monitoring . Furthermore, the factors considered in building code review are worthy of investigation when much of the discussion now involves embodied energy, health, and survivability in the face of extreme events.

Looking to the future, there now are tiers for performance in the most recent version of the Building Code 2020. It is outside the scope of this study, but further research could be conducted to investigate whether the building code changes (and future proposed changes for that matter) come with a cost benefit analysis that considers operation costs along with the upfront cost.

Furthermore, I will be looking forward to seeing if Co-Investment requirements will be changed to align with the new 2020 National Building code. Even further, the question is whether CMHC will continue adopting these "legacy" requirements even when they become outdated or when they prove to be no longer sufficient to meet the greater goals of dramatically reducing the country's environmental impacts.

Moreover, considering that these programs have been in effect for several years now, it is imperative to look into gathering realistic operating data for completed housing projects, (particularly those in Northern areas for which data is currently scarce), to examine the "as built" vs "as designed" discrepancies and to then revisit the current requirements and adjust them accordingly. Additionally, there could be value in collaboration between FCM and CMHC. This could be done through streamlining the applications so that if a proponent has already applied to,

for example, the NHCF and is interested in applying to GMF as well, that there would be accommodations made as to not duplicate efforts on the applicant or the financers' part.

Recommendations for affordable housing developers and providers are first and foremost the application of the Integrated Design Process (IDP) during planning, design, and implementation; secondly, the hiring of an experienced design and development team; thirdly, sourcing for durable materials and considering a life cycle analysis; and lastly devising a targeted air-tightness strategy which will improve energy performance without compromising air quality inside residential units. It is imperative to do the energy modeling to ensure that the building will meet or exceed the requirements. Finally, it is advised to hire a neutral party independent of the construction manager to commission the building. This will ensure that plans are followed and best practices are applied throughout the construction process. And when the construction has concluded they produce materials for the building staff to know how to operate the equipment. This then adds to the overall integrity of the project.

Often overlooked is the role of the tenant. Professionals highlight tenant engagement, education, and participation as a critical factor in achieving energy efficiency goals. This is especially important as building systems become more efficient and the plug load becomes an increasingly determining factor of building energy use intensity. Positive occupant practices are not only to be encouraged but also monitored.

These funding programs have been in effect for years now, and even prior to their existence Canada had set environmental goals that are linked to energy efficiency in the building sector, pleading with the building sector to pursue high energy efficiency. However, it is still not entirely clear to all what is meant by "an efficient building" especially as the goal post for energy efficiency targets is moved year after year. While that might be the case, ultimately, all stakeholders seem to agree that well-built, highly efficient buildings undeniably promote healthier conditions for their tenants, they last longer, have a higher chance of surviving extreme events, help housing providers and tenants cut down on utility bills in the long term, and in a broader sense contribute to a national and global vision towards reducing negative impacts for the climate.

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Appendices

Appendix 1: General Contact Email Letter

Date
contact name
title
company
address
city, province/state, postal code
phone number
email

Dear (insert name of participant):
My name is Aisha Ahmed, and I am a Master of Urban Planning candidate at the McGill University School of Urban Planning. My Master's research project, entitled **"Investigating Energy Efficiency Requirements Associated with Affordable Housing Funding Programs: Co-Investment Fund, Rental Construction Financing Initiative, and the Green Municipal Fund"**, is an exploratory study of the differing professional perspectives on energy performance targets set by National Housing Co-Investment Fund (NHCF), Rental Construction Funding Initiative (RCFI), and the Federation of Canadian Municipalities' Green Municipal Fund (FCM GMF). It will investigate baselines for energy efficiency modelling of new builds as well as funding amounts that can be accessed when varying levels of energy efficiency are achieved. It aims to demystify the details surrounding energy efficiency requirements for new builds as prescribed by the aforementioned funding programs.

I am writing to inquire if you would be willing to be share some information regarding your housing projects as part of this research. The interview should take no longer than one hour and can be conducted online by video software, or by phone. The questions would be concerned with your professional experience with funding tied to energy performance and the trade-offs between energy efficiency and affordability.

With this interview I hope to gain a better understanding of the minimum energy efficiency (EE) requirements set by different national housing funding programs, and to explore the means by which successful projects have managed to meet these requirements in the past. This study looks at a number of case studies of affordable housing development projects. I hope to gain a better understanding of the levels of financial support that can be secured when those minimum requirements are met or exceeded, and to explore the relationship between affordability and energy efficiency. Ultimately, it would be valuable for the purpose of my research to document the lessons learnt through your expertise.

If you agree to participate, that would be very helpful for my research. Once finalized, I would be more than happy to share the final project with you. I will be contacting you via telephone or email in the near future to follow up on this request and confirm your interest in being interviewed. Please feel free to contact me with any concerns or for further information. I appreciate your time and consideration and look forward to hearing from you.

Sincerely,
Aisha Ahmed
Master of Urban Planning Candidate
McGill University
Aisha.ahmed@mail.mcgill.ca
438-926-5539
Supervisor: Madhav Badami
Madhav.g.badami@mcgill.ca
Version 1 June 18th, 2022

Appendix 2: Participant Consent Form

REB# 22-05-055

Researcher(s):

Aisha Salahdiin Ahmed

Graduate Student

McGill University School of Urban Planning

438-926-5539

Aisha.ahmed@mail.mcgill.ca

Supervisor:

Madhav Badami

Professor

School of Urban Planning

Madhav.g.badami@mcgill.ca

Title of Project: "Investigating Energy Efficiency Requirements Associated with Affordable Housing Development Funding Programs: NHCF, RCFI, and GMF"

Sponsor(s): There are no sponsors for this project.

Please read this consent agreement carefully before you decide to participate in the study.

Purpose of the Study:

- To ascertain your professional and/or personal understanding of what the energy efficiency requirements set by National Housing Co-Investment Fund (NHCF), Rental Construction Funding Initiative (RCFI), and the Federation of Canadian Municipalities' Green Municipal Fund (FCM GMF) are, and what level of financial support can be secured when those requirements are met or exceeded.
- To compare this understanding with other participants.
- To glean lessons for the affordable housing development

Study Procedures:

Your contribution to the study will be to answer a series of questions based on your work experience. The interview will be held at your convenience. This will be done remotely via McGill MS Teams

and will take no longer than 1 hour. You will be free to skip any question you do not wish to answer or to end the interview at any point.

Your responses will be recorded, and notes will be taken. You are free to keep your camera off should you wish at any point throughout the interview. You are free to review the notes at any point.

For long term retention, data will be stored in Professor Madhav's (my supervisor's) McGill OneDrive cloud storage. Data will be retained for a minimum of 7 years on the McGill OneDrive cloud, accessible only by myself and the supervisor of this research. In the case that data is to be shared, it will only be at your (the participant's) consent.

As the project progresses, issues not considered in the initial interview (e.g. a particular issue not anticipated) may arise, and you may therefore receive follow-up questions by email or phone, which you may again choose whether or not to answer.

Voluntary Participation:

Your participation in the study is completely voluntary and you have the right to withdraw at any point until which the written report is published (anticipated late-summer 2022). You do not need to answer every question posed to you, and you may withdraw your response at any time until the report is published. Even after publication, you may withdraw your consent, and your data will not be used for further publication. The text of the final report will be made available and shared with you. Please note that despite all precautions, there remains a small risk of interception of data transmitted over VoIP. However, please be assured that recordings will never be disseminated.

Do you consent to being recorded in the interview as part of this research? ☐ Yes ☐ No

Please sign below if you have read the above information and consent to participate in this study. Agreeing to participate in this study does not waive any of your rights or release the researchers from their responsibilities. To ensure the study is being conducted properly, authorized individuals, such as a member of the Research Ethics Board, may have access to your information. Please keep a copy of this information for your own reference.

Signature ……..

Date ……..

Appendix 3: Sample Interview Guidelines

Energy efficiency requirements and rationale

What are EE targets set by CMHC Co-Investment funding program, particularly those set for prospective projects applying through the New Construction stream?

What are EE targets set by CMHC Rental Construction Funding Initiative?

What are EE targets set by the Green Municipal Fund for new builds?

What is the rationale behind setting those specific targets and using those particular metrics?

These requirements apply uniformly to all perspective projects seeking funding in Canada. How can the scoring criteria for funding applications account for variations in climates across different regions of the country ?

Energy modelling for CMHC/ FCM: How do you read the technical energy modelling documents? who reviews the document expert vs policy maker? How deep is their understanding? Who audits the projects to make sure they meet the targets?

What is the long term monitoring process?

How was it previously?

Funding tied to Energy performance

What funding amount can be secured when minimum EE targets set by CMHC Co-Investment funding program are met, particularly those set for prospective projects applying through the New Construction stream??

What funding amount can be secured when minimum EE targets set by CMHC Rental Construction Funding Initiative are met?

What funding amount can be secured when minimum EE targets set by the Green Municipal Fund for new builds are met?

Exceeding the minimum EE requirement is encouraged by funders and is a way to acquire more points when building a funding application. Has any of the projects you've worked with

exceeded the EE requirements set by funders? If yes, what has been your experience with being awarded additional funding?

For FCM: Energy conservation methods- payback periods ?

Energy efficiency and affordability

Affordable housing providers are often at the forefront of sustainability, why do you think that is the case?

Do you think that the specific energy performance requirements set by CMHC and FCM can inhibit innovation and impose unnecessary costs on affordable housing projects?

How do you reconcile more efficient building operation and reducing operating costs?

Since funding is ideally stackable, what challenges do these varying requirements from different sources present to affordable housing projects that aim to secure funding from as many sources as possible?

In your experience, what are some of the challenges of designing for EE?

Are tenants paying rent AND utilities? Or just rent? Does enhancement in EE make a difference in affordability in either case- from the tenant perspective?

What has been your experience with projects that predated these requirements?

What are some lessons you've learned in your attempts to enhance energy performance in order to meet funding requirements for affordable housing projects?

Appendix 4: Ethics Approval Certificate

McGill University
Research Ethics Board Office
www.mcgill.ca/research/research/compliance
/human

CERTIFICATE OF ETHICS APPROVAL

REB File Number:	22-05-055
Project Title:	Investigating Energy Efficiency Requirements Associated with Affordable Housing Funding Programs: Co-Investment Fund, Rental Construction Financing Initiative, and the Green Municipal Fund
Student Principal Investigator:	Aisha Ahmed
Department:	Urban Planning, School of
Supervisor Name:	Professor Madhav Badami
Sponsor/Funding Agency (if applicable):	

Research Team (if applicable):

Name	Affiliation

Approval Period:

FROM	TO
23-Jun-2022	22-Jun-2023

The *REB-I* reviewed and approved this project by Delegated review in accordance with the requirements of the McGill University Policy on the Ethical Conduct of Research Involving Human Participants and the Tri-Council Policy Statement: Ethical Conduct For Research Involving Humans.

* Approval is granted only for the research and purposes described.
* Modifications to the approved research must be reviewed and approved by the REB before they can be implemented.
* A Request for Renewal form must be submitted before the above expiry date. Research cannot be conducted without a current ethics approval. Submit 2-3 weeks ahead of the expiry date.
* When a project has been completed or terminated, a Study Closure form must be submitted.
* Unanticipated issues that may increase the risk level to participants or that may have other ethical implications must be promptly reported to the REB. Serious adverse events experienced by a participant in conjunction with the research must be reported to the REB without delay.
* The REB must be promptly notified of any new information that may affect the welfare or consent of participants.
* The REB must be notified of any suspension or cancellation imposed by a funding agency or regulatory body that is related to this study.
* The REB must be notified of any findings that may have ethical implications or may affect the decision of the REB.