

Urban Renewal: Opportunity for Green Innovation in the  
Face of Climate Change,  
A Case Study of Toronto Community Housing

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## **Abstract**

Cities around the world have established ambitious targets to reduce greenhouse gas emissions in order to limit the global average temperature increase to within 1.5°C of pre-industrial levels by 2050. The effects of climate change are felt globally but urban environments are enormous contributors to emissions. With the majority of the globe's population residing in cities, they are the most vulnerable to the effects of climate change, which can be catastrophic. Urban renewal, the natural replacement and restoration of buildings, presents an opportunity to interject and guide development to a more sustainable trajectory, in a way that considers the benefits of ecological processes in cities.

This major paper argues for the adoption of stronger green building standards in Toronto, beginning from the City's own building stock of Toronto Community Housing (TCHC), in order to demonstrate leadership and protect the people who are most vulnerable to the negative effects of climate change. The paper does this by exploring the current green building best practices used in North America and how they demonstrate, or are limited in, supporting sustainable development. Consideration is given to whether building high-efficiency buildings is the best option for sustainable development by weighing different factors. Despite best practice weaknesses, ultimately, it is the benefits that are extracted from these practices that are important, rather than any form of certification. Green building development is explored by looking at a case study of TCHC, to understand how the City, as a public entity, can lead the way in green development. This research finds that TCHC is tenaciously using sustainability as a motivator for resident wellbeing, financial sustainability, and reduction in greenhouse gas emissions. However, the case study also reveals limitations to further development of TCHC's green buildings and emission reductions. This paper identifies those limitations and formulates recommendations to facilitate further reducing emissions.

The city's overall greenhouse gas emission reductions have come to a halt, and this is a sign that additional measures need to be taken to continue to reduce emissions. Improving green building standards for renovations, investing in data collection, and addressing user behaviour through education are the recommendations given in this paper to take the next steps to further reducing building-related emissions. These recommendations will allow TCHC and its tenants to lead efforts to reduce the city's greenhouse gas emissions. The recommendations focus on maximizing the benefits from green technologies. As a city, Toronto must consider the majority of the current building stock, which will continue to exist into 2050, as well as new buildings which will exist for much longer, in its efforts to further reduce greenhouse gas emissions.

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## **Foreword**

This major paper is the final piece needed to satisfy the requirements of the Plan of Study for the Master of Environmental Studies (Planning) Program in York University's FES. The paper provides a background of urban issues that have become increasingly important in the widespread acceptance of climate change. Following this is a case study that examines how Toronto as a city is integrating its work on climate issues into social housing. From this study, limitations to future progression are identified and recommendations are made to suggest how the city can take its next steps to maximize benefits and continue the momentum it has started.

The body of work draws on the three components of my Plan of Study: Planning Practice, History and Theory of Planning and Urban Design, and Communication Skills in Planning. I have a firm understanding of the planning and related policies in place that guide my paper, as well as an understanding of global climate and local planning issues that relate to my paper. The policies and implementation measures have evolved over time and my paper seeks to address how they can further progress to act on the current and pressing issue of climate change. Lastly, I have been involved in planning policy formulation which has allowed me to better understand the overall planning process, as well as how to create a dialogue between planners and the community, and I have considered this in my paper.

My learning over the past six years in FES has led me to explore many different interests at various times throughout my degrees, and ultimately, I was able to combine each of these flowing interests into city planning. Because of the professors at FES, I was able to see how these elements fit together so that I did not feel lost, or insecure about if I had chosen the right path for myself. Instead, their confidence and shared knowledge

allowed me to feel secure that what I have learned at FES can be applied wherever my interests may evolve to next. It is the mindset of being able to look at the larger picture, and the interconnectedness of everything, which has given me assurance in my studies.

Since I have tried to incorporate as much practical work into my MES degree as possible, I spent a lot of my time during my MES degree doing studio work, and interning within the public sector in order to grasp the problems that municipalities face every day, as well as to understand the intricacies of planning. Much of my course work in MES has involved the topic of climate change, including a paper on how urban design can facilitate climate change adaptation strategies in cities, and a studio project designing a dense living space in harmony with a flood mitigation strategy. My work at the Municipality of Clarington included assisting in developing regulations to enhance the sustainability strategies of the Municipality through providing research assistance for the zoning by-law review and for their Priority Green climate change mitigation initiatives.

My interest in climate change has been prevalent since my undergraduate studies here in FES where I focused on sustainable energy. This major paper is an effort to combine my interests in urban planning and design, with environmental sustainability. My Major Research Paper concentrates on the urgency to act on climate change, identifying additional capacities to reduce greenhouse gas emissions, and the potential to do so with a combination of top-down and bottom-up efforts.

## **Introduction**

The rapid growth of urban landscapes and migration of people into cities over the past several decades have made cities particularly vulnerable to the effects of climate change. However, the concentration of skilled people, capital and contributors to climate change also puts cities in a position where they can take on a crucial role in responding to climate change. Climate projections tell us there is no time to wait to address this challenge and cities must lead the way with climate mitigation and adaptation strategies.

There are opportunities to innovate at this immediate time in order to create a better quality of life for the people of today and for future generations, which will suffer the larger consequences of climate change. Canada's recent agreement at the 2015 United Nations Climate Change Conference (COP21) to significantly reduce its greenhouse gas (GHG) emissions requires immediate action on mitigating climate change. The signing of the Paris Agreement at COP21 should be taken as a pinnacle point of intervention for cities to innovate and transform into environments that are sensitive and responsive to the challenges of climate change.

Toronto is a city that is mostly built-out; it has little new space to build on and is using urban intensification to accommodate for population growth. In its renewal efforts is an opportunity for intervention to create an innovative climate change mitigation strategy that addresses the impact of buildings on the climate and environment. Buildings have an enormous impact on global GHG emissions and cities need to target building sustainably, in the sense of giving consideration to the climate and environment. By using urban renewal as an opportunity to work towards reducing GHG emissions, while also incorporating natural processes into city design, cities can mitigate and adapt to the

effects of climate change. This paper specifically looks at the social housing building stock in Toronto as a place for intervention, in order to help those who can benefit the most from climate adaptation and mitigation measures.

This paper aims to demonstrate the potential for Toronto Community Housing (TCHC) and the City of Toronto to adopt stronger green building practices for buildings as part of its efforts to reduce GHGs. I argue that cities can implement green building standards that prioritize efficient use of resources and also contribute positively to ecosystem processes through opportunities presented by urban renewal. This is done by analyzing the work of TCHC's initiatives to 'build for sustainability', providing homes that aim for green building certifications through retrofits and new construction. This initiative is explored to identify limitations of climate change mitigation efforts and the possibility for the City to lead by example in allowing the values of green building to be accessible to more people. By giving great consideration to the environment when designing, cities can create urban projects that are socially, economically, and environmentally sustainable, lessening our climatic impacts on the globe and contributing to human and environmental health in urban areas.

In Chapter One, I give a general background of the issues addressed in order to demonstrate the purpose of this paper. I begin by explaining the current context of how cities are growing, the impacts that this has on the planet, how climate change is impacting cities, and current climate change mitigation agreements which require action in the coming years. I follow with a rationale of why climate change should be addressed on a city level, how the process of urban renewal can facilitate lowering building emissions, and the value of incorporating nature and its processes into cities. In Chapter

Two, I explain what green buildings are, and what part they can take in reducing GHG emissions. This includes looking at green building policies in Toronto, green building certification types, the strengths and limitations of each, as well as the comparison of building new green buildings versus restoring older buildings for maximized environmental benefits. In Chapter Three, I look at TCHC as a potential leader in moving the City's green building initiatives forward. This chapter includes understanding the background of TCHC and its buildings, the relationship between climate change and people living with fewer resources, and the current green building initiatives, policies, challenges and anticipated growth of TCHC buildings. In Chapter Four, I identify three challenges to moving green building forward at TCHC, and offer recommendation for addressing them. I conclude by offering a future outlook for the further development of TCHC's sustainability efforts and reduction of GHGs in Toronto.

The City of Toronto needs immediate and long-term sustainability plans to accommodate its population growth while creating a healthy and safe environment for its residents. It is possible to provide for social and economic needs harmoniously with climate change mitigation actions although innovation and persistence are key to achieving this. In the end it will be society who bears the consequences of climate change. Progress must begin now if the globe is to reach its goal of mitigating climate change, and every city has a part to play in this. An opportunity has become available to enhance the performance of urban structures and incorporate the environment into these enhancements, in an effort to ultimately achieve the goal.



## **Chapter One:**

### **A Growing City in the Face of Climate Change**

The City of Toronto and its surroundings have experienced massive changes in population and urban growth in the past half century, bringing attention to new challenges faced in the urban landscape. This chapter will provide a background to these changes and demonstrate how climate change mitigation by green building practices can be addressed at a city level. By addressing building related GHG emissions, the City can take steps towards building for healthy and resilient communities, especially touching the most vulnerable people to the effects of climate change that may be living as tenants of TCHC.

#### *Present Context*

The past few decades has seen a rapid change of land cover in the Greater Toronto Area (GTA) as the urban landscape has expanded outward from Toronto due to the increasing population of the GTA (Furberg & Ban, 2008; Wang, Li, Wang, & Li, 2015). The GTA includes the city of Toronto, and four regional municipalities (Durham, Halton, Peel and York) with a combined population of 6.5 million people. The GTA is the most populous metropolitan area in Canada and the fastest growing region in Ontario, accounting for almost 70% of Ontario's projected net population growth to 2041 (Ontario Ministry of Finance, 2014). This will bring the population from 6.5 million in 2013 to 9.4 million in 2041, and the GTA's share of Ontario's population is forecasted to rise from 47.6% in 2013 to 52.9% in 2041 (Ontario Ministry of Finance, 2014). The city of Toronto contains more than 2.7 million residents over 630 square kilometres, and the

population is expected to rise to 3.64 million in 2041 (Ontario Ministry of Finance, 2014). Toronto's population growth is at 31.3%, a similar rate to the province, and significantly slower than the surrounding regions within the GTA, although Toronto's growth expanded five-fold in the past two census reports (Ontario Ministry of Finance, 2014).

The GTA is the economic and cultural centre of Canada, as an important metropolitan area for foreign investment and trade flows, as well as for exchanges of culture, religion and technology (Wang et al., 2015). Keil and Boudreau (2005) state, "[i]t is the country's leading economic and financial hub and is considered by many the most multiculturally mixed city on the planet" (p. 9). It is also the biggest city in Canada due to high immigration numbers involving international, inter-provincial and intra-provincial migration over the past several decades (Wang et al., 2015).

Urban expansion in the GTA has largely been the substantial development of low density urban areas in the GTA over the past few decades (Furberg & Ban, 2012), with urban growth expanding 115 km<sup>2</sup> from 1974 to 2014 (Wang et al., 2015) at the expense of mainly agricultural areas (Furberg & Ban, 2012). This expanding urban growth is reaching into environmentally sensitive areas by sheer expansion outwards, and by construction edging closer to natural features. The extensive cover of impervious surfaces has caused the loss of ecosystem services such as infiltration, filtration, protection against erosion and connectivity between habitat patches (Furberg & Ban, 2012). One particular area which has come under threat from urban expansion is the Oak Ridges Moraine, which has raised serious concern pertaining to water quality and quantity and on the overall ecosystem health of the region (Furberg & Ban, 2008).

More recent urban expansion has been the development of suburban areas into higher density built-up areas and the replacement of rural areas with low-density built-up areas (Wang et al., 2015). In the city of Toronto itself (as the boundaries exist today), growth expanded rapidly around its boundaries from 1974 to 1991, seeing as almost all of the open areas within Toronto had already been developed, before growth expanded outwards in the surrounding regions during the 1990s. The 1990s saw a rapid deindustrialization of Toronto's inner city (Boudreau, Keil, & Young, 2009), especially along the waterfront which created new spaces for new developments and neighbourhoods that continue to be developed today. A number of new communities have grown in these former-industrial areas and railway lands.

The rapid and expansive growth of the GTA makes for inefficient use of physical and capital resources in the form of infrastructure, taxpayer dollars, and healthcare costs. For example, 30% of urban energy consumption goes toward pumping and collecting wastewater (Balaban & Puppim de Oliveira, 2014). Therefore, more compact cities reduce the distance and energy required to carry and pump water, and require less infrastructure to do so. This unsustainable land use pattern is counterproductive to climate change mitigation. In Blais' *Perverse Cities* (2010), she explains that cities can make use of infrastructure already in place by directing development to sites within the built-up urban area, "[i]n Canada, the rate at which we are urbanizing land is outstripping the rate of population growth by about two to one" (Blais, 2010, p. 64). Underutilized infrastructure can be maximized with new development, while also enhancing the physical environment, sometimes playing a part in retrofitting older areas (Blais, 2010). Blais (2010) also notes the many external costs of sprawl such as the destruction caused

to the environment, illnesses resulting from air pollution, noise disturbances, poor quality of life experienced by residents, and the economic consequences of climate change.

Reurbanization, rather than urban growth outwards into greenfield areas, has a number of positive benefits for people and the environment, which address the consequences of inefficient sprawling growth – the benefits of which have compounding effects. For example, increased transit ridership allows for lower road infrastructure costs, less air pollution due to vehicular emissions, positive health benefits, and protection of agricultural and sensitive environmental areas. Because of the enormous costs of building new infrastructure (roads, sewers, telephone wires, transporting electricity, etc.), reurbanization can provide a relatively low-cost way to accommodate new urban growth while preserving environmental lands. Blais (2010) states, “[d]ensity is probably the single most important determinant of the efficiency of the use of land and infrastructure” (p. 60). Urban renewal allows municipal governments to make more efficient use of underutilized lands providing the possibility of “employing a grow-in strategy to concentrate the majority of new developments in existing urban areas” (Balaban & Puppim de Oliveira, 2014, p. 872), in the form of mixed-use developments, effectively slowing the perceived need for urban sprawl.

In fact, the Government of Ontario has acknowledged the benefits of higher urban density levels, creating a vision of compact development, reurbanization and creation of urban centers in its policies. The Provincial Policy Statement (which guides land use planning in Ontario) includes policies on key issues that affect communities, such as the efficient use and management of land and infrastructure, and protection of the environment and resources. Ontario’s Growth Plan is an attempt to address urban sprawl

in the GTA (Ontario Ministry of Infrastructure, 2006). Among its many components, the Plan establishes a permanent greenbelt covering roughly 728,000 hectares of environmentally sensitive land. The policies also point towards mixing land uses to reduce automobile traffic, and more frequent use of public transit. These policies point in the right direction to curb sprawl, although the majority of new development is still allowed to occur in greenfield areas (up to 60% of new growth per region). The Proposed Growth Plan, 2016 strengthens intensification targets, directing 60% of new residential development to already urbanized lands, an increase from the current 40% (Ontario Ministry of Infrastructure, 2016). The urgency of acting on climate change is not expressed in the policies and larger steps need to be taken by cities as opportunities arise. These policies represent only a starting point for initiatives that cities can pursue to mitigate climate change. Initiatives can be pursued through legal and political systems, planning departments, zoning regulations, infrastructure and urban services, real estate markets, and fiscal arrangements (UCCRN, 2011).

### *Addressing Climate Change on a City Level*

On December 12<sup>th</sup>, 2015, COP21, the annual global conference to assess progress in dealing with climate change, came to an end with the signing the Paris Agreement – the commitment of 195 nations to actively pursue a global reduction in greenhouse gas emissions and aid in mitigating climate change effects. The Paris Agreement brought nations to a consensus for the first time on their responsibilities regarding the use of greenhouse gases and addressing climate change. A major part of the agreement is limiting total human-induced warming to less than 2°C relative to pre-industrial levels

(1861-1880), a temperature threshold that has been identified as a tipping point which will trigger abrupt and irreversible change, having drastic anticipated effects on the lives of people, as outlined in the Intergovernmental Panel on Climate Change's (IPCC) 5<sup>th</sup> Climate Change Report (2014). Following the recent election of a Liberal federal government, Canada took a lead role at the conference by supporting an ambitious temperature limit of 1.5°C. Current globally averaged combined land and ocean surface temperature data shows a warming of 0.85°C over the period of 1880 to 2012, putting strong pressure on governments to act now.

Anthropogenic carbon dioxide emissions have been increasing by 2.2% since 2000 (IPCC, 2014a). It is predicted that following this pattern, the world's average temperature could be 2°C hotter within 20 years and 3°C hotter within 30 years (Jackson, Friedlingstein, Canadell, & Andrew, 2015). Environmental scientist Rob Jackson has said that the world would have to decrease emissions on average by about four per cent each year to avoid surpassing the 2°C mark, and as developing nations still demand additional energy, countries like Canada would have to bear more of the burden and reduce their emissions by an extra one per cent (Sagan, 2015). Jackson goes on to estimate that the ambitious extra half degree reduction of temperature threshold that Canada has proposed requires emissions to decrease by 10% or more each year, and this gives policy makers about 10 years to reduce emissions before reaching the mark (Sagan, 2015). Emissions will have to decline sharply in Canada to reach these targets. Canada is currently committed to reducing emissions 30 per cent below 2005 levels by 2030. Climate change policy analyst Gideon Forman has said that Canada must commit to converting to 100 per cent renewable energy over the next 35 years to stay below the 1.5°C mark (Sagan,

2015). Clearly, drastic reformative action needs to be taken in Canada to reach the ambitious 1.5°C goal, as well as the official 2°C goal. This action requires innovation on all fronts, including in cities.

The Fifth Assessment Report of the IPCC (2014) projects that climate change will lead to a number of consequences for urban areas, including declining air quality, an increased number and severity of heat waves, increased pressure on infrastructure, and augmented stress on water resources. Residents of some cities in the world have experienced high levels of mortality due to the impacts of extreme climate events. The 2003 European heat-related deaths and the deaths of over 1,000 people in New Orleans owing to Hurricane Katrina in 2005 are two examples of this (UCCRN, 2011). Extreme weather events mostly threaten the health of the elderly, the infirm and very young. The effects of climate change are especially unfair as those most unable to adapt, and those who contributed least to the problem, will be harmed the most (The World Bank, 2010). The effects are especially significant for coastal cities which face rising sea levels and storm surges, affecting inhabitants, infrastructure, property and ecosystems (UCCRN, 2011).

Toronto has not escaped the effects of climate change. In recent years the city has broken record weather events, one after another (City of Toronto, 2013b). The extremes of this can be shown by records being broken in the most recent two months of February. Toronto's coldest month of February in recorded history was in 2015 with an average temperature of -12.6°C, and in 2016 the record of highest February temperature was a temperature of 16°C. Outstanding events include four massive power outages in three years due to extreme weather conditions: Hurricane Sandy in 2012 (that left 145,000

people without power), a summer flood in 2013 (that left many people stranded in their cars and on the GO Transit commuter trains, left 500,000 houses without power, and flooded 3000 homes), a December ice storm in 2013 (that left 500,000 people in southern Ontario without power over Christmas), and a blackout in March 2015 (that affected 250,000 residents). These power outages had significant impacts on the safety and daily life of residents as many had to temporarily move into hotels, public transportation operations were disrupted - reducing mobility of residents, and flights from Toronto's two airports were affected. There was damage to thousands of trees in and around the GTA, and the clean-up time and costs were considerable. The frequency and magnitude of these events is seen to be increasing, endangering lives, disrupting business operations and city budgets.

Climate change is expected to have significant impacts on four sectors in most cities – the local energy system, transportation, public health, and water supply, demand and treatment (UCCRN, 2011). Cities already tend to be hotter than surrounding suburban and rural areas due to the urban heat island effect: the absorption of heat by concrete and other building materials and the removal of vegetation and loss of permeable surfaces, both of which provide evaporative cooling. Another large problem facing cities is air pollution: the concentration of residential, commercial, industrial, electricity-generating, and transportation activities, contribute to air pollution, leading to acute and chronic health hazards for urban residents (UCCRN, 2011). Climate change poses serious threats to urban infrastructure, quality of life, and entire urban systems (The World Bank, 2010). The valuable infrastructure of cities such as bridges, subway systems, buildings, and roads, historic sense of place, and rootedness of residents are



critical attributes of cities but are also vulnerable in the face of climate change (The World Bank, 2010).

Cities are responsible for somewhere between 40% (UCCRN, 2011) and 70% (Greenhouse Gas Protocol, 2014) of global GHG emissions. Given this fact, and given that cities are home to more than half the world's population and industry (OECD and Bloomberg Philanthropies, 2014) – a number that is increasing – this proportion of GHG contributions will likely only increase over time (UCCRN, 2011). By 2050, more than 70% of the world's population is projected to live in urban areas (OECD and Bloomberg Philanthropies, 2014). As a result of this concentration of people, the benefits of climate change mitigation and adaptation are also more significant in cities. There are existing opportunities for cities to pursue climate action with strategies that also address other pressing environmental concerns, as well as challenges of local economic development. Climate change mitigation strategies can be created to generate growth, employment, increase well-being for urban residents and allow for significant savings from avoided health costs and expenditures on fossil fuels (OECD and Bloomberg Philanthropies, 2014).

Because of the city's influence on climate change and the threats that residents face, cities have recently become more central to the processes of formulating and implementing urban policies to address climate change (Betsill & Bulkeley, 2007). In recent years, several municipalities in the GTA have created climate change action plans. This includes Toronto's Climate Change Action Plan (City of Toronto, 2007) which sets targets for the reduction of GHG emissions and outlines actions for the City and its residents to take in order to achieve this goal. The GHG reduction targets are based on

1990 levels and target 6% reductions by 2012, 30% reductions by 2020, and 80% reductions by 2050 (City of Toronto, 2007). This Plan was followed by the Climate Adaptation Strategy - Ahead of the Storm: Preparing Toronto for Climate Change (City of Toronto, 2008), which outlined a number of actions that will improve the City's resilience to climate change and extreme weather events. City Council also adopted a report in 2010 outlining a Climate Change Risk Assessment Tool (City of Toronto, 2013b), which was developed to provide a systematic method for the identification and evaluation of potential risks associated with an increase in extreme weather events.

Implementation of the Paris Agreement will require action across all levels of government. Because local governments are in close contact with citizens and local businesses, they are often in a better position to influence consumer and producer behaviour by implementing nationally driven emission-reduction policies at the urban level, based on their knowledge of local conditions and capabilities (OECD and Bloomberg Philanthropies, 2014). Cities can also act as laboratories of social and technical innovation, and provide essential experience at the local level that can be scaled up at the national level (OECD and Bloomberg Philanthropies, 2014).

Though cities are vulnerable to the effects of climate change, they are also uniquely positioned to take a global leadership role in both mitigating and adapting to it (UCCRN, 2011). More people live in cities now than ever before and with this growing number comes the opportunity to concentrate investments on climate change mitigation (Shi, 2016). COP21 called attention to the need for coordinated action to help the world's most disadvantaged people bearing the greatest costs of climate change impacts. Among those at COP21 were mayors from around the world advocating for the important role

that cities must have in climate change mitigation efforts (Shi, 2016). These challenges highlight the need for cities to rethink how assets are deployed, how people are protected, how infrastructure investments are prioritized, and how changes in the climate will affect long-term growth and development plans. Cities have a unique ability to address global climate change challenges. Choices made in cities today about what and how we build will determine the extent and impact of climate change, our ability to achieve emission reduction targets and our capacity to adapt to changing circumstances (OECD and Bloomberg Philanthropies, 2014). The upcoming decade could be pivotal for reframing sustainable growth and development.

#### *Urban Renewal to Reduce GHG Emissions*

The influence of cities on the production of global GHG emissions is immense, as cities account for 60% to 80% of energy consumption worldwide (OECD and Bloomberg Philanthropies, 2014). The International Energy Agency (IEA) estimates that 38% of the cumulative emission reductions required to meet the 2°C goal by 2050 could come from increased energy efficiency (IEA, 2014). This being said, much of the potential for energy efficiency improvements lies in cities and the scope of ways to increase energy efficiency is broad.

Reducing energy consumption in the construction, maintenance and refurbishment of buildings can offer important economic and employment opportunities, improve energy security and realized cost savings (OECD and Bloomberg Philanthropies, 2014). The building and construction industry is a primary contributor of GHG emissions, playing a significant role in global warming. This is expressed by the IPCC

(2014) who says the building sector is responsible for 40% of global energy consumption and contributes a quarter of the total CO<sub>2</sub> emissions. Buildings are highlighted as one of three key sectors to be addressed in the Roadmap for a Resource Efficient Europe (RERM) (Herczeg et al., 2014), and the World Business Council for Sustainable Development (WBCSD) identifies buildings as one of the five main users of energy where “megatrends” are needed to transform energy efficiency (WBCSD, 2008). According to the RERM, better construction and use of buildings could help allow significant resource savings: it could reduce 42% of energy consumption, 35% of total GHG emissions, 50% of extracted materials, and up to 30% of water in some regions (Herczeg et al., 2014).

It would be naïve to assume that buildings that are designed with high performance standards could solve the severity of the emissions caused by buildings. Historically, approximately 80% of the carbon emitted from buildings relates to the energy consumption in the use phase, and 20% with the embodied energy (Herczeg et al., 2014). Embodied energy is the energy used in the production of the building; this includes energy to extract and manufacture the materials, transportation of materials, and energy used on-site for construction. Recently, increasing energy efficiency in the use phase of buildings (after completion, when the building is occupied by users) has created an energy shift between material use and energy efficiency and trends are showing that embodied energy is becoming an increasingly dominating factor in the total energy use of buildings (Herczeg et al., 2014).

The immense impact of buildings on the climate and the potential rewards of efficiency highlight the need for buildings to be targeted in mitigating climate change. An

estimate of 10% of global GDP is spent annually on infrastructure (Glemarec & Puppim de Oliveira, 2012) and this capital should be made the most of by keeping climate change strategies in mind during design. The Net-Zero Energy Coalition argues that the most efficient path to altering the negative impacts of climate change is to create buildings and communities that have net zero energy consumption (Net-Zero Energy Coalition, 2015).

In a city that is fully built-out like Toronto, a standard approach to accommodating further growth, as well as for maintaining a good quality of life for existing residents, is to use urban renewal – also called ‘urban regeneration’. In this paper, urban renewal can be defined as a planned process of transforming the mostly physical urban environment with the purpose of improving the quality of the area (Sunikka, 2006) to better respond to present and future requirements for urban living and working, especially when the urban environment is no longer fulfilling the functions for which it was designed (Miller, 1959). A particular focus of urban renewal is on areas suffering from underutilization or decline, and this could include brownfields, vacant lands, reclaimed lands, and historical quarters (Balaban & Puppim de Oliveira, 2014). Urban renewal may involve the upgrading of existing buildings, or demolition of structures, which are replaced with structures or uses that better meet the needs of the area. Urban renewal is not a new practice, but it began in the 1970s when cities in Britain and America began to physically transform deteriorating parts of the cities in order to address social deprivation (Healy, 1995). The concept has evolved over time and today, urban renewal may be in efforts to increase density, reduce sprawl, improve the economic competitiveness of neighbourhoods, improve social amenities and public safety. More than 80% of Toronto’s building stock will still be in use in the year 2050 (City of

Toronto, 2009). In order to meet the City's goal of reducing its GHG emissions by 80% by 2050, these buildings will need to be retrofitted to reduce their energy consumption.

Osman and Puppim (2014) explore the potential linkage between urban renewal and climate change. The authors focus on the impact of spatial and urban infrastructure policies on tackling climate change – two important areas to focus on, as the investments in these shape future patterns for the coming decades, having a lasting impact on climate change and people (Balaban & Puppim de Oliveira, 2014). Spatial policies cover a range of issues on different scales and the policies may also be useful to achieve mitigation and adaptation goals simultaneously (Balaban & Puppim de Oliveira, 2014). Urban renewal allows an opportunity to introduce spatial policies that address climate change. Urban renewal also allows for making best use of underutilized lands, for more efficient use of structural and economic resources, and for improving energy efficiency (Balaban & Puppim de Oliveira, 2014). Improving energy efficiency in existing buildings is often considered to be a cost-effective measure for cutting down on carbon emissions (Sunikka, 2006), especially when pursued as part of an ongoing or planned capital improvement program. Sunikka (2006) suggests that urban renewal offers a good intervention point for switching to sustainable fuel sources, as changes can be done simultaneously during renovation and renovations can also include green design elements. However, payoff for investments in energy efficiency requires both physical and economic neighbourhood renewal because the value of the buildings depends on the neighbourhood and supporting infrastructure as well (Sunikka, 2006). Urban renewal is a strategy that can help overcome climate and building related challenges by retrofitting or renewing existing buildings (Balaban & Puppim de Oliveira, 2014).

The European Green Capital Awards recognize efforts of environmentally friendly cities. The award aims to provide incentive for cities to inspire each other and share best practices toward a greener future. In 2010 Hamburg was voted greenest city of Europe by the EU Commission. Hamburg won the award by showing that it had an ambitious program of addressing typical urban challenges. Hamburg was largely acknowledged for its project, HafenCity, which directs growth inward. HafenCity is Europe's largest city development project, which uses 388 acres of former industrial land in between Hamburg's downtown and Albe River. When completed, the former brownfield site will contain 5,500 homes, with shops, parks, entertainment, schools, daycares, offices and a university. The space is designed as walkable and transit-accessible, it includes a systematic structure of green spaces that are easily accessible to citizens, as well as buildings and infrastructure that are compliant with the city's green building standards. Furthermore, the city has introduced ambitious climate protection goals such as reducing its CO<sub>2</sub> emissions by 40% by 2020 and by 80% by the year 2050. Hamburg was also commended for the leadership role it took in sustainable city building, proposing new ideas rather than only following the initiatives of other cities. This is just one example of a city acting on its commitments to reduce GHG emissions. (European Commission, 2009)

This paper acknowledges that there are larger GHG emitters than buildings in Toronto and the GTA. For example, transportation has an extremely large impact on greenhouse gas emissions in cities. "Of the GHGs emitted directly by Canadian households (i.e., in household travel, home heating, lighting, and running appliances), almost two-thirds is related to transportation" (Blais, 2010, p. 3). This should be given

strong focus in climate mitigation strategies however, it is not within the scope of this paper. Urban renewal has been chosen as a topic of discussion because it is often left out of climate change discussions. Furthermore, it involves working on smaller policies that are of less contentious debate in the political arena – debate which often causes policy adoption to drag on for distressing amounts of time. It is also chosen because it largely continues along the trajectory that Toronto takes in using infill to increase densities, programs which aim to increase residents’ quality of life, considering the contributions to economic growth and contributing to the public sphere. Toronto is the largest metropolitan area in Canada, and the largest economic contributor to Canada. The city has an important role to play in leading the way for future urban development in Canada. As a city that is already largely built, it has the choice to increase densities, use urban infill, and to reduce its use of resources using strategies that improve economic, social and environmental impacts during the opportunity given during the urban renewal process. Reurbanization can present a relatively low-cost way to accommodate new urban growth (Blais, 2010).

Ultimately, urban renewal offers an opportunity to do things differently starting immediately, as action on the issue of climate change cannot wait. Buildings can make a major contribution to tackling climate change. Some policies have begun to push new buildings to lessen their environmental impacts, although these measures are not strong enough to have a significant impact during such an urgent period of time. Furthermore, the policies fail to push boundaries, to think about true sustainability in a larger picture, and consider the inclusion of nature and ecosystem services in its green building policies



– the presence of which would further promote sustainable climatic strategies.

*Ecological Processes and Their Value to Society*

Buildings impact the quantity and quality of nature by the loss and fragmentation of habitats as well as by altering the flow of energy and matter, often causing environmental problems that inhibit natural processes (Oberndorfer et al., 2007). Herczeg et al. attempt to evaluate the impact of buildings on biodiversity, noting that (Herczeg et al., 2014, p. 44):

extraction, manufacturing of construction products, construction, buildings use and demolition all pose different threats to habitats such as species disturbance, habitat loss, dust smothering of vegetation, alien species introduction and spread, sediment run-off, habitat fragmentation and other.

Urban ecosystems are threatened by increasing urbanization yet, people continue to depend on nature for survival both within and outside of cities (Bolund & Hunhammar, 1999). There is a dependence of life processes, and interconnected development of living and physical processes, that sustain life and shape human activities on land (Hough, 2004). Recently, efforts to preserve the natural environment have been mostly concerned with large, bio-diverse and relatively untouched ecosystems or with agricultural lands, rather than the types of nature close to where people reside, neglecting the many potential benefits of nature in cities. Bolund and Hunhammer (1999) say that the quality of life for urban dwellers is improved by locally generated services, and not by distant ecosystems.

Considering the ecosystem services that nature provides, climate mitigation plans of cities should not only focus on energy efficient buildings, renewable energy, and public transit, but should also emphasize the role that nature can play in enhancing

environmental and human health within cities. Gomez-Baggethun and Barton (2013) say, “conserving and restoring ecosystem services in urban areas can reduce the ecological footprints and the ecological debts of cities while enhancing resilience, health, and quality of life for their inhabitants” (p. 235). Beatley’s *Biophilic Cities* (2011) explores the ‘biophilia’, the born need to connect with the natural world, as well as how humans can learn from nature. This is in contrast to what D. W. Orr (2004) calls ‘biophobia’, a culturally acquired aversion or discomfort to nature, that sees nature objectively and mainly as a resource to fuel human technological interests. Hough (2004) explains that humanity and nature have traditionally been thought of as two separate things, and this must be solved by an ecological view that encompasses the total urban landscape as well as the people who live there. The human relationship with nature needs to be considered in climate change mitigation strategies.

Urban ecosystems are often referred to in policies as ‘green infrastructure’, demonstrating their functional role in cities (Gomez-Baggethun & Barton, 2013). Ecosystem services are benefits that humans receive from ecosystem functions. Of the numerous ecosystem services that can be identified, the services which provide a benefit are specific to each location, varying based on the environmental and socio-economic characteristics of a place (Gomez-Baggethun & Barton, 2013). Ecosystem services have a direct impact on climate change mitigation and adaptation. These include the services of water flow regulation and runoff mitigation, urban temperature regulation, air purification, moderation of environmental extremes, and climate regulation. The increasing coverage of impermeable surfaces in cities reduces the capacity of water to percolate into soils, therefore increasing flooding risk. The presence of soils and trees

allow water to be stored and slowly released to lessen the pressure on urban drainage systems; this can help reduce the impact of severe weather events. An increasing amount of built surfaces, combined with GHG emissions from traffic create the urban heat island effect, where the urban area is up to several degrees warmer than the surrounding regions. Vegetation in urban areas helps regulate temperatures by providing humidity and shade, and filters the air by removing pollutants and GHGs which include ozone (O<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), and particulate matter less than 10 µm (PM-10) (Escobedo et al., 2008). Urban trees act as sinks for CO<sub>2</sub> by storing excess carbon as biomass during photosynthesis, therefore regulating the climate.

The presence of nature in cities also causes some disservices. There are some common city tree and bush species which emit volatile organic compounds (VOCs) which can indirectly contribute to urban smog and ozone problems, thereby doing an ecosystem disservice (Chaparro & Terradas, 2009). Other ecosystem disservices include damage to physical infrastructure by animal nesting, root systems, or bird excrement (De Stefano & Deblinger, 2005); plant and animal nuisance species; health problems due to pollen allergies; and diseases carried by animals and insects. However, overall, ecosystem services are a cost avoidance for cities (Gomez-Baggethun & Barton, 2013) as the benefits of the services outweigh the nuisance of the disservices.

Besides numerous environmental services, urban nature contributes to the quality of life of nearby residents. Nature provides social and psychological benefits to humans (De Stefano & Deblinger, 2005), allows people to develop a moral, aesthetic, educational value towards the urban environment (Gomez-Baggethun & Barton, 2013), and allows for increased social interaction (Coley, Kuo, & Sullivan, 1997). Fulfilling the

psychological needs of citizens makes urban nature a valuable municipal resource (Chiesura, 2004).

Building regeneration strategies do not need to only focus on the man-made components of climate change mitigation, but should give focus to green spaces of the urban structure. Integrating nature's processes into the superficial properties of buildings can supplement the benefits of vegetation on the ground, as land suitable for vegetation may be scarce. For example, building roofs can represent up to 32% of the horizontal surface of built up areas (Frazer, 2005) and present a space for builders to decide if they will incorporate features which mitigate the effects of increasing urbanization, reduce GHG emissions and benefit the environment. There are thousands of decisions that are made during the design and construction process. Each decision should be made keeping in mind the objective to mitigate climate change. The following chapter will look at recent efforts that are being made to drive green building standards into building design and construction.

Cities are sites where significant reductions in reducing GHG emissions can be achieved, and where the presence of ecosystem services would be of most value to protect built infrastructure, maximize wellbeing of residents and reduce the human impact on the climate. Action must be taken to address the built environment as part of a larger climate change mitigation plan, but also as a method that may bring other benefits to the city and its residents and reduce costs in the long-term. This will require human activity to internalize natural processes as a necessary benefit to society, rather than a cost that can only be incurred if budgets allow it to be (Hough, 2004). In recent years, Toronto has taken steps to include nature in its development by implementing the Green

Roof Bylaw and the Strategic Forest Management Plan, which includes a goal of increasing the tree canopy cover to 40%. We must make the most of opportunities to include nature and its processes into climate change mitigation strategies that address the many complex, interwoven issues of the city. TCHC will have to undertake this challenge of integrating natural processes and development by exploring how its residents can benefit from nature incorporated into the building design. By understanding the value of nature in cities and in building, we can begin to develop a constructive relationship between the two. In City efforts to reduce GHG emissions, they are opening up to new ways of building that have widespread benefits.

This chapter has shown the urgency to reduce GHG emissions, and the strategic role that the City will need to take in doing so. The commitments that the City has made to reducing GHG emissions is one that will take time and effort to achieve but meeting these commitments is crucial for maintaining access to a safe and healthy environment. Through ongoing urban development, the City can take advantage of opportunities to intervene in the building process by introducing green building practices in efforts to reduce GHG emissions and provide benefits to the natural environment. By adopting stronger green building practices, the City can become a leader in meeting its GHG reduction goals. The next chapter explores green building best practices to guide the City's climate change mitigation efforts.

## **Chapter Two:**

### **Green Building Best Practices**

The City of Toronto needs to adopt stronger green building practices in order to address the significant portion of GHG emissions that are related to buildings. Only by going above and beyond the standards that currently exist, can we continue to reduce our GHG emissions to meet our goals as a city and country. Referencing green building best practices will allow the City to develop green building standards that have a meaningful impact and can provide benefits to its residents.

#### *Green Buildings*

The term green building refers to not only the building itself, but to the application of principles of sustainability throughout the lifetime of the building. This greening process involves decisions guided by the goal of sustainable development during the stages of conceptualization and design, construction, use, maintenance, and presumably ending with re-use, or recycling of the building parts. Simply put, the term green building is defined by Kibert (2012, p.9) as, “healthy facilities designed and built in a resource efficient manner, using ecologically based principles”. Ultimately, the buildings should feature improvement over traditional construction methods with the idea of reducing resource consumption and reducing negative impacts on people and the environment. Green buildings can take form in any sector of use, as well as in historic or renovated buildings with these same guiding principles. Green buildings may be brownfield restorations or built on greenfield sites, although those built on greenfield sites are criticized to have a larger environmental footprint than those built as infill.

Similarly, as will be explained later in this chapter, it is possible that building a new green building can result in larger emissions than renovating an existing building.

The specific measures taken to optimize the sustainability of the building may depend on the intended use of the building, the availability of resources, time and financial constraints, or designer and contractor preferences. Green buildings often focus on optimizing efficient use of resources through maximizing energy performance, energy metering, using renewable energy sources, green roof installation, recycling rainwater and greywater, and collection and storage of recyclables. They may focus on indoor environmental quality by using non-emitting materials, monitoring indoor air quality, improving acoustic performance, thermal comfort, and interior daylighting. They may focus on the structural components of the building beginning with re-use of building materials, construction and demolition waste management, sourcing of sustainable materials, life-cycle reduction, construction for flexibility, and construction pollution prevention. Green buildings can also incorporate natural processes in their functions, such as by rainwater management, light pollution reduction, planting native species, and providing animal habitats. Green design may go beyond the building to include the surrounding landscape and community, as a system of interconnected parts (Kibert, 2012), such as by building in high density and transit accessible areas, thereby reducing the carbon footprint of the users of the building.

Barriers to green buildings are most often cited to be economic, although several studies have disproven costs as a legitimate barrier, showing that in many cases, a tall up-front construction or installation cost has higher paybacks in later years of the building's life. This is especially true as the price of natural resources increases, which will decrease

payback periods. Kibert (2012) explains that high-performance buildings can be made to be cost effective when costs associated with higher efficiencies (e.g. tighter shell, more insulation, better window glazing, smarter landscaping) are shown to be lower than costs to purchase, operate and eventually replace larger equipment such as an HVAC system. Payback of green technologies is generally beneficial to building owners, although certain technologies have a slower rate of return. The benefits are brought by the overall building conditions; designers and builders must weigh the costs and benefits of each investment depending on the particular circumstances, as well as how the investments will work together in a holistic system. The WBCSD (2008) says that efficiency gains in buildings are likely to provide the greatest energy reductions and often will be the most economical option to do so, citing the IPCC Fourth Assessment report (2014) which estimates that by 2020, CO<sub>2</sub> emissions from building energy use can be reduced by 29% at no net cost. Overall, green buildings virtually always make economic sense over a life cycle cost basis although may be more expensive on a first cost basis (Kibert, 2012).

Furthermore, Kibert (2012) also suggests that green buildings are known to increase the comfort, happiness and productivity of those living and working within them, which can be directly translated into increased profit and value. Because the financial payback of green buildings has been documented, several researchers (Hoffman & Henn, 2008; Kibert, 2012) have concluded that the real barriers to green design are not so much economic as they are of imagination and design competence.

There are two types of specific green buildings that are often defined separately. The first building type is net-zero. A net-zero energy building produces as much energy as it consumes annually. This means that it is still dependent on the electricity grid at



times (i.e. at peak hours or during heating and cooling seasons) but overall, it produces as much energy as it consumes. Net-zero buildings take three main approaches to energy neutrality: cutting energy demand (through efficiency measures), producing energy locally from renewable or otherwise wasted energy sources, and sharing energy by generating surplus energy to feed back into the grid (WBCSD, 2008). Although not independent of other energy sources (because for example, most buildings do not have enough space for a PV array large enough to meet its energy needs), net-zero buildings do reduce energy loads significantly (WBCSD, 2008).

The second specifically defined green building type is Passive House (PH). PH buildings are designed to increase comfort while significantly reducing energy consumption, and therefore utility costs. The buildings generally do this by using ventilation systems that constantly supply fresh air into the building, well-insulated windows and building shell to maintain temperatures, and using energy sources inside the building such as body and solar heat. The construction and design allow for improved thermal performance of the building envelope for a simplification of the heating system and enormous efficiency gains as little energy is wasted. Rather than focusing on heating or cooling of air, like conventional systems, PH ventilation systems ensure a continuous renewal of indoor air, avoiding mould, pollutants, odors and carbon monoxide build-up, at a minimal cost. PH standard buildings require merely 20% of the useful energy required for space heating compared to conventional new buildings, and an overall primary energy consumption of 50%. On average, PH buildings are marginally more expensive than conventional buildings, although the return from operating savings is sufficient to generate almost immediate payback. Certain methods such as prefabrication

of building elements offer a potential for cost reduction. In some places, design and competition in the supply of PH building products has allowed PH buildings to be constructed at a comparable cost to conventional buildings. Currently, the Passive House standard is relatively popular in Germany, Austria, and Switzerland, although a market for this is only beginning to emerge in Canada. (Feist, Schnieders, Dorer, & Haas, 2005)

Green buildings have also been noted to be successful at creating working relationships between various industries in order to realize mutual benefits. They combine environmental benefits with goals to keep resource and operating costs as low as possible. Steadily rising energy costs in recent years have facilitated this trend towards green buildings. Currently, building performance certifications are a large driving force behind green buildings in North America.

#### *Toronto Green Standard*

Presently, Toronto implements environmental standards of buildings using the “Toronto Green Standard” (TGS) for new construction. TGS is a key strategy of the 2007 Climate Change Action Plan goal to reduce Toronto’s GHG emissions by 30% by 2020, and 80% by 2050. TGS is a two-tier set of performance measures for sustainable site and building design. Tier 1 is required for all new construction and Tier 2 is voluntary although offers a financial incentive which is a possible 20% refund on development charges, provided that a minimum number of environmental design measures from a described list have been implemented. Both Tiers contribute towards LEED (Leadership in Energy and Environmental Design) certification requirements – a voluntary building performance rating system (more on this in the next section of this chapter).

The TGS aims to integrate environmental performance requirements to improve air and water quality, reduce green house gas emissions, enhance urban ecology, and reduce solid landfill wastes in order to reduce future infrastructure demands and environmental impacts. TGS is organized according to the City's top five Environmental Drivers (environmental pressures being faced by the city) and further divided into Development Features, which have performance measures attached to them. Furthermore, there are two versions of the TGS depending on building type; the first is low-rise town houses with greater than 5 dwelling units, and second is all other development. The latest TGS (Version 2.0) includes new and enhanced performance measures such as energy targets 15% above the Ontario Building Code (OBC) for Tier 1 and 25% above OBC for Tier 2. The Toronto Atmospheric Fund (TAF) predicts that the improved standards will avoid over 750,000 tonnes of GHG emissions by 2025. (City of Toronto, n.d.a) Toronto's minimum requirements aim to raise the bar on energy performance but these standards hardly push for innovation in a time of urgency. The OBC will be updated in 2017 to implement higher water and energy efficiency performance requirements of buildings. By this time, it is likely that Toronto's TGS will need a review as well.

In 2009, Toronto became the first city in North America to create a bylaw to govern the construction of green roofs on new development. The bylaw requires new building permit applications for residential, commercial, industrial and institutional development with a minimum Gross Floor Area (GFA) of 2000 square metres to install a green roof with a size dependent on the GFA. Residential buildings less than 6 stories or 20 meters in height are exempt for the green roof requirement. Applicants may apply for a variance or exemption provided that a cash-in-lieu payment of \$200 per square metre is

made for the reduced green roof area. The Toronto Eco-Roof Incentive Program provides funding for new and existing buildings that are not subject to the Green Roof By-law to install cool roof projects. Many of Toronto's green building standards were inspired by a certification program called LEED.

### *LEED*

Leadership in Energy and Environmental Design (LEED) certification dominates the North American market of green building recognition. LEED is endorsed by the U.S. Green Building Council (USGBC) and Canada Green Building Council (CaGBC) as best practices of environmental and energy efficient design principles, which push towards high standards of excellence. LEED is currently the most well recognized comprehensive green building rating system around the world, and has done immense work in moving the design and construction market to consider the environmental and economic benefits of green buildings. The voluntary rating system can be used for new construction and major renovation of a range of building types. The LEED rating system awards points for meeting prerequisites and credits, and the total number of points earned determines the overall certification level achieved (Certified, Silver, Gold or Platinum). Up to 100 points can be obtained by reaching targets in six categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design, and Regional Priority. The USGBC's Reference Guide for Building and New Construction (USGBC, 2013) describes credit requirements, providing different options for obtaining points depending on the type of build. Renovation requirements may be slightly different, or allow a phasing plan to adopt new construction

requirements. In most cases, it seems as though a major renovation requires nearly a full-gut renovation, in order for builders to have the ability to control and adhere to the credit categories and list of prerequisites.

Canada currently uses the “LEED Canada NC 2009” (LEED NC) rating system, an initiative of CaGBC. LEED NC applies to new construction and major renovations of commercial and institutional buildings, mid- and high-rise multi-unit buildings and distinct others. Other building sectors are regulated by similar LEED Canada rating systems (e.g. homes, commercial interiors, and existing buildings). Beginning November 1, 2016, there will no longer be a stand-alone Canadian LEED rating system, and all projects globally will be registered under LEED v4 in order to create international consistency.

There are three dominant criticisms of LEED. The first is that, certification is given before occupancy, and is based on projected performance, not verified performance. For example, energy performance credits are given on the basis of predicted energy cost savings compared to a modeled code baseline building (NBI/USGBC, 2008). Measured performance results by the USGBC show that on average, the program’s energy modeling is a good predictor of average building energy performance, and LEED buildings save energy. However, among certified buildings, some buildings do much better than anticipated, while an equal number do much worse than anticipated (NBI/USGBC, 2008). Variation in results is likely due to reasons such as differences in operational practices and schedules, equipment not calibrated properly, construction changes, and other issues not anticipated in the energy modeling process (NBI/USGBC, 2008). Therefore, a building does not necessarily have to meet impressive performance

measures, giving little incentive for buildings to operate optimally, for maintenance to occur frequently, for people to be trained sufficiently, or for any standards to be upheld in order to maintain the certified performance level. However, this is only true of new buildings; renovated buildings do need to demonstrate performance levels that meet the defined criteria. The newest version of LEED, v4, has introduced new prerequisites such as metering and recording the building's energy and water use although this comes after certification and poor performance does not revoke certification; it only informs other projects of how they can improve.

The second criticism also relates to the legitimacy of efficiency performance. Williams College (n.d.) states, “there is low correlation between the level of LEED certification and the actual energy use intensity of the building”. This suggests that when compared to the efficiency of a code baseline building, LEED ‘performs’ but this does not mean that the building is not incredibly energy consumptive. For example, the Bank of America Tower in New York City has been advertised as one of the most efficient and ecologically friendly buildings in the world. It achieved LEED Platinum rating. Although the design includes many green building elements (it uses recycled materials, insulated glazing, water efficient appliances and a greywater system), several articles have revealed the large energy footprint of the building. Roudman (2013) found that the skyscraper used more energy and produced more GHG per square foot than any comparable sized office building in Manhattan, and performs worse than similar buildings in New York City with lower level LEED certifications. He notes that the energy requirements of all the office equipment (e.g. the trading floors which require servers, computers, and several monitors per person) could not be controlled or accurately estimated by the building's

developer or architect. Therefore, it is not the fault of the building itself, but of the sheer amount of electricity the digital workplace demands. No doubt the building is performing better than if it did not strive for LEED certification but even so, the green advertising of such an energy intensive building demonstrates a flaw in the efforts to mitigate climate change. Therefore, cities and LEED need to think not only about the design of the building, but the uses of them as well (Roudman, 2013) in order to create solutions which meet sustainability goals, rather than simply filling out a checklist.

Thirdly, within each of the six scoring categories, there are up to four prerequisites, and beyond this, there are a variety of points (100 points in total) that can be pursued. By this logic, designers can pick any of the points to meet the rating standard, perhaps picking the least costly and easiest credits, potentially not obtaining any points in a given category, resulting in a low performance LEED certified building. For example, in the same Bank of America Tower as noted above, ‘easy’ points were awarded for working with a LEED-accredited professional, building near public transportation, and protecting or restoring habitat in Bryant Park (Schnaars and Morgan, 2013). Schnaars and Morgan (2013) found similar cases in another project where developers were awarded points for posting educational displays throughout the building, installing bike racks, landscaping without grass (which the bylaw prohibited anyways), and preferred parking for fuel-efficient cars (this was seen to go unregulated), avoiding more costly measures which would have a more significant contribution to the sustainability of the building. This way of conducting the points system allows people to cheat the overall intent of LEED certification if they want to. These types of projects which take advantage of the scoring scheme make it seem as though LEED is a marketable asset, as well as a way to

receive a tax break and reduce energy bills, rather than a true effort towards sustainability. R. Orr (2014) found the ten most popular LEED credit options to be, in order: hire a LEED accredited professional, use low-emitting paints and coatings, boost energy performance 10.5%, use low-emitting adhesives and sealants, use recycled materials in construction, reduce water use by 20%, use low-emitting carpet, divert half of construction waste from landfill, boost energy performance 14%, and water efficient landscaping. Many of these were described by users as easy to achieve. The top ten least popular LEED credits obtained were: 10% of materials are reused or salvaged, reuse existing building elements, use on-site renewable energy, use rapidly renewable materials, 5% of materials are reused or salvaged, reuse 95% of a building exterior, boost energy performance 42%, reduce use of potable water in wastewater, and reuse 75% of a building exterior (R. Orr, 2014). Users described these credits to be expensive, complicated or only feasible for some projects. Because of the flexibility in the certification, there are very few, if any, net-zero water use and net-zero energy use LEED buildings, suggesting that there is little push for innovation and going above and beyond the norms to achieve true built sustainability (Williams College, n.d.). Credits would be better weighed by level of difficulty or magnitude of reward in regard to its environmental impact, resource conservation and alleviation of climate change (R. Orr, 2014).

Some improvements have been made to the newest version of LEED, v4, to address previous criticisms. LEED v4 has done more to weigh and develop credits that encourage projects to do more good. In efforts to make the scoring look less like a checklist and therefore perceived as such with a price tag attached, USGBC has removed



credit numbers from the system, relying only on the underlying text to describe potential credits. LEED v4 also contains a new credit awarded when the entire construction team is brought into the design process stage early. This is in effort to make the green design a collaborative and process with fewer kinks in later stages, therefore contributing to the level of expected performance. Credits are awarded for a Life Cycle Assessment (LCA) report in order to examine the building's total environmental effects, however, what the report shows does not matter, a credit is gained simply for submission. Further analysis of the credit system shows that there is no penalty for avoiding requirements that would have the most beneficial impacts on the environment. For example, LEED does not deduct points for ignoring walkability (which presumably would require automobile use to get to the building) and does not give any incentive for more people to occupy the building, which would make for more efficient use of the building. Because of these examples, a common remaining criticism of LEED v4 is that there is still little push for innovation in v4.

The LEED rating system is revised as required to update reference standards, re-evaluate credit weights to emphasize climate change mitigation, to introduce alternative credit compliance pathways, and to address its criticisms. Although the rating system is not perfect, there are several positive effects of raising awareness of environmental issues in a field where performance can be measured and there are long lasting benefits. These benefits outweigh the shortcomings. LEED is a system that continues to evolve. It is not the certification which matters, but the examples of best practices which LEED can be of inspiration, as any project can incorporate individual building strategies of the rating system.

### *Living Building Challenge*

In recent years, new certification standards for building have been created that raise the bar on sustainability. The Living Building Challenge was created by the International Living Future Institute (ILFI) as a “philosophy, certification and advocacy tool” (ILFI, 2014, p. 4) that acts to define the most advanced measure of sustainability in the built environment possible today and to carve a path to the end solutions sought after in sustainable building (ILFI, 2014). The LBC is an incredibly ambitious and unique endeavor to raise the bar on the performance of green buildings and to engage stewardship in the green building sector with the goal to, “transform how we think about every single act of design and construction as an opportunity to positively impact the greater community of life and the cultural fabric of our human communities” (ILFI, 2014, p. 6).

The Living Building Challenge is comprised of seven performance categories called Petals: Place, Water, Energy, Health & Happiness, Materials, Equity, and Beauty. A total of 20 requirements called ‘imperatives’ fall under the Petal categories, each which focuses on a specific sphere of influence. The imperatives can be applied to nearly any building project, of any size, location, or age. Projects can achieve three types of certification: Living Building Certification, Petal Certification, or Net Zero Energy Building Certification. The requirements of these will be explained farther in this section. LBC certification is highly regarded for its performance-based accreditation, meaning that certification is only achieved following documentation of a 12-month occupancy

phase, after which the imperatives must continue to perform. The certificate is not something that can be cheated, nor used simply as a marketing tool. (ILFI, 2014)

The certification process of LBC is incredibly rigorous. Imperatives of certification include mandates for buildings to: have net-zero energy and water use, not be built on a greenfield site, calculate and offset embodied CO<sub>2</sub>, set aside habitat to compensate for its land taken from nature, include design aspects that connect people with nature, and the most challenging of which to achieve (Walsh, n.d.) is, the Red List of materials. The Materials Red List prohibits 14 types of materials from use; these materials are the worst in class chemicals from a human and ecological point of view (i.e. persistent bioaccumulative toxicants, and known or suspect carcinogenic, mutagenic and reprotoxic chemicals). Projects must prove their omittance of these materials by supplier audits of every product used in construction. In terms of resources, living buildings are designed to be so efficient that they need no external energy. This is achieved by reducing energy demand, and incorporating technologies that produce energy from sunlight or wind (combustion is not permitted). The imperatives also include measures to ensure healthy buildings, comfortable workplaces, and minimized travel distances. Living buildings must meet a zero imported water standard where their water tanks may only be filled once, and following this, must only be replenished by rainfall or immediately recurring on-site water resources. The water must then be cleaned, purified and returned to the building's use or immediate environment. The Living Building Challenge offers three certification levels:

- Living Building Certification: The full certification requires buildings to adhere to all 20 imperatives assigned to its typology. A living building is to demonstrate that the built environment can actually help restore the natural environment.
- Petal Certification: The imperatives of three or more Petals must be satisfied, including at least one of: water, energy or materials. Both imperative 01 (limits to growth) and 20 (inspiration and education) must be achieved. Petal Certification provides a platform for a project to inspire and inform other efforts around the world to accelerate the adoption of restorative principles.
- Net Zero Energy Building (NZEB) Certification: Projects must achieve the Energy Petal along with a subset of imperatives within the Place and Beauty petals. This is the most simple and cost-effective certification to earn. The idea of net-zero buildings is not unique to the LBC, although the LBC is the only program in the world that verifies net zero energy building performance, where as other buildings claim to be designed as net zero but in actuality, may not be.

The Living Building Challenge defines itself as (ILFI, 2014, p. 6):

not a merely a noun that defines the character of a particular solution for development, but is more relevant if classified as a series of verbs—calls for action that describe not only the building of all of humanity’s longest-lasting artifacts, but also of the relationships and broader sense of community and connectivity they engender. It is a challenge to immerse ourselves in such a pursuit—and many refer to the ability to do so as a paradigm shift.

The LBC is innovative and ambitious because it is a holistic approach to buildings that requires some participation from stakeholders all the way up to the material supply chain. All suppliers are forced to consider the life cycle of the building design, construction and operation. For example, the Materials Red List supplier audits demand a

certain market from suppliers, and the message of LBC moves through the entire supply chain. The Challenge pushes architecture and design to be more progressive, sustainable and accountable (Walsh, n.d.). The Program Director of ILFI, Amanda Sturgeon, describes that other imperatives have inspired reform up the chain of command: in Oregon, gray water and rain water were recently made legal for use in residential and commercial buildings – an issue addressed for the purpose of meeting a water imperative (Walsh, n.d.). There are no optional credits in LBC, and therefore the impact of every design choice must be weighed and extra provisions must be made to meet requirements. Despite this, the Challenge is more focused on the ends rather than the means, and therefore allows flexibility in the design team. For example, the balance of energy or water achievement measures is not dictated, as long as net-zero is achieved. Designers can choose how they achieve improvements it through whatever means they feel they can optimally balance the costs of conservation and production. The proven exceptional performance of LBC presents the potential for enormous reductions in carbon emissions from the building sector (Williams College, n.d.).

### *LBC and LEED*

LBC is the most advanced measurement of sustainability in the built environment. However, rather than competing with LEED, LBC builds on the momentum of it, promoting the goals set out by the USGBC and CaGBC (which endorse both LEED and LBC). The Challenge establishes a vision for a project's environmental and social responsibility from a new vantage point, with an emphasis on different ideals. By

working harmoniously, the organizations and standards can influence project outcomes for a larger ecological benefit. (ILFI, n.d.)

LBC exceeds the requirements of the highest level of LEED certification, requiring rigorous performance standards. Williams College (n.d.) outlines some comparisons that demonstrate how LBC goes above and beyond LEED:

- LBC Certification is based on actual performance, and is only obtained following evaluation of 12 months of monitored use. LEED certification is based on projected use, without performance evaluation affecting certification. A LBC building must achieve net-zero energy use, while a LEED building needs only to achieve a marginal improvement over standard energy building codes.
- LBC requires that the project uses only water that arrives on the site naturally, which must then be treated on site and returned to the water cycle, achieving net-zero water use. A LEED building must only achieve a marginal improvement over standard water efficiency building codes.
- LBC requires the landscape be a source of local, organic food production. LEED gives points only for irrigation-free landscaping.
- LBC requires that a building achieve every single imperative. LEED offers optional points in a variety of categories. (Williams College, n.d.)

In addition to the last point, perhaps most importantly, LEED does not subtract points, thereby allowing elements of the building that may have the largest negative environmental impact, to go ignored. Clearly, the rigor of LBC makes certification difficult to achieve. Since its inception in 2006, the Challenge has certified 26 projects,

eight which have full certification, six with petal certification, and 12 with net zero energy building certification (as of September 2015), while 300 buildings in 13 countries are registered LBC projects (ILFI, n.d.). By comparison, LEED certified 2,870 projects between January and July of 2015, 47% of which were outside of the U.S. (USGBC, 2015).

Both LEED and LBC seek to move beyond individual buildings and bring principles of sustainable design to entire neighbourhoods. This is necessary for catalyzing stronger movements towards climate change mitigation as well as for recognizing that green energy systems are more efficient when adjacent buildings can share systems and space to achieve their aims. The work of both building certification programs are precedent-setting and pushing the design and construction industries to be greener.

### *Restoration vs. Rebuilding*

Urban renewal may take the form of renovating existing buildings or constructing new buildings, either by first demolishing older buildings or by occupying unused space such as brownfields. This choice is based on many factors such as budget, quality of existing structure, relocation of residents, and time allowances. This paper is concerned with the level of GHG emissions released as a consequence of the decision to renovate or build new. Many building projects focus on the energy consumption of the building during its use state, ignoring the emissions from the construction process as well as the embedded carbon. The green building certifications above, too focus on new buildings rather than renovating existing buildings. As this section will show, renovating can drastically reduce the overall amount of GHG emissions produced on a developed site.

An enormous amount of CO<sub>2</sub> emissions result from construction, mostly in the extraction and processing of new materials (Herczeg et al., 2014). The greater part of GHG emissions in building construction is due to a relatively small group of materials (De Jonge, 2005) including steel, aluminum, copper, and concrete due to the high volumes used. Chau, Yik, Hui, Liu, and Yu (2007) found that, concrete, reinforcement bar, copper power cables, and copper busbars were ranked to be the four most significant materials to the total lifecycle environmental impacts of buildings, the exact degree to which varying by building type. While other materials seem negligible in weight, they still play a significant role in global warming (Hong, Shen, Feng, Lau, & Mao, 2015). As for emissions during the construction process, Yan, Shen, Fan, Wang, and Zhang (2010) found that the four major emission sources were: material production and transportation, energy use of construction machinery, energy use for processing resources, and disposal of construction waste. Overall the GHG emissions embodied from manufacturing and the fuel used in construction equipment accounts for 88-96% of total GHG emissions during the construction process (Yan et al., 2010). A similar trend was found by Hong et al. (2015), who documented that emissions due to onsite construction were small at 2.24% of total GHG emissions, while embedded emissions through the production of building materials, transportation, and human activities accounted for 97.58%. New construction that typically requires extensive energy use and resource extraction can be compared to renovation, which typically uses fewer physical resources, in terms of their contributions to GHG emissions and climate change.

Several studies have compared the environmental effects of new-construction versus those of renovation. De Jonge found that (De Jonge, 2005, p. 9):



the difference between new construction and renovation is mainly related to the combination of the relatively high ecological burden of Substructure, Structure and Skin elements of buildings in the production phase, and the fact that these elements have different approaches in new construction and renovation projects.

De Jonge (2005) finds that environmental harm can be avoided by reusing the existing structure. Trusty and Meil (2000) had similar findings when they used a lifecycle assessment tool to gauge the environmental implications of building new versus renovating and existing structure. The researchers gauged the environmental implications of retaining the structure and envelope of an existing building instead of replacing it, as well as its annual operating energy. They found that as operating efficiency improves, the importance of the initial structure and envelope embodied energy increases. That is to say, the initial embodied energy is equivalent to an increasing number of years of operating energy as the energy efficiency of the building increases. As a result, there is a significant amount of energy used as a result of the materials that make up a new building, compared to when the building's original envelope is left intact. In a case study, Trusty and Meil (2000) found that by reusing the structure and envelope of a building and thereby avoiding demolition of these component systems, the total energy saved approaches the energy used to construct the office building and operate it for a year. Alternatively, the total environmental avoidance is equivalent to 10 years of HVAC operating energy for the c200 office building design (Trusty & Meil, 2000). Both examples demonstrate that the avoided environmental impact is indeed, significant. Demolition and waste management themselves, however, cause relatively few environmental impacts (Herczeg et al., 2014).

An option that meets renovation and new construction in the middle is, ‘deconstruction’. Deconstruction involves the selective and systematic disassembling of buildings for the purpose of gathering the materials suitable for reuse. This process is more labour intensive but has many benefits for the environment over demolition, which often only recycles some materials. Using recycled materials has a much lower impact than using raw materials, especially for metals (Herczeg et al., 2014). The shift happening towards deconstruction is due to landfill space becoming scarce in some places, increasing fees at landfills, and the value of certain materials salvaged for recycling has increased (Manuel, 2003). Construction and demolition wastes make up approximately 33% of non-industrial wastes in landfills (Herczeg et al., 2014). The re-use or recycling of materials rather than demolition, allows for a use of material that would be lost in demolition, substituting the need for virgin materials, and therefore reducing GHG emissions produced during extraction and processing (Herczeg et al., 2014). Deconstruction is not always possible when materials are difficult to retrieve.

New, flashy construction dominates the green building conversation, and little attention is given to the environmental benefits that major renovations can have, as they require far less material than new construction. LEED offers a certificate for renovations, although this is used seldom, and typically only for high profile projects – not a category that aging apartment buildings fit into. Since it has been shown that renovation-based interventions appear to be better for overall CO<sub>2</sub> emissions, policies are lacking sufficient attention to encouraging upgrades to existing buildings when the needs of the users can be met this way, rather than building new. Seeing that in new construction, certain materials contribute the most GHGs, avoiding the use of these new materials should be

focused on for major targets for improvements in environmental performance of commercial buildings. Through the use of alternative and environmentally friendly materials (which emit less GHGs during extraction, production, manufacturing and transportation of materials), the overall embodied energy of buildings can be reduced.

Though a discussion of green building best practices, this chapter has shown how much further TGS can be improved in order to be able to shift its development course to one that is drastically more sustainable, and is on track to achieving GHG reduction targets. The City will need to adopt stronger green building practices to help its residents in future years. It may start this movement by looking at its own buildings, managed by TCHC, which house some of the most vulnerable people to the consequences of climate change.

## **Chapter Three:**

### **Toronto Community Housing Case Study**

The City of Toronto is able to lead in implementing meaningful green building standards. There is no better way to lead than by demonstrating that these standards are possible – and preferable – to achieve, shown on their own building stock. If the City is to adopt stronger green building practices, it may begin to do so by addressing its own social housing, which is home to some of the people most vulnerable to the effects of climate change in Toronto. Green building initiatives can create community pride and resilience against the encroaching dangers of climate change.

#### *TCHC Background*

Toronto Community Housing (TCHC) is Canada's largest provider of social housing, providing homes for almost 60,000 low to moderate-income households in Toronto – a total of 265,000 people, with 94,000 more on the waiting list. TCHC is an agency of the City of Toronto, funded by the City, and the provincial and federal governments. Tenants pay rent according to income, with some residents paying market-level rents while others pay subsidized rental rates. Working with the City of Toronto, developers, and other organizations, TCHC aims to provide clean, safe, well-maintained and affordable housing and neighbourhoods. Their work largely focuses on revitalization efforts to transform aging housing infrastructure as well as creation of vibrant communities with increased opportunities and amenities. Housing provided by TCHC includes 2,200 high, mid, and low-rise apartment buildings, townhomes and houses, the average age of the buildings being 42 years old. TCHC was formed in 2001 without a

stable, long-term source of funding to pay for capital repairs to its housing stock. Since then, it has been operating with a backlog of repairs needed for its buildings.

The City of Toronto and TCHC have developed a 10-year capital repair plan (2013-2022) in order to conserve the agency's aging buildings. The planned repairs will cover 18,000 capital repairs to benefit 40,500 households. Without \$2.6 billion in repairs over 10 years, TCHC anticipates that 4,000 of its buildings will be in critical condition, and 7,500 homes will be boarded up. Over 350 homes have been boarded up in the past two years due to their poor condition. Maintaining this housing is crucial to protecting affordable housing and quality of life for thousands of residents, as well as for benefiting taxpayers (ultimately the owners) who will otherwise see this building stock further degraded. The current housing stock is worth \$9 billion, and without renewal, costs will continue to grow. The capital repair plan is in progress and dozens of improvements to the buildings have been made around the city to meet resident needs. These improvements include repairs to elevators, building envelope, boilers, roofing, windows, security cameras, kitchens, and plumbing, returning homes to only a 'fair' state.

In the 1990s, the federal government was largely responsible for subsidizing public housing, followed by the handing down of this responsibility to the provinces, and finally to the municipalities. The federal government currently provides \$140 million annually to TCHC although this number is decreasing at a rate that will see zero federal contribution to social housing by 2032. The City of Toronto has increased the capital repair investment each year, from \$68 million in 2013 to \$128 million in 2014, \$175 million in 2015 and \$250 million in 2016. The provincial and federal government have provided an additional \$801 million in investments over five years, although this cannot

be allocated to capital repairs. The City is providing funding through mortgage refinancing over the next two years in order to finance its budget for 2016. These investments are still not enough, as TCHC has secured only one-third of the money needed to complete the capital repair plan. The City and TCHC are advocating for secure federal and provincial funding of \$1.73 billion in order to complete the repairs. The future is uncertain for the thousands of people who depend on public housing, and the outcome could be devastating.

The TCHC building stock is in a dire state of repair and the most prominent barrier is lack of capital. TCHC's CEO, Greg Spearn, says, the spike in health-care costs that will come from further degrading housing will far exceed the investment being asked of governments (Pagliaro, 2015a). An additional challenge is that utility costs have risen 37% over the past five years, further tightening the budget (Pagliaro, 2015b). A new initiative of TCHC is providing rebates to 1,200 TCHC households that pay for their own electric heating to help with these rising costs.

TCHC has recently reformed its repair management model in order to make more coordinated and timely repairs, and efficient use of finances. Until the end of 2015, TCHC awarded individual contracts for various types of repairs needed, resulting in crews working independently and information being poorly relayed to residents. The new model allows one architectural firm to work with residents to assess the needs of the building and the community, and to subcontract jobs to a variety of contractors. The program, named ReSet, is expected to help stretch the city's approved funding.

The 10-year capital plan is also expected to create significant environmental benefits across the city, allowing energy cost savings to be used to support repairs. In

order to reduce gas and electricity consumption, TCHC works with a number of partners to deliver programs focused on energy efficiency such as, Toronto Hydro's saveONenergy Home Assistance Program (HAP), Low-Income Energy Assistance Program (LEAP), Brighter Nights; Enbridge's Home Winterproofing Program; Energy Star's Energy Star Program; Toronto Atmospheric Fund's TowerWise Retrofit Project, replacing inefficient toilets with low-flow ones to reduce water consumption; as well as sharing conservation tips for residents and staff.

The joint-effort with Toronto Atmospheric Fund (TAF) (an agency of City of Toronto) is an initiative to allow public housing to become more energy efficient, cheaper to operate and more comfortable to live in. The TowerWise Retrofit Project aims to address the impact that aging buildings have on GHG emissions, demonstrating best practices for buildings across the city. The plan will finance and implement energy efficiency upgrades in seven aging TCHC buildings, ultimately benefiting 1,200 families. The plan also has a strong focus on improving health and wellness benefits from the retrofits, by improving temperature, air quality and indoor comfort – areas of concern for residents surveyed by TAF (Leach, 2015). Retrofits will include double-glazed windows, low-flow faucets and toilets, high-efficiency fridges, boilers, motors and lighting. The cost of the retrofits will be \$4.2 million – \$3 million in fund financing and \$1.2 million in grants and utility incentives. The finances will be structured as an Energy Savings Performance Agreement, where TAF funds the costs upfront, and shares utility cost savings with TCHC over ten years, ultimately helping to fund the 10-year capital repair plan. The building's GHG emissions are expected to decrease by one third, cutting building operating costs by 20%, 50% of which will be returned to TCHC (Rider, 2015).

Many of TCHC's buildings constructed over the past decade have implemented LEED best practices into their construction. One of these buildings is the new construction of 150 Dan Leckie Way, which aims for LEED Gold status. Construction of the building involved the remediation of soil quality on the site, the use of 7.5% recycled materials, and a diversion of 8% of the site's construction waste. The green building features include: collection of rainwater to reduce the load from the municipal rainwater system and use for irrigation, 50% of the roof area towards a rooftop garden, a ground source heat pump, water and energy efficient appliances, recycling availability to residents, and features to increase the wellbeing of occupants.

The City of Toronto also has a Tower Renewal program, which allows for deep retrofits of apartment towers and their surroundings in Toronto – a program that TCHC is currently involved with in the benchmarking phase. The retrofits include upgrades to exterior cladding, solar water heating, water efficiency, the tree canopy, local employment, tenant engagement, access to parks, and community space. Retrofits that include building envelope cladding to add insulation and high efficiency heating systems can result in 50% utility use reduction leading to a 5% reduction in overall city greenhouse gas emissions. The City of Toronto says that, “although challenging, it is technically and financially possible to make the buildings, sites and communities we work in perform to as high a standard as newly constructed facilities” (City of Toronto, n.d.b). There are approximately 1,200 buildings that could be eligible to partake in the program. (City of Toronto, n.d.b)

The City of Toronto is the largest landlord in the city, TCHC itself owning 134 older high-rise buildings. If the City of Toronto and TCHC can lead by example by



setting a high standard within their own building stock, as well as by demonstrating the benefits of retrofitting, energy efficiency, and green design, they have the potential to influence the two thirds of Toronto's 1,200 apartment buildings which are for-profit, privately-owned rentals. Today the 1,200 concrete apartment towers built between the 1950s and 1980s are aging and inefficient, while the open spaces that surround them are underused and poorly maintained. The Tower Renewal Program combines green technology with neighbourhood revitalization projects to make stronger, greener communities across the city. The sustainability efforts of TCHC will be analyzed to see what objectives are being met and how additional measures can be taken to meet the goals of the City and Corporation.

### *Focus on Community Housing*

The hazardous effects of climate change are experienced more strongly by those living in poverty (IPCC, 2014b). This is especially true in the global south where poverty is prevalent. However, the diverse and widespread effects of climate change are felt globally. Wealthy countries comparatively face much smaller or less widespread risks, although the risks are real and they are felt both directly and indirectly. The human risks that are faced in Toronto are mainly due to local air pollution and extreme weather events although global issues such as food security and vector borne diseases are felt locally as well. Low-income urban residents can be especially vulnerable during and after extreme weather events that damage their homes, disrupt critical public transit links, prevent access to work, and heighten exposure to health risks (IPCC, 2001). Climate change has important health, economic, and social impacts on persons living in urban areas affected

by climate change, and especially on vulnerable groups of people. Vulnerability represents the degree to which groups of people are able to cope with the adverse effects of climate change, often due to a lack of resources available. The risks of climate change are further amplified for those living in poor-quality housing.

Groups with lower amounts of social support, education or economic resources are most vulnerable to the effects of climate change (City of Toronto, 2013a). The consequences of climate change could potentially force more people into poverty, as those who are most vulnerable also have fewer resources to adapt or recover from adversities, and therefore may have a more difficult time recovering (“Climate Change Complicates Efforts to End Poverty,” 2016). The poor often live on the most vulnerable land which is prone to effects such flooding, or land that is more likely affected by loss of services due to extreme weather events. In addition to increased vulnerability, poorer households also take preventative action less often and received assistance after flooding less frequently than more affluent households (IPCC, 2001). Also, those with low incomes may not have access to an automobile to escape extreme weather events, for example in the evacuation of an anticipated hurricane, and may have little choice but to allow themselves to be at risk to climate dangers. The damage incurred on property (e.g. basement flooding, damage of roof from trees falling) and health due to climate change can prohibit the poor from escaping poverty, thereby perpetuating the cycle. The adverse effects brought by climate change can have crippling economic shocks on those living in poverty.

Extreme weather events may cause damaged infrastructure and a loss of power. Many low-income groups live in low-quality housing which is less likely to provide

protection and more likely to suffer damages from extreme weather events. Residents of these properties may have more difficulty repairing these damages or may depend on a landlord to ensure their home is livable. Loss of infrastructure can displace people from their homes and jobs, disrupting social support networks and access to their belongings. Damages may also disrupt transportation (most often public transit) and telecommunication, effectively making it more difficult for residents whose only transportation option is public transit, more difficult if not impossible. People in positions of precarious employment are at risk of losing their income if the effects of extreme weather events prevent them from working. For example, disrupted means of transportation, relocation away from the workplace, and finding childcare when services have been closed can result in a loss of income. People of low-income must cope with climate shocks under highly constrained conditions.

Food security can be a major issue both in the long term and short term for those living on low incomes. Displacement from home during extreme weather events creates challenges for access to affordable and nourishing food. Extreme climate events can increase risks of food contamination, as well as food availability overall due to the breakdown of food systems (i.e. precarious crop yields year to year due to extreme weather conditions) (IPCC, 2014b). The poor spend a higher percentage of their income on food and when food security issues brought on by climate change raises food prices, this disproportionately affects the poor (IPCC, 2014b; The World Bank, 2010).

Poor people in wealthy countries may be more vulnerable to climate change health impacts than those with average incomes in the same countries (IPCC, 2001). Health impacts from climate change are experienced from the quality of immediate

environments, as well as indirectly from many of the issues discussed which are determinants of health (food security, employment status, quality of housing, access to core services). Groups vulnerable to the risks of climate change health impacts include infants and children, women, seniors, people with underlying health problems, low income and homeless people, people living off the land and First Nation communities (City of Toronto, 2013a). Reviews by federal agencies, Health Canada and Natural Resources Canada outline the potential direct health impacts from climate change which include: increased heat-related illnesses and mortality (a not uncommon phenomenon of seniors, young children, people who are isolated, homeless, or under-housed people who do not have access to cooling but may also not have great mobility to leave these conditions), respiratory and cardiovascular illnesses (caused by degraded air quality, especially smog which occurs on hot days), increased in vector-borne diseases (such as disease-carrying insects who have moved further north due to the warmer climate), risk of food-borne illnesses due to contamination, and various risks arising from extreme weather events (City of Toronto, 2013a). Some research also suggests that increases in extreme weather can have significant impacts on mental health due to stress (City of Toronto, 2013a).

The impacts of climate change are anticipated to worsen, and with this, the stressors felt by the poor will likely be stronger with the potential to push them further into poverty. Cities have the opportunity today to address some hardships felt by those living in poverty, by acting on climate change. This can be used as a window of opportunity to lessen the adversity felt by the poor by prioritizing their housing needs at this time. Because the ill effects of climate change are felt most strongly by the poor,

green building policies should focus on this group of people who have the most to gain from mitigation and adaptation strategies. For these reasons, this paper seeks to see the potential for TCHC and the City to adopt stronger green building practices for all construction practices. This will help improve the lives of those who are least well off by reducing vulnerability and exposure while also allowing the governments to lead the way in reducing GHG emissions. Initiatives which build resilience and enable sustainable development can accelerate successful climate-change adaptation globally (IPCC, 2014b).

Knowledge and innovation are required for adapting existing and new buildings to reduce GHG emissions. Toronto needs affordable, good quality housing built to climate-resilient standards, which allow residents to live healthy and safe lives, and protects residents from injuries, damages, displacement, and disruptions to household income. Although governments have developed climate change strategies that include measures to regulate building practices, the strategies neglect measures to protect the most vulnerable populations of climate change. The government should explore the range of actors in the housing sector, advancement of green building technologies, and innovative measures to coordinate strategies that support resilience and climate mitigation goals (IPCC, 2014b).

### *TCHC Sustainability Policy Initiatives*

The idea of sustainable development within TCHC has been prominent since the beginning of the organization and this has strengthened even more so through the years. This section of the paper is mostly informed by an interview with a member of TCHC's

Smart Buildings and Energy Management Department, in May of 2016 (TCHC Employee, 2016). This Department at TCHC is responsible for utility consumption across the building portfolio and their work includes evaluating energy systems and support for them, initiating conservation measures, and utility incentive programs. I will refer to the interviewee as “Mark” to allow for anonymity although the information obtained was purely in the staff member’s professional capacity as a public sector worker (see Appendix for ethical context). The interview sought to understand the policies and background research that support TCHC’s sustainable building projects, how climate change influences these policies, and what the barriers of sustainable building have been and might be moving forward.

The policies that guide TCHC’s building for sustainability projects began in the early days of the organization, after its formation from legacy companies. The Green Plan, developed in 2004, initiated sustainability practices within the Corporation, to guide internal policies when it came to green and sustainable practices. This guidance came partially from an Environmental Policy Statement (Toronto Environmental Alliance, 2004, p.10):

Toronto Community Housing will be an environmental leader and will encourage leadership from tenants and staff at all levels. The approach will be proactive, systematic and comprehensive in seeking to prevent pollution wherever possible, and committed to ensuring that all sectors of the company are involved and engaged.

The earliest iteration of the Plan was based on the Kyoto Protocol, calling for action on City and Federal environmental targets, and setting a basis for the approach that TCHC would take in future years for building healthy homes and communities. The subsequent version of the Plan in 2006 included significantly increased targets for GHG reductions

close to targets being looked at internationally today. In some respect, TCHC was ahead of the curve in regards to sustainability initiatives. The Plan is not a key policy document referenced today (although certain parts of it are currently being revised) but instead, the Plan has taken a life of its own as many aspects of the Green Plan have become part of day-to-day business of the company. Reducing GHG emissions was the initial motivator of the Plan, and rather quickly the motivation also became avoiding the largest controllable cost in residential settings – utility costs, which, in the case of TCHC, is a cost of \$150 million a year. The city’s water price has risen 8-9% in the past 7-8 years, electricity costs have risen significantly, and gas prices will rise next year, especially in Ontario. Rising costs have spurred a lot of action as people have come to realize that larger payments can be avoided. Further to the City’s commitments to reducing GHG emissions, there has been engagement at all levels of government, and GHGs have become a greater motivation today because of the funding available for GHG reduction. By being able to lower utility costs, and receive funding by the same avenues, there are many good reasons to reduce these burdens. When asked if lowering costs was the main driver of these initiatives, Mark explained that, the main motivator is resident quality of life, particularly relating to comfort and health, but operating costs are a large motivator as the two go hand in hand. Capital improvements and upgrades to improve resident quality of life require money, and saving money from utility bill turns into building improvements and upgrades. A commitment to a strategic creation of co-benefits is present in the Green Plan, which states the need for integrated environmental criteria that addresses environmental health, resident quality of life, and financial sustainability (Toronto Environmental Alliance, 2004).

In the past decade, the majority of TCHC's new construction buildings have been LEED certified. As most of TCHC's building stock was constructed in the 1960s-1980s, new construction is a minority of the building portfolio. LEED is looked to for performance standards during renovations, although not exclusively. Ultimately TCHC looks at how to maximize performance outcomes in order to have a longer impact on consumption, which LEED does not necessarily do, and is especially lacking when it comes to retrofitting buildings. A number of TCHC buildings have undergone fairly deep retrofits, which have included the replacement of HVAC, water and lighting systems. Mark describes the major renovation projects as generational; currently the organization is moving through a generation of envelope upgrades – something new for TCHC. The project with TAF of deep retrofits has just begun its construction phase. In cases where TCHC buildings have been demolished, they have been in a state of disrepair where it was not economically viable to rebuild. In addition, new construction efforts have been made more feasible as efforts are coupled with the opportunity to build infill (as seen in the rebuilding of Regent Park and Lawrence Heights). Infill allows social housing to be kept on-site in terms of number of units, with the addition of market units to help offset the costs of rebuild.

When it comes to informing green building practices at TCHC, a number of data collection methods are used to better plan future initiatives of the organization. Utility usage data is collected from all buildings by referencing billing information, and a number of buildings are sub-metered. The sub-metered interval data is used as a benchmark for the City's Tower Renewal project mentioned earlier in this chapter. The data collected helps inform investment in terms of what buildings to focus on and what



aspects of conservation to focus on. Data is also used as an engagement tool to share with the community to share how well they are doing – something TCHC will be focusing on more in the coming year. There is an ongoing task to make a more centralized system of data collection, one that can be tied to a dashboard to share with frontline staff and residents.

The sustainable building programming at TCHC is continuously evolving. In coming years, Mark anticipates that PH and net-zero buildings will be projects that the organization takes on. The ReSet program, explained earlier in this chapter, is looking at not only efficiency and community support which will gain a lot of traction in coming years, but it also looks at all types of available technology, and how resources can be maximized so more resident needs can be met. For example, a PH social housing project was recently designed as a project in Ottawa. Salus Clementine is a \$7.5 million, 42-unit environmentally sustainable project that will provide affordable housing for individuals with mental illnesses. The PH design includes extensive insulation, an airtight building envelope, extremely efficient window systems, avoidance of thermal bridging, and a ventilation system that keeps air fresh and the building comfortable (Ottawa Construction News staff writer, 2015). PH buildings require a premium cost of about 20% but the payback is quick and there is a strong case to be made for its use. For these reasons, TCHC would like to explore design avenues of passive technologies in the near future.

While TCHC has had great successes in transforming its older buildings to be good performers in energy consumption, the organization has encountered barriers. First is quite obviously, financial, considering the significant capital repair backlog of TCHC. Often money needs to be diverted to infrastructure fees and other upgrades that do not

necessarily have the payback that energy does. In terms of regulatory barriers, the flow of data can be unreliable and there is no set system to get a regular data feed which is clean, and would thereby help with analysis of what changes the Corporation could be initiating. Certain regulations such as the requirement for stairwells and hallways to be brightly lit at all times inhibit conservation measures; LED light bulbs are used but the organization would like to go further if possible. TCHC uses the City's green building standards, as does anyone building in the city (although social housing is not required to pay development charges and therefore the development refund for Tier 2 green development is irrelevant), and are quite proactive with new construction. However, Mark states that there is little being done on the retrofit side of building because the OBC is only for new construction and consequently, there is little push for the contracting, design and construction management community to get on board with retrofitting to high efficiency standards.

Perhaps the largest task for TCHC is engaging residents and staff on how to live in a slightly different way in these buildings. This includes teaching residents to understand the relationship between consumption and ways to live in a home: how this affects individual comfort and health, the impact of the comfort of the entire building, as well as the financial cost to the Corporation as a whole. Tenant engagement is in fact, an element of how TCHC defines green housing, “[e]ngages tenants, workers and neighbours in designing programs and making positive environmental changes to their own behaviour and building operations” (Toronto Environmental Alliance, 2004, p. 7). The burdens of user behaviour are not well understood by residents and this is a challenge that TCHC is currently working on addressing.

During the construction bidding process of its projects, TCHC sees an increasing number of people understanding green building applications. Private property management companies now understand conservation and are on board to push the construction community in this direction. A few years ago it was difficult to find support for these types of projects but since then, it has become a lot more popular. In the past, TCHC has encouraged vendors to undertake sustainability as a priority initiative, and in recent years TCHC has been getting a lot more specific in terms of its scope and specifications during the tender process. Both internally and externally, TCHC is becoming more focused and not only looking at energy consumption and efficiency but long term maintenance and support, to ensure that these systems are long lasting and truly sustainable solutions.

Hoffman and Henn (2008) identify a lack of complete understanding of green building technologies as a barrier to green building, especially when additional time is required for understanding technological lifecycle and payback returns of green technologies. Mark dismissed time constraints related to information processing as being a limitation to green building at TCHC. The Corporation feels that it is best to take a long-term view to understand the maintenance outcomes, product support and durability of the product, and they make all efforts to work with people who understand the industry. Within TCHC, most people have an understanding of green technologies that are fairly standard fare now but in some instances, a lack of understanding can prevent projects from reaching their full potential. For example, new practices to North America (such as PH) have a limited number of people who understand what it is about and

therefore there is hesitancy to approach this. Ultimately, TCHC is not fearful of stepping out, and is truly looking at going ahead of the green building curve.

The federal, provincial and municipal governments are looking at a number of ways to support green housing. Mark states that much of the funding available to TCHC is for GHG reduction strategies. This comes from all levels of government as well as from partnerships with other corporations. The \$801 million in provincial and federal funding mentioned earlier in this paper is partially from the provincial cap and trade system. The provincial funds are permitted to be spent on energy efficiency measures to further reduce GHG emissions; and the federal funds are coming from a variety of pots, some of which is for new construction only, and some is for energy efficiency measures. None of the money can be spent on capital repairs unless they have an energy efficiency outcome attached to them. Mark says that the banking system has historically not been friendly to green building practices, as there is little long-term thinking involved and the projects at TCHC have a payback period of 10-20 years rather than 3-4 years that the bank expects from developments.

A small percentage (5%) of TCHC residents pay for their own utilities while 95% have utilities incorporated in their costs. There is the notion that when users are charged for use, they consume less, and so perhaps restructuring rental costs to separate utility costs could be an option to encourage individual conservation efforts. Mark says this may be possible although it is not desirable; there are equity issues that make user-payment of utilities a difficult argument to make. Instead, TCHC is more focused on looking at sub-metering as a tool to help people make changes, so that problems can be addressed at a granular level. In ongoing resident engagement work, TCHC would like to build on

demonstrating incentives for conservation. This includes demonstrating to residents a more direct relationship between savings and how they can be reinvested into buildings. Mark says that typically from residents, the motivation is less about money and more about quality of life – the health outcomes for their families, and the effect on the environment. These conversations have had a lot of resonance within the community, which has shown that the community has pride in wanting to be one that does good things.

This chapter has shown the many challenges that TCHC is facing, but also the commitments it has made to sustainability, and how implementing those have far-reaching benefits. Ultimately, a lack of financial resources is limiting the potential of TCHC’s sustainability initiatives although, they have demonstrated a business case for green investment. The city as a whole needs to adopt stronger green building practices in order to reduce its GHG emissions, mitigating the consequences of climate change, and therefore improving the lives of its residents. By identifying the limitations to energy conservation, the City can identify where investments might be needed to maximize benefits received from them.

## **Chapter Four:**

### **Analysis and Recommendations**

Through the interview with a TCHC staff member, several aspects of the organization's operations have been revealed. The small sample size in this study should be noted as it does not allow for other perspectives to be heard – those of critics, tenants, other TCHC employees and groups working with TCHC. There is perhaps a biased opinion given of TCHC's work on sustainability, and the findings represent the statements of only one person of the Corporation. For these reasons, the analysis should be viewed carefully, and with an open mind. An interview with solely a TCHC employee was deemed to be sufficient for this study, as the intent was to understand the policies behind the projects discussed, limitations experienced by the Corporation, and the direction that sustainability initiatives are taking. The interview conducted sufficiently met the intent by offering the perspective of a public sector worker. The analysis and recommendations are made with consideration of both the interview, and the policy framework discussed throughout this paper.

From the interview, it has become evident that TCHC as an organization is committed to the objectives of sustainability for financial reasons, for the health and wellbeing of its residents, and for consideration of the global climate. The interview revealed that the TGS, TCHC's Green Plan and financial incentives tied to reducing GHG emissions propel green building of the TCHC building portfolio forward. This has shown the potential for the City to expand on its sustainability work by adopting stronger green building practices in order to reduce its GHG emissions. This chapter will seek to address the limitations that TCHC is facing when it comes to improving the performance

of its green buildings, so that improvements can be made to the City's climate change mitigation strategy, and it can maximize the benefits received from the green building practices that it has implemented thus far.

The limitations on advancing green building within TCHC have been identified for the purposes of reducing GHG emissions, improving resident quality of life, engaging residents, and reducing costs, as described in TCHC's Green Plan. The first limitation is the lack of significant efficiency building standards for renovation and retrofitting of buildings. The current presence of green building standards for new construction is relatively forward thinking however, the standards lack almost any note of addressing renovations. The turnover of building stock from new construction is quite low, so green building standards currently influence a very small portion of the building stock.

The second limitation to improving the performance of TCHC's green buildings is a lack of reliable and detailed data of energy consumption. Without this data, it is difficult to identify and target energy waste reduction, and identify where tenants may be able to change their behaviour.

The third limitation is a lack of user understanding of how behaviour influences consumption. Although the TCHC is working on this, the issue will need to be solved with a long term engagement plan with tenants and employees. Addressing the second limitation, lack of reliable and detailed data, could help act as a tool for engagement and education strategies.

Climate change action requires the development of regulations, policies, technical innovation and social support programs to overcome limitations of pushing sustainable development forward. This type of action is especially important for those who are most

vulnerable to the negative impacts of climate change, in order to protect their health, wellbeing and safety. The following sections will further describe the limitations on reducing TCHC's building GHG emissions.

### *Form Green Building Standards for Renovation*

Regulations to enforce a reduction in building-related GHG emissions need to stretch beyond new construction to include standards for the re-use of buildings.

Toronto's Green Standards, LEED certification and the benefits associated with them are providing a great push for higher efficiency and improved performance levels of new construction buildings. What is lacking in the movement towards reduced building GHG emissions, are green standards for renovation that address the majority of building stock which will continue to exist over the next several decades. Renovation of TCHC's aging buildings is crucial to improving living conditions and maintaining livable residential unit numbers.

If we are looking for energy savings and reductions in GHGs, then we must look to reuse of existing building stock. This may be through major renovation, or through using recycled building content in new construction. Improving resource efficiency along the lifecycle of buildings will reduce material use, energy use and environmental impacts associated with new material production, and has the potential to allow for a net energy benefit (Herczeg et al., 2014). Cities are advancing energy efficiency by developing building codes, and by offering related financial incentives to developers and buildings; building retrofitting is an area that these advances should be applied to. Because the OBC and Toronto Green Standards are mainly for new construction, there is little push for



contractors, designers and the construction management community to provide services for green renovation. With the presence of green building standards for renovation, TCHC could potentially justify the use of money from budgets that allow investment in energy efficiency to improve its crumbling building stock. Energy efficiency and GHG emission reduction efforts need to be complemented with policies that cover a broad range of contributors, and take into account the full lifecycle of buildings, old and new.

As described in the last section of Chapter Two, buildings hold embedded emissions – the GHG emissions released in order to extract, fabricate and construct the building, prior to its use. Therefore by choosing to renovate rather than construct new, a significant amount of emissions can be avoided. Earlier in this paper it was also mentioned that, the embodied energy of buildings begins to weigh more heavily as energy efficiency technologies improve. Although renovation avoids many of the GHG emissions that new construction creates, is it possible that renovated older buildings will be able to operate at the same efficiencies as newly constructed green buildings?

Renovating a building will almost always be cheaper than building new, although, is this still the case if an older building should be upgraded to meet equal efficiency standards as a new building? The answers to these questions can only truly be determined on a case-by-case basis. However, they highlight an important point that green building renovation standards must in some way give incentives for upgrades that push boundaries and make significant efficiency gains in an affordable way. If the costs are comparable between building new green buildings, and renovating to comparable efficiency standards of a new building, the answer from a developer's perspective will almost always be to build new – consequently, producing new embodied energy.

Upgraded renovation codes should not only focus on improving energy efficiency, but also creating a high-performance building by applying the integrated whole building design process (Paradis, 2012). By considering multiple parts of the building's systems, an optimal design solution can be decided on which meets several design objectives. For example, an HVAC system should not be looked at without considering the building envelope insulation, window upgrades, or opportunities for passive heating. All elements should be considered to create the most cost-effective solution that meets the individual needs of the building. Furthermore, an integrated whole building design process involves considering operation costs, building value, building lifespan and quality of the environment. Improvements can be made all at once to improve indoor environmental quality, accessibility, safety and security, and energy efficiency to increase the building durability and resiliency (Paradis, 2012). These standards can be developed in concert with builders in order to best understand what is feasible, and training programs can help contractors learn about new construction techniques and environmentally-friendly materials.

Formulation of a defining measure to distinguish when retrofits shall comply with green standards may be complicated. Also, it is possible that the requirement to meet certain standards may deter TCHC and homeowners from retrofitting, while others may do it without the necessary permits. For this, it will be necessary for local governments to influence owners through education, and incentive programs to facilitate retrofits. Financial incentives to stimulate retrofitting buildings for energy efficiency may include rebates on investment (e.g. provide 20% rebate on renovations which reduce energy use), or waiving costs of applications or permits (e.g. development applications or building

permit fees). To encourage renovations or retrofits for greater energy efficiency, governments must reduce unnecessary imposed costs and barriers to supply, as well as streamline the process. Planners may link these investments to land use planning, focusing on the process of green buildings, and how they will achieve greater efficiencies; for example, by introducing elements of sustainability into zoning by-laws. Planners may be able to leverage green standards by coupling financial incentives with planning efforts; for example, by providing grants or refunds through community improvement grants within a designated Community Improvement Area by utilizing Section 28 of the Planning Act. Section 28 allows lower-tier municipalities to improve their communities in various ways including providing grant or loan incentives for landowners and developers to undertake sustainable activities (e.g. retrofitting existing building for energy efficiency). This may be done in conjunction with tax-increment financing which benefits both the business owner and the municipality financially, and for the purpose of reducing greenhouse gases, improving the quality of the building stock, and enhancing the community atmosphere. There are a few City-run financial incentive programs that exist today including, the Better Building Partnership, Tower Renewal, and Home Energy Loan Program, which support the retrofit of older buildings, thereby reducing their energy use and GHG emissions. The objectives in these programs need to be joined with mandatory standards in order to make projects more financially feasible and sustainable for everyone.

In addition to the financial funding provided to Municipal programs such as the ones listed above, investing in these programs is an acknowledgement of the impact that embedded emissions have on GHG production. By investing in renewing existing

structures to become more energy efficient, we eliminate creating new emissions through demolition, recycling of materials, extraction and production of new materials, and construction. In addition, major renovations to existing buildings will most likely be more financially attainable than building new structures, especially as financial incentives for boosting efficiency are available from various sources. Ultimately, the decision of whether to build new or renovate existing buildings will depend on a variety of factors including the state of the existing building, cost-benefit analysis, the need to relocate residents, and whether the existing building can meet the current needs of TCHC.

Implementing renovation standards may deter or even financially inhibit owners to upgrade their buildings if they need to build to Code requirements every time renovation is undertaken. Currently the OBC requires the performance level of a building after renovation to not be less than the performance level of the building prior to renovation (*Ontario Building Code*, 2016), meaning that the mandated performance can be that of several decades ago. Owners renting to tenants may also feel that they are paying for building efficiency while the tenant reaps the rewards, depending on if tenants pay utility bills directly to the utility or as part of the inclusive rent. Determining savings for efficiency in multi-unit residential buildings is difficult due to a lack of accurate submetering (Lockwood, 2009). For these reasons, Code requirements should be financially attainable, and information should be given that demonstrates the value of renovations to the owner. It is also important for homeowners to understand how to determine if the investment is worthwhile in consideration of other building conditions, what repairs need to be made to meet current Code requirements and how will it affect tenure (Paradis, 2012). In an Urban Land Institute publication, the feasibility of building

renovations is discussed following the economic crisis in 2009. Through discussion with developers, Lockwood (2009) finds that retrofits do not yield the same profit margins as new construction projects however, in unstable economic times, they offer a safer way for repositioning developers' operating assets. Green renovations are seen to be less risky because the most costly structural components are already in place, and there are fewer material expenses. The developers claim that building retrofits can only be cost-effective if they are piggybacking on existing capital and operational repair plans. Therefore, buildings need to be retrofitted at the point that it is needed, rather than on a timeline based on government incentives. This piggybacking introduces integrated design so that systems are not evaluated by themselves, but as a larger picture where systems can support each other and benefits can overlap (Lockwood, 2009).

While explicitly described standards (e.g. LEED) have been criticized to not necessarily result in the most effective outcomes, Anguelovski and Carmin (2011) describe how institutionalization in climate governance can be associated with rule-bound behaviour, rather than entrepreneurship, and therefore inhibit true innovation. From this viewpoint, a lack of resources, capacity and best practices may promote innovation and the advancement of initiatives which are grounded in the local realities (Anguelovski & Carmin, 2011). However, this is a gamble that requires a waiting period, which Toronto does not have, to act. In addition to this, research on industry leadership has show that many building industry professionals only adopt new practices if required to by regulation and so, the building industry requires a regulatory framework to achieve dramatic improvements in energy efficiency (WBCSD, 2008). Perhaps it is necessary for regulatory standards to refrain from being strictly prescriptive and to allow for flexibility

that gives incentive for a push towards green development. The OBC does currently allow for flexibility when testing for energy efficiency. It requires homes to meet a benchmark EnerGuide score, by using whichever methods suit the builder best, as long as it is compliant with the Code requirements. This flexibility will need to be maintained. By making a push through institutional action, there may be a larger capacity to reduce greenhouse gases, as well as to contribute to the global advancement of sustainability.

In order for buildings to make valuable contributions to reducing GHGs, all of the building stock should be permeated, as programs that encourage retrofitting are just as important as programs for new developments. Addressing GHG emissions of TCHC's older buildings will perhaps give a new life to aging structures, and create healthier living spaces. New policies to affect existing buildings can additionally educate the public and real estate industry on green development, rather than only providing incentives to developers to pursue green building standards.

### *Invest in Data Collection*

Data collection and monitoring has the potential to play a crucial role in further reducing GHG gas emissions both by identifying where users can change their energy consumption behaviour and by revealing what technical aspects should be focused on. Strategies to reduce emissions in green buildings have emphasized using more efficient types of equipment and technology. There is a large area of opportunity for TCHC to maximize emission reductions by better understanding energy consumption at the user and building level.

To date, Ontario has reduced its energy use in buildings through conservation programs, efficiency requirements in the OBC, product efficiency regulations, ending the use of coal for energy production, investing in renewable energy, and by targeting every home and small business to be equipped by a smart meter. Investment in data collection at the level of building managers, the City and the province, will better describe energy conditions of buildings so that specific targeted measures can be taken for energy reductions.

There are several data collection and evaluation tools that exist today. These tools allow users and energy analysts to view real-time data to identify exactly when and where energy is being used, how energy might be being wasted and therefore where energy operating costs and emissions can be reduced. Web or mobile app-based energy reporting softwares existing today include CircuitMeter, MeterConnex, Wattsly, Bidgley and Eyedro, all doing similar things at different levels of detail and complexity. On a larger building scale, CircuitMeter can identify where energy is being wasted through mistakes in control system settings, equipment working during hours it does not need to be, inefficiencies due to lack of maintenance, aging components, and low power factors.

MeterConnex is also designed for a much larger scale which allows property managers to view the performance of each of their buildings within their portfolio, providing monthly consumption for all main utilities, comparison between buildings and between previous years and more. On a small scale, Eyedro provides the most detailed energy use, showing timely and actionable insights by allowing the user to see energy usage minute by minute so they may identify how individual appliances draw energy when being used, and the costs associated with its use. Simplified technologies, Wattsly and Bidgley, offer

interactive platforms that allow users to visualize their energy usage, partake in challenges and log activities to help identify energy intensive activities.

Many of these technologies can also be used as a communication tool, connected to dashboards in common spaces of apartment buildings so that all users can be made conscious of energy usage. Data visualization informs users on their energy use, allowing them to address inefficiencies or turn off appliances, and notifying them what changes in the household could be made to reduce energy usage. Several studies have shown that feedback is an effective method for promoting residential energy conservation, because it shows the relationship between one's actions and the given outcome, therefore producing meaningful feedback to inform future actions (Carrico & Riemer, 2011). To be effective, feedback must closely follow the action, unlike monthly usage notifications, in order to provide information to the users that changes in their actions will lead to the desired effect of reduced energy consumption (Carrico & Riemer, 2011). Data collection tools that provide feedback allow for an easy and affordable way to empower the average person, or community within a building, to take control of their energy use and costs, for property managers to identify poor energy performance, and for everyone to evaluate savings as a direct result of their change in behaviour.

Improved energy reporting could greatly reduce energy consumption and emissions for TCHC. The costs associated with these technologies are reasonable, especially considering the energy savings use of the applications will allow, and the rising cost of utilities. By using innovative technologies such as these, new opportunities are opened for reducing energy consumption and GHG emissions. By investing in these,



TCHC and the City have an opportunity to be a leader in reaching its GHG reduction goals.

#### *Address User Behaviour Through Education*

Energy efficient building components and data collection technologies can only perform to their full potential if the users understand how they work and how personal actions impact energy consumption. In the interview with TCHC, it was made known that tenant engagement is currently a key focus for energy conservation, as many tenants do not fully understand the relationship between their actions, energy consumption and costs associated with it. This lack of full understanding likely rings true to others in the city including in homes and workplaces. For this reason, TCHC should look to user education as an additional avenue to help reduce energy consumption. User education can help ensure that a building's performance meets energy conservation expectations. It can also be linked to data collection, as data can be used as a real-time education tool in order to maximize potential benefits.

In Lockwood's (2009) interview with building developers, lack of understanding from both tenants and building operators are identified as the greatest challenges to maximizing the benefits of green buildings. The most well engineered buildings can only perform at their maximum efficiencies when users understand how the equipment works, and why they should operate it as such. One participant gives the example of a case where building operators are not trained properly or choose to manually manage the energy systems, thereby immediately diminishing operating efficiency and building comfort (Lockwood, 2009). Proper management would provide the expected

performance results and environmental benefits typically gained from new systems, effectively maximizing the potential benefits experienced by TCHC and its tenants.

Educating building owners and builders on the financial benefits of energy conservation can allow for active conservation efforts as well as encourage renovations and retrofits. One of the primary barriers to energy efficiency is the perceived additional costs and a misunderstanding of the payback benefits purchase cost (Hoffman & Henn, 2008). Energy efficient buildings are typically more expensive to build, but less expensive to operate. Building purchasers may not be completely informed or convinced on the potential paybacks of efficiency installations, may not completely understand the technology or how it will affect the building, and may be deterred because they are not the users of the building or do not plan to stay. Building tenants can have a similar limited understanding of the building technologies, costs and benefits associated with them. Education efforts must demonstrate that regardless of doubts, inefficient buildings are more expensive and less comfortable to live in for residents (who ultimately pay the cost of the building). Affordability can be addressed by understanding the full costs and benefits of conservation, as well as a range of investment options for the building, which are less intimidating. Proper maintenance of the buildings without any major structural changes can contribute to efficiency benefits similar to those typically gained from new systems.

Methods of educating and engaging tenants include: sharing efficiency goals and benefits with occupants, assessing usage to create baselines and identify ways to improve with residents, sharing usage data, benchmarking data and achievements, providing interactive tools or posters, involving residents in organizing performance goals and

suggestions, and ultimately maintaining a consistent two-way communication with tenants (“Engaging Tenants In Energy Conservation,” 2016).

Tenants, both of workplaces and residential properties, are largely in control of energy consumption no matter the capabilities of the building. Therefore, engaging tenants to understand how their actions impact consumption is crucial to ensure TCHC’s buildings are performing to their highest potential and meeting energy conservation expectations. Most conservation education material is given for the household, ignoring behavioural changes where most adults spend their peak energy use times. Behavioural changes within the workplace is especially challenging as employees generally have no direct financial incentive to energy reduction, nor do they receive any feedback on their level of consumption (Carrico & Riemer, 2011). A similar lack of financial incentive and direct feedback for tenants regarding their energy use is the case for TCHC homes at the moment. Reducing consumer demand for energy through behavioural interventions is an inexpensive strategy, and tenant engagement is a more long-lasting and effective option for reducing energy consumption that aligns with the objectives of TCHC’s Green Plan.

By understanding the limitations to improving the performance of TCHC’s green buildings, the City can better plan for the position it needs to take in order to improve its green building standards in efforts to reduce its GHG emissions, improve the quality of life of its residents, and be a leader in sustainable urban development.

## **Future Outlook**

### *Areas for Further Research*

The findings of this paper will require further exploration into what role governments and policy makers will need to take in order to effectively reduce GHG emissions for a healthier built environment. With Ontario's recent filing of the Quantification, Reporting, and Verification of Greenhouse Gas Emissions Regulation, taking effect January 1, 2017, certain identified activities will require emissions data to be collected and reported. The emissions data is a tool to provide a baseline for companies and to help understand, manage and cut emissions. This Regulation will support the implementation of Ontario's cap and trade program – the initiation of which shows that climate change mitigation policies are continuously evolving in Ontario. Initiatives of various levels of government will need to be expanded to fully realize the potential of climate policies, and to demonstrate the influence that governments adopting a leadership role can accomplish in transitioning to a cleaner built environment.

In efforts to strategically produce larger climate change mitigation strategies, governments will need to align their objectives to create accessible, consistent, and reliable information on energy use and reporting. Currently, various environmental groups offer climate change mitigation tools. These include GHG accounting tools to inventory and audit GHG emissions, allowing benchmarking of carbon footprints and an understanding of how to manage climate change impacts. These fragmented initiatives are generally working toward the same direction, although with slightly different agendas, and with inconsistent reporting of findings. This can make it difficult for interested parties to make a strong argument for environmental initiatives as the lack of

coordination between the groups produces an overall hazy message. If resources were pooled and efforts were streamlined and coordinated, it is possible that these organizations could have a stronger momentum in achieving their goals, consistent messaging could be used to educate the public, and costs could be reduced. The lack of standardized methods, consistent messaging and data in existence today results in a weaker argument for climate policies. By supporting long-term commitments to universal benchmarking, building energy performance data collection, and an open education portal, governments can push the agenda of reducing building emissions. Going forward, various levels of government will need to demonstrate their leadership roles and commitments to climate mitigation initiatives by providing standardized tools for GHG accounting which can be used as part of other initiatives.

Another area of research that will need to be explored is how using public sector investments can stimulate adoption of opportunities for reducing emissions, providing alternative building forms, and healthier spaces for occupants by the private sector. Public projects can showcase green building public projects including benchmarking data and disclosure of building performance. Movements of the government's role in addressing built environment emissions will determine if Canada will be seen as a leader of climate change action in cities.

### *Conclusion*

Toronto's carbon emissions have dropped by 24% since 1990 levels, and 18% since 2004 levels. The City has made significant reductions since 2005 however, reductions in emissions plateaued between 2014 and 2015 following the complete phase-

out of coal-generated electricity (City of Toronto, 2015). The City must now seek alternative opportunities to meet its GHG reduction goals. There is an enormous amount of untapped potential to reduce GHG emissions in the renewal of buildings, and the City will need to optimize these opportunities by implementing stronger green building practices through its policies. By demonstrating that green building practices are economically feasible and preferable, as well as the environmental and social benefits that green buildings can provide, the city as a whole can move towards more sustainable development.

Cities are increasingly in danger of the effects of climate change, and the globe has reached a point where people must make drastic reductions beginning immediately, and continue to for at least the next 35 years. This will require all corners of energy efficiency to be explored. Buildings offer an opportunity for intervention as their lives naturally come to an end and are replaced, as well as the opportunities for renovation and improvement for both the benefit of the residents' comfort and the performance of the building. Best practices in green building are important for advancing the efficiency of buildings, although due to their weaknesses, and their inability to account for user behaviour, these are not the complete solution to reducing greenhouse gas emissions. The sustainability efforts of Toronto Community Housing has shown how efforts can be made to reduce greenhouse gas emissions for all types and aged buildings, and the benefits that can be brought to the population most vulnerable to the effects of climate change.

The difficulties faced by TCHC bring to light difficulties that are likely experienced across the city. The recommendations given in this paper suggest that the TCHC cannot solely rely on technological fixes for reductions in building emissions, but

needs to acknowledge the way in which we use buildings in order to use the full potential of the innovation we hope to continue to achieve. This is by forming green building standards for building renovations, which will address more of the building stock that will continue to exist for several decades; investing in data collection to be able to better identify where efficiency improvements can be made as well as link into an education program; and lastly, to create a communication and education strategies to tenants of buildings in order to be able to maximize technological efficiency gains, and to create a long-lasting change in behaviour. These lessons can be applied to similar challenges faced in the city.

Climate change action requires the development of regulations, policies, codes and support programs in order to address physical and behavioural capacities to reducing greenhouse gas emissions. The average homeowner is not well versed in the logistics of green building technologies and products, and many do not see the impact of each of their actions on their overall energy consumption. Technologies should be demonstrated in a way that people can understand the functionality, the benefits of use, and especially the financial reward. Creating a consumer shift will require a push that will be more graciously accepted when builders and homeowners are engaged in a clear understanding of the benefits.

While mitigation efforts are crucial to slowing climate change, adaptation will be equally important as cities experience delayed effects of climate change. The city will need to invest in the appropriate physical infrastructure and regulations, as well as possibly an enhanced social safety net to respond to those in need following the effects of disaster.

The involvement of a broader scope of buildings in the green building practice, by the recommendations given in this paper have the ability to do more than only reduce emissions. By engaging people in understanding their consumptive behaviour, and by making changes in their own homes and workplaces to achieve these benefits, there is potential for a larger response from people to include sustainability efforts in their everyday way of thinking and acting. This could have multiplying effects on addressing climate change that combines a bottom-up and top-down approach to GHG emission reductions. Our work on addressing these limitations today and exploring further areas of research will determine the future of the built environment in Canada. We must take advantage of arising opportunities to transform the nation into one that is proactive about meeting its international commitments to reducing climate change, protecting the health of natural environments, and improving the quality of life of Canadians in built environments.



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## **Appendix**

This section will outline the ethical context of the interview conducted for this paper.

The case study of TCHC required written correspondence and oral discussion with staff of TCHC in order to get a thorough understanding of the organization, policies, strategies and goals of green building projects. For this, an application to Conduct Human Participants Research was completed and approved by the Faculty of Environmental Studies Ethics Review Committee at York University. A research request application was also completed and approved by TCHC before commencing the interview. The research conforms to the standards of the Canadian Tri-Council Research Ethics Guidelines.

The interview participant was selected based on their professional role as a TCHC employee that works on the management of TCHC's green building stock. Following the approval of my research request to TCHC, I was put in contact with a member of the Smart Buildings and Energy Management Department. Upon contacting my interviewee through email, I explained the purpose of my research, how the interview would support my paper, and the anticipated outcome of my research. I included the interview oral consent script that had been approved by the Ethics Review Committee. This script was also read orally before the interview and oral consent was given. This script explained the interviewee's role in the research, the right to anonymity and confidentiality, the right to not participate or to withdraw at any time, and the benefits of the research. The interviewee was also provided the contact information of myself (the researcher), my supervisor, and the Senior Manager & Policy Advisor for the Office of Research Ethics at York University. Because the interviewee was only asked questions in his professional capacity, there were minimal risks or discomforts anticipated in the research. Before the interview, I also included a list of questions to be asked during the interview so that the interviewee would fully understand what information I was looking for and so he could prepare if necessary, in order to make the most of the interview opportunity for the both of us. The prescribed list of interview questions was followed during the interview and some dialogue ensued. Following the completion of my paper, I will share my research with TCHC.