THE COST OF BUILDING FOR THE FUTURE:

THE RECONCILIATION OF SUSTAINABLE HOUSING ISSUES IN TORONTO

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ABSTRACT

Although some green housing elements have become more commonplace in residential renovations in Canada, the undertaking of complete green retrofits is relatively uncommon. This paper explores the barriers to green retrofits, such as affordability and bureaucracy, in the urban context of the City of Toronto. The research was informed by one main case study, one supplementary case study, and six interviews with sustainable housing experts. The research has yielded nine recommendations that are directed towards three levels of government and related public and private housing organizations. These recommendations have been made in the hopes of making sustainable housing more ubiquitous in Toronto.

Key Words: Sustainable housing, green housing, affordable housing, Toronto

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Table of Contents

List of Figures

Introduction

"The greatest use of life is to spend it for something that will outlast it."

-William James, 1880

Green housing and the provision of affordable housing are two processes which can appear contradictory in the Toronto context. As green building remains expensive and housing prices rise in the city's core, attempting to create sustainable housing that implements green ideals while remaining affordable can seem like a lost cause. At a larger scale, projects such as the Regent Park and Lawrence Heights redevelopments have implemented green building features to meet environmental targets. However, retrofits of smaller-scale developments such as single-family homes, townhouses, and low-rise apartments seem at the outset to be rare and mostly undocumented. Using case studies and interviews, this research will examine why these retrofits are rare, their place in the realm of green housing, and the causes behind their unaffordability. It will also seek to explore ways in which the cost of retrofits can be lowered, as well as other avenues to making housing in Toronto more green, durable, and affordable and ultimately, sustainable.

Literature Review

The implementation of green retrofits at the household level has been slow to occur in Toronto. At the same time, living in the city has in many ways become less affordable. Accounting for inflation, the average income of a Torontonian dropped slightly, while the average value of housing rose more than $100,000 (Statistics Canada 2001 a,b) (Statistics Canada 2006 a,b). These pressures of affordability and sustainability of housing in Toronto require us to examine the academic and professional work done regarding sustainable development. This review will briefly survey this work.

Before talking about "sustainable development", the term must first be defined. We can begin with the tried-and-true definition from the 1987 Brundtland Commission, that being development that "meets the needs of the present without compromising the ability of future generations to meet their own needs." This is a useful starting point, but the complexity of urban environmental systems and the housing market requires further delving. How can the needs of future generations be met through housing? Can present housing needs be met while creating a healthy urban environment for future generations? Are what current generations consider needs actually necessary? The impact of housing on the urban landscape means that these questions must be answered urgently.

These are questions we must consider not only when looking at the focus area in Toronto, but when considering sustainable housing more broadly. Is what we consider to be sustainable housing actually sustainable? Are current green building practices conducive to socially sustainable communities, or are the processes that spur environmental protection and healthy communities still to disparate too be correlated? The Brundtland Commission's definition implies some unity of purpose. Roseland et al.(2005) make us aware that the idea of environmental protection denotes the separation of humans from nature. He explains that actions we take without the environment in mind, such as housing or transportation, tend to have a larger affect on natural ecosystems than do attempts at purposeful environmental protection. It can be difficult for one person to connect their individual actions (such as better insulating their home or taking public transit) to environmental outcomes, whereas giving money to an environmental charity may appear to aid at a broader scale. By taking something human-made and considering its place in the natural world, lowering the ecological footprint of housing aims to bring these two realms together. This research will then regard the issue of housing as an example of an area where we can assume the process of reconciling the imperatives of sustainable development at a small, visible scale. That is, the reconciliation of the environmental, ecological, and social (Dale 2001).

An Overview of Sustainable Housing

In comparison to other hot-button issues (i.e. automotive and industrial pollution) the effects of houses on the environment have been relatively ignored (Winston 2009). But with shelter being a necessity and residential development covering our landscape, urgency surrounds the need for a change in the way housing is produced. The dilemma surrounding housing is then similar to the one surrounding food: how can we produce housing that meets our needs and those of future generations through their design, the materials required to implement the design, the energy and water required for daily use and ultimately perhaps rethinking the choices people make to live in their homes.

The rise in green building interventions has over the last decade coincided with the creation of national bodies that have (generally along with some sort of accreditation aspect) sought to define "sustainable development". The definition given by the Canada Green Building Council, Canada's Green Building Authority, is "building design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants in five broad areas: sustainable site planning, safeguarding water and water efficiency, energy efficiency and renewable energy, conservation of materials and resources, and indoor environmental quality" (Canadian Green Building Council 2006). The United States Environmental Protection Agency similarly highlights the potential of green buildings to "reduce the overall impact of the built environment on human health and the natural environment" (USEPA 2009). It also relates current green building design to the "classical building design concerns of economy, utility, durability, and comfort"(ibid.). There are many influences from which to draw ideas for green housing. Abundant best practices and technology exist to inform municipalities on how they should plan for housing. The difference between a municipality that has a shaky or non-existent green housing vision and one with a comprehensive, useful framework lies in the ability to take all these disparate ideas and create something that works in, and speaks to, the local context (Crabtree et al. 2009). Only then will

housing be properly be identified as having a major impact on the environment, and consequent action taken.

In terms of energy consumption in Canada, there is certainly a large amount of room for improvement. As of 2006, Canada ranked 28th out of 29 OECD countries in energy consumption per capita (World Bank 2006). Indeed, in Canada the built form accounts for 50 percent of total energy consumption (Natural Resources Canada 2009). We can see then that changing the nature of buildings has the potential to greatly decrease energy use. Certainly many aspects of a building can negatively affect the natural environment throughout its whole life cycle. From site location, building materials, and construction, to its use and management, to its final destruction, a physical house and the activities it invites have the potential to permanently and negatively alter the immediate landscape and broader environment (Huby 1998; Knudstrup et al. 2009; Tosics 2004; Winston 2007; Winston 2009). However, throughout this cycle there is the potential to limit its harm to the natural environment and make housing more harmonious with its surroundings.

The construction of shelter so as it is made of local material, positioned to harness passive solar energy, or has excellent insulation is not a new phenomenon (USEPA 2009). However, in the post-World War II era, the North American trend of suburbanization has for the most part ignored these considerations, creating a landscape of houses built on large lots in greenfield sites, geared towards car usage. However, in the decades since the Oil Crisis of the 1970s, architects, builders, and consumers have understood the advantages of green building measures. Research and development in the area have grown with the demand. On the architect and builder's side, much of this research stems from the creation of the American Institute of Architecture's Committee on Energy, while the Environmental Protection Agency's creation in 1970 influenced much of the policy. Keeler et al. (2009) highlight the importance of these two bodies (p.35):

"Green building emerged from the groups, and it was seen as a multibranched discipline, encompassing a concern for the life cycle and waste generation of building materials, soil and water

conservation, indoor air and indoor environmental quality, and, as well, the original linchpin, energy reduction."

In Canada, 1971 saw the creation of Environment Canada. Throughout the 1970s, the Canadian Mortgage and Housing Corporation began to gear its programs towards a denser residential form (CMHC 2009-a). This helped to ensure the relatively vibrant downtowns of Canada's major cities, even if the aim may have at that point been affordability rather than environmentalism. Today, CMHC is at the forefront of green housing development. They have helped to organize private and public for the Equilibrium program, which builds green housing demonstration projects across Canada. The aim of these projects is to develop housing that uses zero net energy.

At the same time as these progressive initiatives, we can see that in Ontario that weak legislation has a lower standard in building design. Led by Premier Mike Harris, the provincial government of the 1990s made revisions to the building code that, besides requiring only minimum standards for health and safety, eliminated nearly all mentions of environmental and energy standards (Winfield et al. 1996). While improvements have been made to the Building Code in more recent years, it still lacks the teeth to require development to adhere to a high green standard. Hence, we see in this research and others the dichotomy between generic and "green" housing.

There are many ways of examining the changes brought on in the field of green building. Some literature focuses on the implementation of green technology in large developments, some on the technology itself. Winston (2009) creates an analytical framework to describe four aspects of what she calls "sustainable housing": *location, construction and design, use, and regeneration.* With single-site retrofits being the focus of this research, it is helpful for our purposes to use this framework for the literature review to explore the components of a green building. Having examined the physical necessities of green building, this research will then look at subsequent affordability issues. However, whereas Winston's framework is useful when conducting an overview of sustainable housing, a different structure is necessary for examining the case study. Looking into this specific green building retrofit requires a less temporal structure, as the retrofit lasted two years

whereas the ideology behind the process has far more long-term goals. For example, applying the retrofit to the tenet of *regeneration* is difficult as a long-term look at the building's future durability is required. Winston's framework also allows for little focus on process of change, an important tenet of sustainability. As such, a Winston-inspired structure that is geared towards the features added in this case will be used.

Location

Arguments against suburbs on the basis of their effects on social cohesiveness pre-date the 1970s oil crisis and continue to this day (Jacobs 1961; Kunstler 1994). The critique of this growth pattern in regards to its demands on agricultural and preserved land has also grown in recent years. Despite widespread policies to curb urban sprawl, many cases have shown practice in the Canada, United States, and Europe to contradict these attempts (Sewell 2009; Knaap et al. 2007; Gelan et al. 2008). In Ontario, new legislation has been passed over the last decade (such as the *Greenbelt Act* and *Places to Grow Act*) that has in part aimed to curb sprawl, much of which is residential development. The *Growth Plan for the Greater Golden Horseshoe*, released under authority of the *Places to Grow Act*, sets intensification targets for 25 existent major growth centres. Five of these areas fall within City of Toronto boundaries. However, these five centres are areas that are already fairly high-density. There is no mention of surrounding residential areas that are connected to these major growth centres, and the part they play in providing housing that is dense relative to suburbs surrounding the city proper. Indeed, residential areas that are somewhere between suburban and high-density urban have an important role to play in cities. They provide the simultaneous physical proximity of houses with a slower pace that eases communication between neighbours. They also provide a diversity of housing options that can be retrofitted, such as single-family homes (as one or multiple units), townhomes, and low-rise apartment buildings. Along with density found in

downtowns, the density, access to transit, and sense of community that can be found in these inner-city residential neighbourhoods make them an option for the site of green housing retrofits.

At a far more localized level, the physical situation of housing is important in another way. Many benefits can be derived by taking into account the position of the sun, prevalent wind patterns, soil type, and other ecological considerations (Stang et al. 2005). Houses can be situated so as to take maximum advantage of the sun's rays (useful during Canadian winters, springs, and autumns). Houses receiving direct sunlight are also candidates for passive solar panels. Considering wind patterns, though difficult in a built urban environment, is worthwhile due to its eroding effects to the outside of a house as well as its effect on its indoor temperature (Khanduri et al. 1998). Finally, ensuring that a building is built on optimum soil is important to the durability of the structure. If the soil is compact and does not contain too little or too much moisture, the building is more likely to stay structurally sound.

Construction and Design

Arguably the largest advancements in sustainable housing over the past decades have been made in the area of construction and design, although much technology used is based on ideas that are centuries old. Examples of energy, heat, and water-saving technology as well as waste reduction techniques can be seen across Canada. However between 1990 and 2004 the size of the average house in Canada grew, meaning more space to heat (Natural Resources Canada 2009). This illustrates the disconnect between technology and values. Nonetheless, it is important to realize the role that technology has to play in sustainable housing. It has undoubtedly led to much of the environmental degradation that has occurred throughout the Canadian landscape, but along with more conscientiousness it will play an important role in lowering the ecological footprint of housing. The complete gamut of advancements made cannot possibly be covered in this space but a quick overview of a select few is useful.

Lowering the exhaustible energy used by a building can be achieved in three fashions. You may improve the quality of the building's envelope, use a different source for energy, or simply use less energy through technology or use (the use stage of a sustainable house will be covered later) (Buck et al. 2007). First, the conservation of energy through insulation has three main benefits (Banfi et al. 2008). It reduces costs spent on energy, provides thermal protection, and reduces external noise. Well-installed insulation with an air barrier and few gaps is very useful for these purposes. At the same time, much of the material used for insulation is questionable for its effect on humans and the environment. The effects of fibreglass on the human respiratory system are suspect (Finnegan et al. 1985). Mineral wools have been linked to cancer (International Agency for Research on Cancer 2002). We must then consider whether we want these durable substances in our homes and eventually in a landfill. The Archetype Sustainable House being built in Vaughan, Ontario uses two types of spray foam that are mostly made of renewable materials (The Archetype Sustainable House 2009). If proper insulation is a necessity in order to conserve energy used for heating, there is an urgency to not only create this type of technology, but advocating and subsidizing its use as initial costs can be expensive.

Using an alternative source of energy in Ontario (that is, not standard hydroelectric, nuclear, or coal power) is a tricky proposition. The installation of solar panels, a wind turbine, or a geothermal system is very expensive and frequently not suitable for the layout, structure, or location of a residence. There is currently in Ontario one green energy power supplier, who feeds 20% wind power and 80% low-impact hydroelectric power in the grid, adding more with each customer (BullfrogPower 2010). While this is a more indirect way of powering one's house through an alternative source of energy, it is at this point the least expensive and cumbersome way to power a residence in a more sustainable manner. In the future, solar and wind energy have the potential to power the homes of a larger amount of residences across Canada as customers increasingly buy into the ideology behind purchasing alternative energy (Syed et al. 2008). The technology exists; we must

now focus on implementation and the considerations of wind turbines' impact on the local environment.

The biggest barrier between consumers and sustainable housing is price. The federal and Ontario provincial government have energy savings programs in place that give grants towards a home energy audit and potentially retrofit upgrades. This is laudable; however it would arguably be more beneficial to have more strict regulations on new home construction. One hopes that the Building Code Energy Advisory Council, established in 2009, makes useful changes to Ontario's Building code that place higher standards on the efficiency of houses in Ontario.

The local government also has an important role to play on easing barriers to the creation of green housing. Policies such as the Toronto Green Standard (TGS) and Green Toronto Award bring awareness to green housing issues. A member of CMHC's research division says that Canadian municipalities are attempting to facilitate the creation of green buildings:

"*Municipalities are starting to recognize that this (green building) is value-added moving forward. And they are trying to work more closely with developers that have green building plans in their development, and trying to push those developments through faster. Five years ago there was a big gap in interest on green buildings between citizens and municipalities. In the last five years that gap has shrunk quite a bit.*"

At the same time, much of the focus of the City of Toronto (based on TGS and Regent Park and Lawrence Heights redevelopments) seems to be at a scale larger than the small-scale retrofit. The City's Affordable Housing Office helps to distribute funding from the federal Residential Rehabilitation Assistance Program, but the focus of this initiative is repairs rather than retrofits. Also, while it can be said that the city as a whole has an increased interest in green housing, there still exists a lack of communication between departments, an example of the "silos" of which Dale (2001) has spoken. This will be illustrated in this paper's main case study.

Use

A house may be constructed in many ways, but the efficiency of a house depends on the activities of the residents: their behaviour, the products they purchase, and the possibilities open to them. Behaviour is certainly the guiding factor and if a resident actively wants their house to be efficient, it will inform and make them aware of the latter two factors.

Technology in products to heighten energy and water efficiency is widespread and has become an important component of many household products. Energy Star is an energy-efficiency standard created by the United States federal government but also used in Canada, among other countries. Products from computers to refrigerators to lighting carry the Energy Star seal. However, some questions are arising over the standards required. A report from the U.S. Environmental Protection Agency suggested that data used to measure products was frequently unreliable and that the program has many loopholes (US Environmental Protection Agency 2008). Indeed this raises the problem of certain products being seen in a "greener" light while potentially not being any more efficient or sustainable. Humans' unwillingness to change has created a situation whereby we do not actually have to change our behaviour, and merely have to make an informed consumer choice. Indeed, we can tie this in to Ehrlich's "infinite substitutability", as we have come to believe that if we buy an appliance that is slightly more energy efficient, buying appliances will forever be sustainable (Ehrlich 1982).

Nonetheless, there is an incredible complexity to understanding what makes a person want to act sustainably (Kollmuss et al. 2002). At this point, we must unfortunately hope to change people's behaviour through consumerism. The effort must then be made to ensure that a label such as Energy Star really means efficiency, and allow for different sectors to offer a green choice.

How a residence handles waste is also an important matter. Household waste accounts for 40% of all solid waste in Canada (The Daily 2005). This waste is not a product of necessity either, as the higher a Canadian's income and consumption, the more waste they produce (ibid.) Municipal

programs play an important part in waste diversion. The City of Toronto, through its blue and green bin recycle and compost programs, is aiming to divert 70% of its waste by 2010. Realistically, that is an unlikely number based on its 2008 rate of 44%, but the trend is moving in the right direction (City of Toronto 2010). However, these waste diversion programs do not change the amount we produce and consume. How do we reconcile behaviour change through consumerism and the waste that consumerism produces?

Regeneration

"I am certain that writing about rooms is a way of writing about people."

— Akiko Busch, Geogragraphy of Home

The home acts as a representation of a person. It is not only one's physical place of rest, but a place where one can be *themselves*. Its contents and usage are representative of a resident's values. At the same time, we construct houses with the hope that they will last. It is likely that a house will be the home of numerous generations. And as such, we must construct houses so as they are strong and adaptable enough to do just that. To go back to the Brundtland Commission report, housing must meet the needs of today and tomorrow's generation. It must be made of sustainably harvested resources and of quality resources and craftsmanship that will be durable. At some point, we can assume that the house will no longer be inhabited. Considerations of the house after it has ceased to be a home are few and far between. Perhaps it is as Dale (2001) says: looking into the future and recognizing the limits of our resources means recognizing our own mortality. If we are to be a mature and truly intelligent society we must then create housing that both suits the needs of generations to come and the environment when its time comes to pass.

Affordability

Where Winston's framework is less useful for the purposes of this research is the exclusion of the issue of affordability. A city full of green buildings that are unaffordable for the majority of the

population will not be sustainable. If we are to consider the environment impact of housing among generations, it must also be equitable within each generation. However, in Canadian housing, environmental and social equity considerations do not go hand in hand. It can in fact be argued that there is frequently a negative correlation between the two. Looking at case studies in Toronto, Victoria, and Vancouver, Dale et al. (2009) show a close relationship between "sustainable development" and gentrification. Furthermore, they find many green projects (particularly in brownfield redevelopments in existing urban fabric) to have a neutral or negative effect on social diversity in the area. Wheeler (2009), on the subject of housing in Australia (which has also seen copious open space result in much sprawl) suggests that affordability and sustainability are "diametrically opposed" as long as people keep desiring larger houses. If creating a sustainable community involves the consideration of all its social processes, these problems must be reconciled. How can this be done in a society where cost and market demand dictate the ability to build equitably?

Part of the issue is policy-based. Federal subsidies for affordable housing diminished over the 1980s until 1993, when it more or less halted altogether, exacerbating issues that the Canadian low-income population has with procuring suitable housing (Skabursis et al. 2000). Dalton (2009) also attributes this housing problem to two other factors: income inequality, and a rise in housing prices. The average cost of a house in Canada rose by 66.5 percent between 1985 and 1989, 39.2 percent between 1998 and 2005, and 21.3 percent between 2006 and 2009, despite a national recession (ibid.) (Canadian Real Estate Association 2010). Although the market is unpredictable, nothing suggests that housing values will stop rising.

Dalton suggests that part of the reason for the inadequate provision of affordable housing is that there is too much of a focus on production rather than policy. He proposes giving federal and provincial housing agencies more say in the development of housing policies, specifying that in global cities like Toronto this could be tied in to broader economic policy development. This makes

sense in a complex, interconnected economy such as Toronto's so as to make sure that housing in the downtown core does not become completely unaffordable as is the case in many global cities. Moore et al. (2004) similarly suggest a need for policy improvement at the three levels of government and find a negative correlation between city size and housing affordability. As Toronto continues to increase in size the unaffordability of its housing will likely become more pronounced. This raises a problem: if already built-up areas downtown and in the inner suburbs of Toronto are the most useful for retrofits, will stable and central neighbourhoods become increasingly expensive?

The multitude of issues that have been mentioned can seem somewhat overwhelming. Indeed there is quite a complexity to the questions that arise. What constitutes sustainable housing? How do we make it affordable? This research will seek to answer these questions in the Toronto context. We will use a case study from the High Park neighbourhood in Toronto to illustrate a situation that required the consideration of these questions.

The Toronto Context

As stated earlier, there are an enormous number of issues that must be considered when classifying certain housing as "sustainable". If we consider built form as one of the more important aspects, it is useful then to look at this issue in the Toronto context. Toronto, incorporated in 1834, contains quite a variety of built forms within its many neighbourhoods. At once an established and growing city, different areas face different challenges.

New construction in Toronto and its outskirts is occurring at a grand scale. The CMHC estimates that approximately 36,000 new units will be built in the Greater Toronto Area in 2010, split by half apartments, half single family houses and townhomes (CMHC 2009-b). New construction is occurring predominantly in two main areas. The regions surrounding the City of Toronto have seen significant growth over the past decade. Cities such as Vaughan, Markham, and Brampton saw 31.2, 25.4, and 33.3 percent gains in their population between 2001 and 2006, these populations mostly

housed in single-family homes (Statistics Canada 2006-c). At the same time, the last decade has seen an influx of residents to the lakefront. Dozens of condominium buildings can now be found in areas that were predominantly industrial for most of the 20th century.

Both modes of growth bring their own concerns. As shown earlier, the low-density growth that has occurred in the municipalities outside of Toronto is not conducive to sustainable ecological living. One could argue that these suburbs are more socially equitable as housing prices are more reasonable than they are in Toronto's core. However, once we consider associated costs with living in suburbs this argument loses its relevance[1]. Some municipalities in the Greater Toronto Area, such as Mississauga and Markham, are making attempts to create a more vibrant urban fabric that could lead to more sustainable growth, although their success cannot yet be evaluated.

In between the downtown core and the growing suburbs is an area less frequently discussed when looking at sustainable construction or refurbishment. That area is Toronto's inner and outer suburbs, the former described as the old cities of York and East York and the latter as old Etobicoke, North York, and Scarborough. These areas are already built out and, save for some large development near subway lines, are not currently being redeveloped at a large scale. Certainly the housing prices in many neighbourhoods in the aforementioned communities are low when compared to more attractive or simply more conveniently-located housing in the core (Toronto Real Estate Board 2009).

It then stands to reason, based on the ideals of affordability and brownfield development that these communities ought to be targeted for sustainable redevelopment.

The question is: can these improvements be made without putting the cost of housing out of reach for the population that currently lives there? Current homeowners may derive a benefit from

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1 Suburban land use, development, consumption patterns, and transportation may lead to long commutes spawning increased pollution from automobile use, an exorbitant amount of sprawling built space leading to wildlife degradation, reduction of water quality, loss of wetlands, social isolation, lack of innovation, social inequity, increased obesity rates, and other problems (Clark 2007)(Hu et al. 2004)(Putnam 2000)(Hull House 2003)(Garden et al. 2009).

increased housing values, but renters and those on government assistance may be driven out. This problem can plague green initiatives in cities (Atkinson 2004). That being, neighbourhoods that support a green lifestyle with public transit access and mixed-use development are attractive, and therefore tend to be more expensive. If the City of Toronto wants to promote inner suburb renewal, it must alleviate the effects of gentrification on the current population. Renewal and gentrification are not synonyms, but the history of Toronto has shown that to frequently be the case. The Mayor's Tower renewal project indicates that the city is interested in redevelopment of high-rises in the inner suburbs. However, much of Toronto's inner suburbs contain low-density single-family housing, and any comprehensive plan must propose solutions for that housing type as well.

Residential areas within downtown and near-downtown Toronto, such as Riverdale, Roncesvalles Village, and High Park, are predominantly made up of early 20th century housing stock. Due to the appealing housing stock in areas like these, resale prices are very high when compared to the inner suburbs, and the average housing value in these neighbourhoods is above $500,000 (Toronto Transitions 2010). In these neighbourhoods there are also restrictions to the measures that can be taken to make a house more sustainable. Certainly the location of the house in a denser central area has benefits in lending viability to certain infrastructure and public transportation systems. And the activities within the house may be altered so as its residents may live in a more sustainable manner. This will be explored in our case study. But the established and spatially confined nature of these neighbourhoods places limits on the possibilities for construction and refurbishment. For example, permission to add a more efficient insulating envelope over a house's traditional exterior may be rejected by the City as it contravenes the character of a neighbourhood designated a heritage conservation district (Rosedale, Cabbagetown, and Riverdale are examples of these). Or, installation of a green roof may be unsuitable due to lack of sun or too much wind exposure. However, in certain instances such refurbishment is deemed feasible and is undertaken due to will power on the part of residents.

There is currently in Toronto a stronger focus on sustainable retrofits in multi-unit buildings. The Toronto Green Standard (TGS) is a set of performance measures that new multi-unit residential (with five or more units) and high-rise development must adhere to. It includes regulations on energy and water use, among other considerations. However the high unit threshold to which it applies, combined with the fact that it is only required for developments needing a zoning by-law amendment, site plan control, or draft plan of subdivision means that the TGS' pertinence to smaller site retrofits is minimal. Also, there has been talk of the redevelopment of social housing neighbourhoods like Regent Park and Lawrence Heights being based on sustainable principles (City of Toronto 2005)(Toronto Community Housing 2010). Certainly, some of this is due to economies of scale. Many green housing features are simply too expensive at this stage for the city to require them to be installed in single units. It is possible that their increased usage in larger developments will help to lower their cost, and in the future broaden the required developments under the TGS to smaller-scale residential development and retrofits. However, the use of expanding the TGS is still unforeseen as there has still been little exploration into smaller-scale green housing interventions.

Method

Green retrofitting is a process that, as has been shown above, is being undertaken at a slow pace. Government subsidies exist to improve single features in houses, and households across Canada are undoubtedly making improvements. However, complete overhauls of the entire building system are relatively rare. One can argue whether the key to achieving sustainable housing in Toronto is the piecemeal approach or undertaking more drastic measures. However, to create a built form that is less wasteful over the long-term, these complete retrofits are likely more effective. As such, it is then necessary to conduct a case study of one such retrofit. This research will centre on a case study that will be examined in the section that follows. The case study was informed by a site visit and two-hour in-person interview with two housing owners. This case has also been publicized

in local newspapers, on Canadian network television, and on a public online blog. Some of the information from this case study will be contrasted with a supplementary case study of a similar retrofit. This second case study was informed by a forty-five minute interview and an online blog written by one of the owners. The events behind this case were in fact discovered via this blog. While the rationale behind this retrofit differs from that of the case study, this process also involved major reconstruction and many similar features. The exploratory nature of this research lends itself to using case studies as a method. The need to gather experiential knowledge about the mechanisms of sustainable housing also leads towards the case study method (Yin 2009). Interviewing the housing owners will further this understanding. Interviewing experts in the housing field (which interviewed owners also turn out to be) is also necessary as knowledge is contextual, and to understand the meaning of the case studies their broader knowledge is required (Kvale et al. 2009).

Six interviews have also been conducted with architects and housing experts in person, with supplementary data being added via email. These interviewees have been either recommended directly by the owners or else recommended by others interviewees. They have been selected based on their professional knowledge of either green building design or policy. The interview process was found by the Ryerson Ethics Board to not be under their jurisdiction. Certain interviewees chose to waive their right to anonymity, as did two owners from the main case study. The purpose of these interviews is to grant a picture of sustainable housing within the Toronto area and give context to the case studies. The views of the interviewees will be expressed through quotes throughout the rest of this paper.

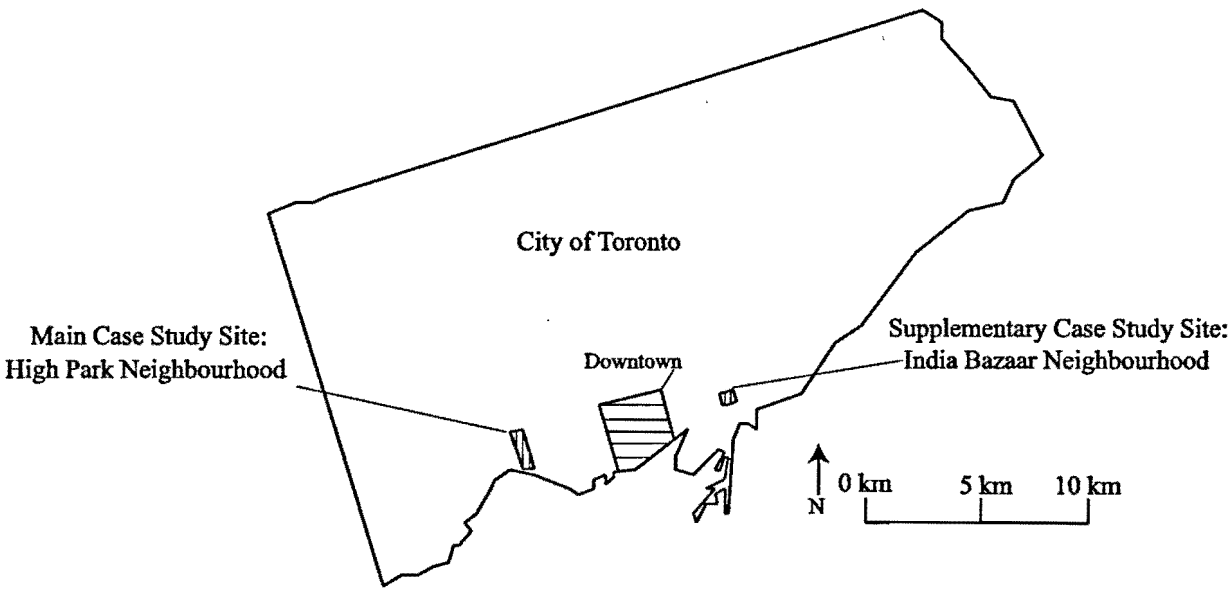
Case Study

High Park is a middle to higher-income neighbourhood in the west end of Toronto. Bounded by a large green space of the same name to the west, Bloor St. W. to the north, Roncesvalles Ave. to the east, and Queensway to the south, High Park is one of Toronto's older neighbourhoods. It was

annexed by the Village of Parkdale in 1879 and the City of Toronto in 1889, and much of the housing stock dates from this era (Hayes 2008). The housing stock is generally large and has been well kept up. The 2005 average housing price in the neighbourhood (including the Swansea neighbourhood on the other side of the park and of a similar vintage) was $530,000, well above the Toronto average of $409,000 (Statistics Canada 2006-a). However, there are certain houses in the area that have fallen into disrepair. It was this type of house that Donald Cole, Jennifer Penney, and their partners found and bought in 2006.

Figure 1

Context of Case Study Neighbourhoods Within City of Toronto



Four years ago, Cole and Penney found themselves in a situation similar to many couples once their children reach university-age: they were in a house that had become unnecessarily large. They took this situation as an opportunity to fulfill a professional and personal interest in sustainable housing. Penney has served as the Director of Research at the Clean Air Partnership and was involved in the Green Phoenix affordable housing project in the Parkdale neighbourhood, while Cole

is a professor at the University of Toronto and has a research interest in environment epidemiology. The couple had an interest in undertaking a green project on a small scale where they had more control and could see the results of their efforts. They were also looking for new accommodations with this in mind. In the spring of 2006 a four-plex apartment building went up for sale on a residential street less than a block away from High Park. The building housed four large apartments but had not been renovated in quite some time, which provided some positives (lower asking price, elegant woodwork in the apartments) and some negatives (old electrical system, lead piping). The building is within five blocks of three streetcar lines and a bus line. Two of these lines are less than ten minutes away from a subway station. These transit access points mean that living in the building without a car was a possibility, and a likelihood considering the building had one parking spot.

Cole and Penney placed, and won, a bid on the building with the assumption that they would be joined in this project by friends of theirs in a similar situation, and that this retrofit would yield a community housing element. However, upon viewing the property the other partners backed out, feeling that the project was too daunting. The couple then turned to a friend that was a real estate agent and was involved in provincial politics at the local scale. He became interested in being involved in the project (as well as being an owner) upon learning that a) a green roof could be installed, and b) a green roof would require the addition of an extra floor, making the apartments larger and able to house his growing family.

Previous connections to, and interest from the CMHC led the housing authority to fund a small charette of architects, engineers, and prospective owners to consider the future of the house. The viability of harnessing solar thermal and geothermal energy and the implementation of other features was considered. Out of these and many other discussions came a vision for the future of the house.

With Penney, Cole, the real estate agent and his wife on board, the retrofit got underway in the summer of 2007. A renowned green architect was also part of the team, and he provided his

expertise on green building and aesthetics. From that period to present day (the retrofit process is complete, though other features may be added in the future) a series of features were added and alterations made to the building in the attempt to make it more green. We must consider that although the building was functional in its previous state, problems due to the building's age meant a series of renovations were necessary. Certainly though, we will see that the retrofit undertaken went above and beyond what was necessary to keep the building merely functional in its previous incarnation. The following is a brief explanation of the changes made. The real estate agent maintained a blog, containing information on many of the specifics of the features of the retrofit, throughout some of the retrofit process. This blog was an informative tool in this research, and it has the potential to be useful for other citizens interested in the process of retrofitting.

Changes to the Envelope and Exterior of the Building

One of the largest additions made to the building was to its envelope. Extra insulation has been added to all levels, from below grade to the roof. After much consideration (and basement flooding) it was decided necessary to apply exterior waterproofing and four inches of extruded polystyrene below grade, making for a R25 insulation value. Behind the concrete slabs just above grade recycled insulated door cut-outs have been added. On the building's first two floors the old brick exterior is covered with two layers of 2 inch poly-isocyanurate boards, which have been used for both for their insulating properties and their rigidity. This rigidity is necessary when applying stucco, which is now the exterior of most of the front of the building. Finally, the roof has been blown with spray insulation from renewable materials, similar to that mentioned earlier regarding the Archetype Sustainable House. Attempts have been made to eliminate any thermal bridges where air can escape, particularly around the new fibreglass windows.

Sloped sections of the roof are layered with aluminum roofing tiles coated with a Teflon protection agent. Flat sections use a two-ply SBS modified bitumen surface. The green roof will be

situated on where the third floor protrudes through the rest of the roof. Although the harvesting of bitumen in Canada is often undertaken unsustainably, Teflon is not a health concern non-cooking temperatures. The projected durability of the roofing system has justified the use of these materials.

The roof of the third floor (110 square feet) is covered with a green roof. It is covered with six inches of growing medium. Sedums and grasses have been planted, and other plants may soon be added. These species have been chosen for their ability to withstand heat, cold, and draught. There is a watering system is place and the owners hope that it will be used sparingly. The roof was funded by an incentive from the City, one of the last given for a residential building, with the focus now being on commercial, industrial, and institutional buildings.

Before the retrofit was undertaken there was pavement in the backyard. That has been removed and replaced with a grassy area and wooden porch to allow for more permeability. In front of the building, a large setback yields a thin reclaimed stone path to the front door, surrounded by a green area with grass and short native shrubbery. Issues arose regarding the lack of parking space in the building. Cole and Penney found that potential owners, even though attracted by the building's green features, were wary of not having a place to park their car. They pushed and convinced incoming owners to not push for more parking with local planning.

Energy

Along with the energy reduction that added insulation will hopefully bring, this retrofit involves other elements that will ease the building's reliance on traditional power sources (which in Ontario include nuclear, coal, and hydroelectric power). One of the longer discussions the owners had was about whether to install a geothermal heating and cooling system. This system works by inserting a series of pipes in the ground to below the frost line. These pipes distribute heat (using a heat pump) from the ground to a furnace unit in a building. Heat then moves to the rest of the house

through a distribution system. To cool a house, this system works in reverse. This air circulation also serves to mediate condensation build-up that may occur in a very well-insulated building.

Despite the cost (over $100,000 when work was completed), the owners to decided to install such a system with 1350 feet of in-ground piping. It is estimated that costs for most geothermal systems will be recuperated with a decade (US Department of Energy 2009). However, it is possible that it will take longer to recuperate costs with this building. The particularly efficient insulation that was mentioned earlier means that less heating and cooling energy will be used to begin with. The owners have also considered adding solar photovoltaic panels to their roof, which would potentially result in the building producing more power than it uses, and adding power back to the grid. However, due to cost considerations they have not yet been installed, though they may do so in coming years when the cost of photovoltaic or indirect solar systems is likely to fall.

Indoor Features

A look at the features inside the building shows great care given to elegance, and once again, environmental concerns. Old worn (but potentially still usable) oak flooring throughout the building have been replaced by locally harvested bamboo. Concrete flooring is used in the communal basement which houses a workshop area, a cold cellar and a partitioned storage area. Many of the more attractive aesthetic features in the apartments, such as dark wood panelling and exposed brick, have been retained.

Kitchens and bathrooms have been remodelled. In the kitchens, designer particle-board cupboards (with low formaldehyde finish) and quartz countertops (with crushed glass) have been added, as have high-efficiency dishwashers and refrigerators. Bathrooms feature German-made bathtubs that are made using sustainable production methods, and dual-flush toilets that use three or six litres depending on the flush option selected. Walls throughout the building have been painted

with a zero-VOC product that has been certified by institution such as LEED and GreenGuard Environmental Institute.

Size

The two-floor units are each just over 2,000 square feet in size. 2,000 square feet is in fact the average size of new single-family detached homes in both Ontario and the whole of Canada (Canadian Home Builders Association 2010). The number of bedrooms (three not including a sunroom) and bathrooms (two) are abnormally large for apartments in Toronto. While the building was sizable to begin with, the addition of the extra floor creates the potential for this extra space.

Re-Use of Materials

The re-use of materials during the retrofit has not occurred as much as the owners would like. There were toilets and sinks in the old building that could have been re-used, but during demolition the crew discarded them and broke them. As mentioned earlier, there was hope of salvaging the old oak flooring, but water damage from roof leaks and damage done during demolition was too great.

However, many materials and appliances have been re-used. Before the retrofit, the owners found that there was furniture and appliances from the 1920s and 1930s in the basement. They placed much of these items on the curb, where they were quickly snatched up by passersby. Owners have also made sure that metal taken from the demolished house is recycled. It took some guidance to get the demolition crew to make the effort, but they eventually agreed to bring the scrap metal to a metal recycler in the neighbourhood. Also, where possible, wood from the old house has been re-used. One example is that many of the old wooden roof joists that were too small to support a green roof are re-used throughout the house. Some materials have been reclaimed from other sites. Landscapers were going to use stone imported from India for walkways in the front yard and backyard until the real

estate agent discovered that Victoria College was discarding some of the Ontario limestone on their property. This has been placed around the building.

The owners, over the course of moving out of a six-bedroom house and during the retrofit, were able to reduce some of the burden of having so many belongings.

Cole: *"We have gotten rid of masses of stuff. Really, I mean the amount of stuff you accumulate. (...) Our actual amount of material goods has substantially decreased. And that in itself is a really positive feature about doing this now, rather than when we're seventy-five or eighty. (...) You see these storage lockers proliferating for people's stuff because they don't have enough room in their buildings. And it's not like people's housing imprint is decreasing particularly. That is fundamentally unsustainable in terms of resource consumption.*

While this research mostly focuses on the features added to the building, Cole in particular feels that one of the most important aspects of the retrofit was lowering the amount of material goods in their unit.

Features That Were Planned but Not Implemented

As well as removing the pavement in the backyard, there were originally plans to replace the driveway, which runs deep along the side of the house. Plans were to replace it with a more permeable pavement (to help sustain the water table and nourish the trees in the front yard), but there was some question as to whether removing the original pavement would pose a structural risk to the building. A flood occurred in the basement in the middle of construction, before exterior waterproofing had been applied to the building's base. As a result, French drains had been created on both sides of the driveway to relieve water pressure. This episode caused the owners to think twice about removing a potential supporting structure on the side of the building. Also, high cost was a concern.

There were also hopes for installing a water capture system on the roof that would go towards landscaping. However the size and number of different slopes on the roof would have required a very

complex solution. The diversion of water from the sewer system via French drain was deemed sufficient.

Process of Decision-Making

Decisions made over the course of the retrofit were made by Cole, Penney, and the real estate agent. The decisions were made in conjunction with the architect and various contractors, but the ultimate visions realized were those of the owners. Penney credits some of the more progressive decisions made on the building to owners' partnership:

"I think if we had moved into a house we wouldn't have nearly done what we did here. And this is where the partnership was really great. We egged each other on. Even though we didn't see eye to eye on everything, we really wanted to make a green place. And as things settle down with the ownership of the building we'll just have to worry about maintaining the place and we're really looking forward to that I must say. It's a much longer process than we ever thought it would be, and much more expensive. We learned a huge amount from it though."

In terms of an ongoing structure of governance in the building, there is a process underway to create a condominium corporation. This would be comprised of the owners of the four units and would make decisions based on the upkeep of the building. However the communal living elements originally envisioned in the future of the building have not yet been realized:

Penney: *"The social hopes we had for the building haven't really come to fruition, in terms of an intentional organizational structure."*
Cole: *"It's not like we're antagonistic, everybody just tends to keep to themselves."*

While the knowledge-sharing element may not be occurring between residents within the building, over the course of the retrofit numerous neighbours came to view the construction. Some neighbours consulted Cole and Penney on certain green features that they then implemented in their homes, and it is possible that others were similarly inspired by this retrofit.

Owners' Opinion Post-Retrofit

The retrofit is complete, save for potential additional features, such as solar panels. The whole process lasted approximately two years. Cole and Penney seem proud of the retrofit, but also have some reservations about the whole process. They have gained experiential knowledge of the difficulties of green retrofitting, but also its benefits. They also seem to have a greater sense of the place of single-site retrofits within the broader realm of sustainable housing.

It is impossible to judge all of the features of the retrofit at the moment. We may look at how every installed material was harvested or how each product was manufactured, but for the sake of brevity we cannot undertake that investigation in this research. What matters most, I would argue, is first the overall durability of the building as well as the success it achieves in reducing the energy and waste it and its residents produce. The former must be determined over the course of decades and centuries. With the latter we can see some preliminary evidence.

Certainly the insulation seems to already be making quite a difference. As of mid-November, the heat had not yet been turned on in Cole and Penney's unit. They are less enthusiastic about their choice to put in the geothermal system. They originally had the notion that it could function as the sole source for heating and cooling, which has so far proved not to be so. Cole has also expressed misgivings about the complexity of the system. While he had the ability to fix everything in his previous residence, the geothermal system is so complicated that he questions its future should it break down. Cole finds this fundamentally unsustainable.

The cost of the project is something that Cole and Penney also have some reservations about. They were able to receive some rebates to recoup their costs. These include $6,000 from the City of Toronto for the green roof and $10,000 from the province for the energy savings achieved. Nonetheless, concerns about marketing the building led expenses to be higher than Cole and Penney would have liked.

Despite concerns about costs and material throughput, Cole and Penney seem pleased with the end result:

Penney: "*It's a wonderful place to live. We're really liking it.*"

Cole: "*And in contrast what were the other options? Staying where we were living before? No, this is way better. Going to a place that was already done (retrofitted) by somebody else? We really didn't see much (other green housing).*"

Penney: "*We looked at some small single-family homes and we looked at some condos including (lofts in the neighbourhood) which had some green features, but nothing really appealed.*

This case study illustrates many of the considerations that must be made when retrofitting a low-rise building. It, along with the other interviews conducted for this research, will inform the analysis of what is needed when retrofitting said buildings.

Analysis

Commitment is Needed

The interviews undertaken for this research illustrate three important points for us. First, on a practical level, having committed individuals for a project of this complexity is a must. This case exemplifies the intent that lies behind the creation of sustainable communities. As Roseland et al. say (2005, p.2): "*Sustainable communities are not merely about 'sustaining' the quality of our lives—they are about improving it.*" In this case there were four people (Cole, Penney, the real estate agent and the architect) with strong visions about how the house should look and function. Without their level of commitment, it is unlikely that such a project would have ever gotten off the ground. Or, if it had, corners would have been cut and many features would not have been installed. Our other supplementary case study shows perhaps an even higher level of perseverance on the part of the owners.

This retrofit was taken on by a young couple who had purchased the house in the east-end residential area near Toronto's India Bazaar. The original house, a small bungalow that was

deteriorating from year of termite and water damage, was demolished and rebuilt as a three-floor house with numerous green features. However, the process was an extremely stressful one for the couple. Over the two-plus year process, the couple had their first child, worked their full-time jobs, and had a series of unfortunate experiences with contractors right from the start. The highlights of these mishaps include having the demolition crew taking an exorbitant amount of time to complete the job while not erecting safety fencing (they were later forced to complete the job by city officials), having both neighbours driveways slide into the hole where the house had been, and countless other minor issues. Says the husband:

"There's too many things that can go wrong for you to know about them ahead of time. (...)If someone's keeping track of a list somewhere...I mean there's a million little details in a house. It was a really hard year to work and have a baby and build a house. It was absolutely dreadful and the sort of thing I hope I never have to do again; there was very little sleeping involved. You had to be here every day to look at what was going on, what you were going to need. I don't think we ever felt like the builder was dropping the ball. It was just: 'there's a million details here, and someone's going to get something wrong'".

These cases show that undertaking retrofits of this magnitude (essentially building a new house) is a massive endeavour. For employed people, finding the time to manage both work and retrofit is extremely difficult. Having young children or not having a network to depend on (where people undertaking a retrofit can relocate temporarily during renovations) are other barriers. The people undertaking the retrofits in these two cases began the process with a strong will and significant knowledge of green buildings. They managed to come out with a final product that was fairly close to what they had imagined, but after a multitude of headaches. Attempting to completely alter a building's footprint is, at this point, a task for which the general population might not be ready. An owner and executive director of a company in Toronto that designs and builds green homes remarks on the values of people that undertake retrofits:

"We, as a company, have noticed that the only people who make enquiries to date for our services are, for lack of a better word, 'believers'; believers in the need to reduce energy use."

Similarly, she says, the costs of retrofitting need to be demystified:

"Even if we do enter into dialogue with such a client, they do not seem to have a realistic idea at all of how much anything costs. So when they are presented with a true (and not exorbitant) estimate of out-of-pocket cost, they seem to in the end prefer to spend whatever is in their pocket on glamourous finishes which they can see, rather than insulation behind the wall which they can't see but which will not only provide them with an unimagined quality of comfort, but enormous energy savings. Short-sightedness is the crippling factor, and I just can't see how to assist the about-turn of that, with the exception of raising energy costs. And what a hullaballoo there would be over that! Though it realistically may come to that."

We can then see that there exists the need to educate the public about the time and monetary commitment involved with undertaking a retrofit. Preliminarily, the Canadian Home Builders Association (CHBA) is working with CMHC to create a green renovation guide for home owners that would educate the public on the process and other concerns like product greenwashing. Such a guide would be extremely useful, and hopefully it will come to fruition in the near future.

Role of Local Government

One of the original purposes of this research was to discover the role that planning, and local government intervention in general, plays in these retrofits. However, the two interviews showed that the city planning department had no major objections with either project. For the east-end project, communication with the city went fairly smoothly. None of the features of the house were particularly experimental in themselves, and the paperwork that was submitted to the city was standard procedure. Says the east-end retrofit husband:

"The builder we had came to us by recommendation from a couple of architects. He had no desire to cut corners in any way. The city process is long, and it's a huge pain the butt, but I can't think of anywhere along the way where I thought 'the city is being really unreasonable'. They are trying to plan a city from behind a desk. That's a pretty tall order, and I think they do a pretty good job."

However, he expressed exasperation with the types of financial incentives offered by the municipal and provincial government.

"One of the things that really ticks us off is the financial incentives for this construction. There's nothing. Zero. Take an old house and do a half-assed job, a patch over, there's tons of

rebates for that. But if you want to build something from scratch with a cohesively low footprint, there's nothing for you. What would be great is something at the municipal tax level that says 'if you are going to use our land for an efficient building, we'll give you a break.' You could take the square footage of the building and see how much gas, electricity, and water it uses. If it were below a certain threshold, you'd get a rebate on your property taxes. Mind you, property taxes go to the city, so there would have to be support from the federal level. It seems to me it should be on an annual basis of 'how efficient were you this year?' Because saying that you did something good with walls or windows or whatever, that doesn't tell you anything. If I put in really great windows but have no insulation in my attic, it won't matter at all. You won't have done anything until you build a complete efficient system. Any incentives shouldn't be on the product you're buying but on the efficiency of the result."

A building designer says that municipalities have an important part to play in ensuring that federal and provincial funding continues:

"The EcoEnergy program is about to expire. This program is admired and copied the world over for its sheer effectiveness in reducing energy use and greenhouse gas production. If municipalities were to step up to the plate with replacement funding, the Province would undoubtedly be shamed into keeping their matching funds available. Without this program or something similar in its place, the energy retrofit and thus the transition to sustainable housing market will diminish substantially, possibly to the point where it was 20 years ago (i.e. non-existent)."

The owners from our main case study similarly found that the city's planning inspectors were supportive of their retrofit. However, they take issue with the dissimilar thought and lack of communication between different departments. One of the more aesthetically pleasing and ecologically useful aspects of their street is the maturing maples that line its sides. However, within several months the owners had to deal with two actions by city departments and distributors that threatened the livelihood of these trees.

City inspectors found that the house still had lead piping and that its water had a high concentration of lead. The city then hired contractors to replace the piping at no cost to the owners. However, the owners did have to place an $11,000 deposit to guard the two trees in front of their property while this work took place. During the course of this job, the contractor lost his tunneling machine underground. The contractor then returned to the site with a backhoe and dug up the front

lawn to retrieve the item, placing many of the tree roots at risk. Similarly, some months later, Toronto Hydro ordered that the house's electrical wiring be replaced, as major renovations require a building be brought up to Ontario Building Code standards. Because the street unusually has their power lines underground, and because the latest updates had only been made five houses down, a major excavation was again needed. This time the cost was $30,000 to the owners. Cole and Penney were again shocked by the disregard shown to the tree roots. What is particularly confusing is that mature trees such as these are exactly the type that the city's Parks, Forestry, and Recreation department are attempting to preserve. These situations serve to show us that silos are still very prevalent in Toronto's municipal government, and that they can serve as a barrier to sustainable development in the city.

Similarly, some feel that municipal policy could positively affect urban sustainability in other ways. Martin Liefhebber, a Toronto architect that is nationally-renowned for his approach to green building proposes more flexibility in planning:

"I think that your place (resident's housing), whatever it is in the city, has to be become way more of an instrument that enables, rather than something that you're saddled with. In terms of sustainable planning, of course live-work (property arrangements) should happen everywhere and there should be no restrictions. (The city needs to) change the rules so that people could become self-starters and bring about their own initiatives to make it a really interesting neighbourhood".

The focus of this research being retrofits, this paper will not further explore policy alterations in this direction. However, future research should look into how policy can affect enabling property ownership arrangements in Toronto.

Throughput v. Future Durability

The main and supplementary case studies provide examples where owners determined that significant material throughput was justified by their building's projected durability and reduced consumption. When new infill construction is necessary (on brownfield sites), it is easier to justify a material throughput as the land has already been urbanized and is likely to stay that way (unless urban gardening or agriculture is an option). Construction should occur on land that already fits in

with the urban fabric and choosing low-footprint building materials yields a positive gain. When construction is deemed not completely necessary (building a new house on the site where the previous house was safe and structurally sound, renovation of a kitchen or bathroom for aesthetic purposes, etc.), a high material throughput becomes more difficult to justify. However, whether a retrofit is necessary is not a black and white decision. What constitutes a justifiable reconstruction is completely subjective. The proper site for development must be made in good virtue if the true ideals of sustainability are to be followed.

Also, our ideas of what qualifies as a necessity have changed drastically over the last century. Refrigerators and air conditioning are two examples of appliances that are now considered more or less standard in any home. Within these parametres we consider purchasing a less wasteful version of appliance to be the more considerate decision; the idea of having a home without a refrigerator is now unimaginable. This requires the constant purchasing of products as they inevitably break down due to age or planned obsolescence. Similarly, building standards have increased. As such, when faced with owning a property that contains harmful materials or is structurally unsound (as is the case with the east-end case study), the justifiable choice is to rebuild a new, more durable building. Says Martin Liefhebber:

"We need to get used to the fact that we should once again be making buildings that will last five, six, seven hundred years. And that is a net gift to society. Instead of having this throw-away approach that is still ongoing."

Technology

The advancement of building and appliance technology poses a conundrum to the realm of sustainable housing. In one sense, the advancement of sustainable technology has provided us with fewer harmful substances and less wasteful machinery. Toilets can now flush using far less water than toilets did forty years ago. VOC-free paint can now be produced. Humans have been able to

learn how much of the technology we have produced is harmful to the environment, and have gone to great lengths to minimize this damage.

At the same time, this improvement in technology perpetuates the idea the technology is the solution, rather than the problem in the first place. And even if we decide that certain technology is a valid solution, there is no guarantee that the general population will agree. Within our market-driven society, we frequently are unable to make the connection between what we purchase and its effects on natural systems and social equity. Crabtree et al. (2009) found only weak correlation between concern for environmental impacts in housing and purchasing green technologies.

Also, if we do purchase green technology that is less wasteful, it is frequently not durable. It may also be so sophisticated that maintenance is a difficulty. We can refer back to Donald Cole's frustration at not understanding the building's geothermal system. Sharing knowledge is about social equity, and if barely anyone understands how an air circulation system functions, it is arguably not a sustainable technology. Martin Liefhebber agrees:

"In order to maintain sales, no one wants to build equipment that lasts forever. (..) A real green feature is to not have equipment, or to not have equipment that breaks down. We're having a trend today where a lot of manufacturers are taking a page out of the books of the computer industry, and saying 'hey, why not have it break down sooner?' Ground source heating and cooling is an example. This is a phenomenon that no one really talks about. That technology is so sophisticated, so complicated, that there is very little ability even in the field to repair (these technologies). And even when there is the know-how, people don't have the stomach for it. So we're advised, just as we are with cars and computers, to replace the part. Or just replace the whole system. When we talk about sustainability, this is really the complete antithesis.

A member of CMHC's research division says that smart design is a more important element in green building, and that avoiding certain technologies is important to keeping costs low:

"We are trying to drill down that you can design smarter buildings without it costing any extra money. You can take advantage of passive solar gain. You can cut your energy by 30 or 40 percent just by designing a building properly. A lot of the buildings we're building now, we've reduced the energy consumption so much that they don't need to put in expensive systems."

Certainly nothing is infallible. Even simple technologies like a wooden roofing joist may contract and pose structural risk. However, understanding the mechanisms of natural ecosystems means nothing if we cannot understand how our homes function. Simplicity does not necessarily equal durability, but may help us to create and maintain less wasteful buildings.

Affordability

Minimizing waste and simplicity in built form can also help to minimize construction and maintenance costs. If complete retrofits are to become widespread, this ought to be an important consideration. As we can see from the case studies, completely retrofitting a house is an expensive endeavour. At this point, we cannot consider these retrofits feasible for the majority of the population. Even the east-end couple required financial help from their families to be able to afford fibreglass windows over their vinyl counterparts. As shown before, different levels of government provide financial incentives for some work, but do not give substantial rebates for complete retrofits. In Toronto having enough money to buy a house is becoming difficult, let alone conducting a retrofit. However, we can hope that they become more widespread in the coming years for two reasons.

First, demand for green features and alternative energy will increase as non-renewable resources become scarcer. As technology becomes more established, consumers will be able to judge with more certainty the durability of green products. Also, as processes such as global warming and issues such as food shortages begin to rear their head more clearly, consumers will hopefully start to make more environmentally-friendly purchasing decisions. Second, prices will drop as demand increases. The price of alternative energy, particularly at the household level (putting a solar panel on one's roof for example), is likely to drop particularly sharply (REN21 2008).

However, making sustainable housing affordable requires not just that we look at the price of green housing features. Affordability also depends on the income that residents are making. Arman et al. (2009) suggest that the ideal of sustainability is impossible until poverty is eradicated (p.3038):

"While the benefits of a healthy environment are well documented and altruism motivates environmental concern, proponents of sustainable development may be misguided in suggesting that 'we can have it all' as environmental objectives conflict with other objectives. (...)Debating such tensions is applicable to the concept of affordable housing. By its very nature, affordable housing seeks to not only meet usual housing objectives such as the provision of basic shelter, meet certain planning and building code standards, meet consumer expectations in terms of amenity, location and size, but also needs to meet affordability requirements. The increasingly difficult economic requirement of maintaining affordability (...) depends not on construction or land costs, but household incomes, a factor completely independent of the construction industry."

Making housing affordable in a wealthy city such as Toronto is difficult even before considerations of sustainability. Certainly making sustainable housing affordable is not solely achieved by lowering the absolute price of green features. Much of it also depends on people understanding that over the long-term considerations such as insulation, taking transit, and energy-friendly appliances are money savers.

Recommendations

The James quote that opens this paper expresses how efforts in the present can be used to create something that will be useful for generations. The City of Toronto and its citizens are currently faced with a variety of technologies and concerns that have the potential to shape the future of the city. With the understanding that the focus of this paper is the housing end of the equation, here are five recommendations that will make it easier for home owners to undertake retrofits, and potentially create a more sustainable Toronto:

1. The City's Toronto Building department, potentially in conjunction with the Toronto Environment Office and the Affordable Housing Office, should work to educate the public on green retrofits and the time and money commitment necessary. Heavy emphasis should be placed on recognizing what technologies are helpful for each particular household. This would help to minimize excess cost and the installing of technology of limited use. A useful way to undertake this would be to team up with CHBA and CMHC, and to publicize their

proposed green renovation guide. It is also necessary for this guide to be updated frequently, as technology and price in green features changes swiftly.

2. The City of Toronto must improve communication between departments and distributors so as to ensure that they are working towards the same sustainability goals. It is the municipal government's responsibility to make sure that all parties connected to it are on the same page. An education program on the roles different departments play in the city's goals that would allow for frank discussion has the potential to broaden understanding on the need for all departments to be on-board. Departments, such as the Affordable Housing Office, must give sustainability a more active role in its decision-making.
3. The City of Toronto must focus on making housing prices affordable. Should current trends continue, having a green home will become unattainable for most, even as the price of green features drops. Thus, the importance of greening drops as fewer people can afford ownership. The City's Affordable Housing Office should facilitate affordable green home ownership by giving fund preference to green building developers.
4. Build Toronto should begin the task of creating targets and monitoring measures on numbers of retrofits in the city. This would require the creation of thresholds that would define a retrofit, and should include energy and water consumption among other indicators. The purpose would be twofold. First, it would give the city some data on the state of green housing in their city, and secondly it would give the city something to strive for in terms of facilitating retrofits.
5. The City of Toronto should consider unprecedented measures that would lead to an increased number of retrofits. Placing a carbon tax on residential (as well as commercial and industrial) buildings could place pressure on homeowners to green their homes. Tax revenue from residential buildings could go towards municipal incentives to financially aid residential

retrofits. The City should commission a report to evaluate the feasibility of different forms of carbon taxes and their potential outcomes.

6. The City of Toronto, with improved and continuous support from provincial and federal governments, must improve public transit service. In this case, the Toronto Transit Commission serves as purveyor of sustainable forms of transportation such as subways, streetcars, and light rail. As houses do not exist in silos but as part of a greater community, all levels of government must realize that effective public transit systems are necessary to support intensified urban form. Increasing the number of houses that are prime for retrofit and subsequent sustainable living requires an expansion and improvement of Toronto's transit system, through the Transit City initiative and beyond. Also, money saved by lack of car ownership can be used by homeowners towards improving the quality of their housing.
7. The Ontario Building Code must be strengthened. This should be done in two ways. First, the regulation itself must require higher standards of buildings, particularly in this case, single or low-unit number residential buildings. Improvements should be made across the regulation, from energy efficiency (requiring buildings to score a 90 on Natural Resource Canada's Energuide system or similar alternative as opposed to the current 80) to water conservation (requiring greywater re-use in certain household appliances). Second, existing houses should be checked more regularly for their compliance with the Building Code. As it is, buildings are rarely checked unless they are undergoing a major retrofit of some sort. A system to ensure compliance, mandated by the province but run by municipalities, could along with improved incentives push homeowners towards household improvements and hopefully major retrofits.
8. The CMHC should continue to embrace principles of simple design. Ensuring simplicity in building design will save residents from the need to purchase costly technology and will allow them to comprehend and maintain the mechanisms of their home. The City of Toronto

should continually be involved with CMHC's Equilibrium program to demonstrate this type of housing.

9. Federal and provincial energy savings rebate programs (such as ecoENERGY Retrofit and Ontario Home Energy Savings Program) should consider extra funding to help shoulder the high cost of complete home retrofits. One way of making this possible would be create incentives that are based on tested efficiency. This would reward homeowners that make their houses complete efficient systems. While the testing and larger incentives would require a larger government commitment, the program would see more complete retrofits undertaken that adhere to higher efficiency standards. This type of government investment could result in lowering long-term costs in physical infrastructure (as houses become less energy and water dependent) and spur the trade industry, as complete retrofits require more work.

Conclusion

This research looked at the issue of sustainable housing through a specific lens. The focus was on complete house retrofits, which are far rarer in Toronto when compared to piecemeal improvements. However, the case studies serve as examples as the possible future of home building. The intent was to take an in-depth look at an emerging and evolving process with many barriers to its success. They illustrate the multitude of considerations that go into consider the meaning of "sustainable" at the building level.

This research has also focused on experiences of homeowners. Approximately one third of dwellings in the Toronto census metropolitan area are rented (Statistics Canada 2006-c). As well, many of those owned dwellings exist in condominiums where the ability to undertake retrofits is limited. Further research should be undertaken on the ability of rented dwellings or condominiums to be retrofitted by landlord, tenant, or condominium corporation. This research has also looked at the house as the single building level. However, a community is more than a sum of its buildings.

Communication and networks can play an important role in the ability to coordinate plans and share knowledge on green features such as, for example, conducting maintenance on geothermal systems. The role of the community in sustainable housing in Toronto would be another worthwhile subject to explore.

The framework used to explore sustainable housing and affordability on a broad level touched on the four aspects of *location, construction and design, use,* and *regeneration.* These proved to be useful areas to look at housing as they represent continuity throughout a building's life cycle, and consideration of the future is arguably the most important tenet of sustainability. Also, all of these aspects are areas where the issue of affordability applies. However, within this research it was necessary to focus on location and construction and design elements predominantly, as they proved to play the largest part in the high cost of retrofits. If the focus in these case studies is green building features, the question should then be asked whether these case studies showcased "green housing" or "sustainable housing". At this point we can only acknowledge the former with any certainty, as to ascertain the latter requires time to evaluate these buildings' durability and place within the greater urban realm. Housing literature needs to be able to properly differentiate between "green" and "sustainable" housing, otherwise issues such as affordability may get ignored. Nonetheless, creating a healthy and less wasteful built form is an important piece of a sustainable community. The ability to be housed in buildings that are resource-efficient and harmonious with their surroundings must be possible for every Torontonian. Just as we consider durability in buildings, we must ensure social equity over future generations. Only then will sustainable housing truly be affordable.

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