

Engineering Sustainability Policies within the Building Sector in Ontario as a Basis for Impact on Equity Seeking Groups



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1.0 Introduction

1.1 Background

With the rise of climate change, many Canadian provinces and territories are adopting sustainability plans and making commitments to reduce greenhouse gas (GHG) emissions [1]. The building sector has been at the centre of several sustainability plans, as it has been identified as a high-energy consumer and GHG emitter. It is estimated that the building sector accounts for 22% of GHG emissions in Ontario [1]–[3]. To reduce GHG emissions, Ontario has implemented sustainability plans, such as the Toronto Green Standard (TGS), stating strategic goals and requirements to support Ontario's Climate Change Action Plan [4]–[6]. The TGS has set a limitation on the energy consumed by new and retrofitted buildings by outlining Energy Use Intensity (EUI), Thermal Energy Demand Intensity (TEDI), and Green House Gas Intensity (GHGI) values that need to be met based on the archetype. In addition to the TGS, the recent iterations of the Ontario Building Code show a high increase in energy production and embodied carbon studies through implementing a tiered approach, which is to provide a trajectory to achieve net-zero. In addition, the National Energy Code of Canada for Buildings (NECB) is pushing towards a step energy code to reach more energy-sustainable buildings. Furthermore, according to the Canada Green Building Council (CAGBC), “green buildings are a cost-effective solution for carbon reduction, job creation and innovation”. Through CAGBC's involvement in various projects, there have been 37 Zero Carbon certifications, and 4,858 LEED-certified buildings, leading to the consumption of 3.8 million tonnes of recycled construction waste, and 4 million tonnes less GHG emissions.

In the building sector, there are different methods of achieving sustainability that can vary based on the definition of sustainability through energy reduction or carbon reduction. Also, the strategies to achieve sustainable buildings vary significantly based on a newly built or a retrofit building, and, at the micro-level, dependent on the individual building. Despite the definition of a sustainable building being dependent on multiple different aspects, the strategies to achieve a sustainable building are broken down into ‘active’ and ‘passive’ strategies. The reduction of energy consumption through active strategies can include automated blinds, more efficient HVAC, ground source heat pumps, motion sensor LED lights, etc., and energy consumption through passive strategies including building form, window-to-wall ratio, overhang, continuous exterior insulation, airtightness, etc. The constant research and field application of these strategies helps to achieve the benchmarks outlined by policies, standards, and codes such as TGS, Passive House (Passive House Institute and Passive House Institute US), and Ontario Building Code.

Along with the increase in the push towards sustainability in the building sector, Ontario has increased in population and diversity [7], [8]. The sustainability plans have incorporated sections on inclusion policies, which state that regions provide healthier and more livable places for equity-seeking groups, which account for 29.3% of Ontario's population [7]. Equity-seeking groups are people facing Employment Barriers, Unemployment or Underemployment; or experiencing barriers to economic opportunity participation. These include, but not limited to members of Indigenous communities; members of a visible minority group; immigrants and refugees; people with recognized disabilities; racialized communities; women; members of the 2SLGBTQIA community; low-income residents; people with mental or physical health barriers. In Ontario, Indigenous people and other equity-seeking groups have seen population increases of 2% and 18%, respectively, from 2011 to 2016 [8]. With equity-seeking groups expecting to increase in population in upcoming years, they will play a crucial role in helping achieve the goals outlined in sustainability policies. Alongside the parallel rise in diverse populations and sustainability policies, there will be new employment opportunities. Canada's 2030 and 2050 carbon reduction goals will require newly built or newly retrofitted buildings to achieve nearly zero-carbon performance, which leads to an increase in the training of new skills and knowledge [9], [10]. The green building industry provided over 460,000 jobs in 2018, which was a 55% increase from 2014 [11]. According to the Canadian Green Building Council, an increase in green policy emphasis and progressive sustainability policies could result in 1.5 million direct green building jobs by 2030 [11].

The movement toward equitable sustainability has been noted as Environmental Justice (EJ), and Just Sustainability [12]. Previous literature on EJ has proven that the communities classified as low-income and populated by equity-seeking groups “bear a disproportionate burden of environmental hazards and externalities” [13]. Furthermore, previous studies on EJ show that equity should be incorporated into the planning process of sustainability policies to avoid barriers to equity-seeking group participation [14].

Previous researchers have used communication and participation from equity-seeking groups as a measure of inclusion and equity. The participation of equity-seeking groups can be viewed as achieving a holistic view of solving a civil

problem or better planning for the future socially, and, sometimes, environmentally [13], [15], [18]. Environmental Justice centric research shows that a comprehensive problem statement can be developed by including diverse groups during the planning phase [13]. Additionally, EJ studies illustrate that the increase in diversity leads to expanding opportunities such as an increase in potential employment and carbon reduction industries [13], [14]. Although the participation of equity-seeking groups is essential, many researchers stress the importance of assessing the impacts of sustainability strategies and policies in terms of sustainable development through a Sustainability Impact Assessment (SIA). This is a crucial step in justifying strategic sustainable planning [18].

The sustainability policies should encompass all Ontarians. However, the degree to which these policies could impact equity-seeking groups is the question which will be studied in this research. Research will use policies such as the Toronto Green Standard as case studies to assess their potential impact on equity-seeking groups through a literature review, followed by one-on-one interviews with the sustainability experts. Previous research conducted by Koontz and Thomas (2006) assesses the effectiveness of equity in sustainability policy based on sustainability plans, programs, and development projects [19]. Implementation of sustainability policies also presents an opportunity to increase employment. Current modelling shows that there will be 161,000 new jobs in Canada from 2020 to 2030 due to a push towards sustainability [20]. According to the report published by Future Skills Centre, entitled 'Jobs and Skills in the Transition to a Net-Zero Economy', workers are required to have different skills in the process of decarbonization; however, workers need to be supported through skills training programs that allow a transition from oil and gas to greener occupations [20]. Furthermore, the Future Skills Centre states, "subsidized on-the-job training and education, age-targeted supports, and better labour market information" are essential for switching careers [21]. Additionally, Smart Prosperity Institution demands these claims were to be further investigated in the report entitled "Shed Light, Resilience Series – part 1". The report states, "Recognizing the current dearth of information and the need for rigorous research at the nexus of gender, intersectionality, and climate change, 'through' design of inclusive climate adaptation efforts and to improve the resilience of communities and equity-deserving groups" [22]. The studies completed by Koontz and Thomas (2006) and supported by Future Skills Centre (2022), and Smart Property Institute (2022) will form the basis to assess the impact and effectiveness of Ontario's sustainability policies by identifying quantitative and qualitative metrics.

1.2 Purpose of The Study

In an increasingly diverse population with housing stock concerns, such as in Ontario, sustainability housing policies play an essential role in providing equitable shelter. By understanding the past, present, and future of sustainability policies, the potential changes to the housing market can be understood. Although sustainability housing policies are dependent on the politics, supply chain, and demand and supply of houses, the general trend is to move towards sustainability and a "green" environment. A growing concern with the sustainable housing market is the identification and implementation of changes to current and future housing markets. As a result, the integration of housing policies with local government's urban planning is essential for creating a sustainable future [23].

The general purpose of this research is to understand the potential impacts of sustainability policies from the perspectives of academic and industry experts. As the current global policies from the EU and local policies from municipalities are considering sustainability as the prime focus, identifying the impacts of these rapid changes are of increasing relevance to society. In southern Ontario, the changes to building construction policies are governed by the objective of (1) achieving a carbon-free atmosphere, (2) reduction of energy consumption, and (3) affordability of housing. The outcome of this research will highlight the gaps and biases in sustainability policies by focusing on either reduction of carbon emissions, decreasing energy consumption, or affordability of housing. Through examining the sustainability housing policies, a growing concern is in understanding the enforced changes. Despite many individuals working on creating, developing, and implementing policies, a government-published document that captures the impact of sustainability building policies is missing. The aim of this project stems from the research gap of capturing the impact of sustainability building policies on equity-seeking groups.

1.3 Scope of Research

The research aims to investigate the perceived impacts of Ontario's sustainability building policies from expert's views. To achieve this objective the research is completed in three phases: (1) literature review, (2) interviews with experts, (3) analysis of the literature review and interviews. The scope of this research is confined geographically, the criteria for someone to be considered an expert, and the number of interviewees.

- Geographically, the Greater Toronto Hamilton Area (GTHA) has the highest population density and the most diverse population in Ontario. Higher density results in more people being impacted by sustainability policies. Furthermore, a study conducted by the City of Toronto showed that buildings produced 55% of GHG emissions [24].
- Ten interviews were conducted to ensure the project is completed in a timely manner. To understand the deep influence of the policies and implementation of the policies, the experts interviewed must be living within GTHA, or conduct research/work within the GTHA boundary.
- The hand-picked experts belong to either academia, policymakers, or industry experts. For this research, it is understood that most sustainability scholars may not have a deep understanding of relating sustainability policy to the diverse population of GTHA. Therefore, their opinions on the impacts of sustainability policies on equity-seeking groups may be biased and learning towards their research. However, for the overarching success of the entire research project it is essential to identify, and if possible, quantify the changes enforced due to amendments and the creation of sustainability policies. Additionally, the policy experts on sustainability housing may belong to the government, not-for-profit, or policy development organizations.
- The policy experts interviewed for this project have a minimum of five years of experience within their industry.

1.3.1 Sustainability definitions

With the apparent rise in global warming and land development, the term sustainability has attained several definitions when applied to the housing market based on engineering/architectural, geographical, environmental justice, and sustainable lifestyle viewpoints.

The dominant view of sustainability in the engineering and architectural realms is through two methods: (1) net-zero energy and (2) net-zero carbon. The net-zero energy term refers to the amount of energy consumed annually by a building that is less than or equal to the on-site energy produced annually. Whereas net-zero carbon refers to buildings that are extremely energy efficient and reduce greenhouse gas emissions through construction material selection and building operational standards.

The geographical viewpoint of sustainability looks at resource management and pathways to ensure sufficient resources are available for future generations. This is extremely important as humans require natural resources to live a modern life. Resource management is crucial as it must ensure procurement and distribution of all resources within a geographical location to reach all populations while keeping sustainability at its core.

Environmental justice is also at play. Environmental justice portrays the vision of the need to ensure sustainable policies are inclusive from a financial perspective. Currently, the general norm is that if something is “sustainable, then it is going to be expensive”. The cost of participation within sustainability efforts creates a gap between rich and poor. Therefore, environmental justice creates a bridge between different finance categories. Overall, environmental justice creates inclusive sustainability policies. [25], [27]

Another view of sustainability refers to a sustainable lifestyle [28]. The sustainable lifestyle movement evaluates “the way we live throughout the lifecycle of everything we buy and use in our daily lives, and at the same time delivering a good quality of life for everyone” [28].

Despite the different ways of viewing sustainability, they are all interconnected. For example, previous research has shown that to achieve a larger impact on climate, a more equitable distribution of energy consumption around the world is needed [28]. It comes as no surprise that the construction of a low-energy consumption building requires more construction materials and higher efficiency air conditioning equipment. However, the view of sustainable housing is that the initial capital investment will be paid back through the operational cost of a building. For example, the Passive House Institute of United States (PHIUS) standard claims that the initial investment during construction is paid back on an average of 5 years through energy reductions.

1.4 Research Objective and Questions.

The overarching objective of this research is to investigate what current and upcoming sustainability policies would mean for the building industry from academics’ and industry experts’ knowledge. The objective of this research can be further broken down into three specific points:

1. From sustainability experts' perspectives, (A) What changes would current and upcoming sustainability policies mean for the building sector, and to identify the overarching advantages, disadvantages, and risks associated with the implementation of sustainability policies on equity-seeking groups, and (B) classify the potential of economic growth and job creation which may impact equity-seeking groups.
2. Lay the foundation for further research on identifying barriers that may prevent equity-seeking communities from benefiting from the sustainability movement in the building sector.

The following research questions are derived from the research objectives.

RQ1: Based on the literature review and interviews with experts, what are the current and upcoming changes in building sustainability policies?

RQ2: How would the changes identified in RQ1 potentially impact the construction industry or equity seeking groups?

1.5 Current and Future Building Stock and Energy Consumption Breakdown

For this research, it is essential to understand the current building stock, and energy consumption breakdown which can form a rationale to focus on a specific building type. The building stock are the existing buildings built in a geographical location.

1.5.1 Existing building stock

According to the 2021 census data, the existing building stock of GTHA is 2,718,900, which accounts for 49.5% of total Ontario's building stock. Additionally, GTHA accounts for 47.5% of Ontario's population [7], [29], [30]. Most of the existing building stock is composed of single detached houses followed by apartment buildings that have five or more storeys. These will be the focus of this research. Table 1 shows the breakdown of the population and building stock of Ontario, the GTHA, and Toronto, Hamilton, and Oshawa. A map outlining the GTHA is shown in Figure 1.

Table 1 – Population and Building Stock Census data for Ontario and GTHA [29]

	Ontario	GTHA [Census metropolitan area]	GTHA Breakdown		
			Toronto, ON [Census metropolitan area]	Hamilton, ON [Census metropolitan area]	Oshawa, ON [Census metropolitan area]
Population					
Population, 2021	14,223,942	7,402,720	6,202,225	785,184	415,311
Population, 2016	13,448,494	7,055,433	5,928,040	747,545	379,848
% Change	5.77%	4.92%	4.63%	5.04%	9.34%
Building Stock					
Single-detached house	2,942,990	1,149,630	883,125	169,265	97,240
Semi-detached house	303,260	182,480	164,580	10,110	7,790
Row house	505,265	269,590	210,100	43,785	15,705
Apartment or flat in a duplex	181,030	104,225	90,500	8,300	5,425
Apartment in a building that has fewer than five storeys	548,785	252,085	215,325	25,560	11,200
Apartment in a building that has five or more storeys	984,665	755,795	694,735	49,645	11,415
Other single-attached house	10,220	4,220	3,470	555	195
Movable dwelling ⁴	14,985	875	635	160	80
Total Occupied private dwellings by structural type of dwelling - 100% data	5,491,200	2,718,900	2,262,470	307,380	149,050

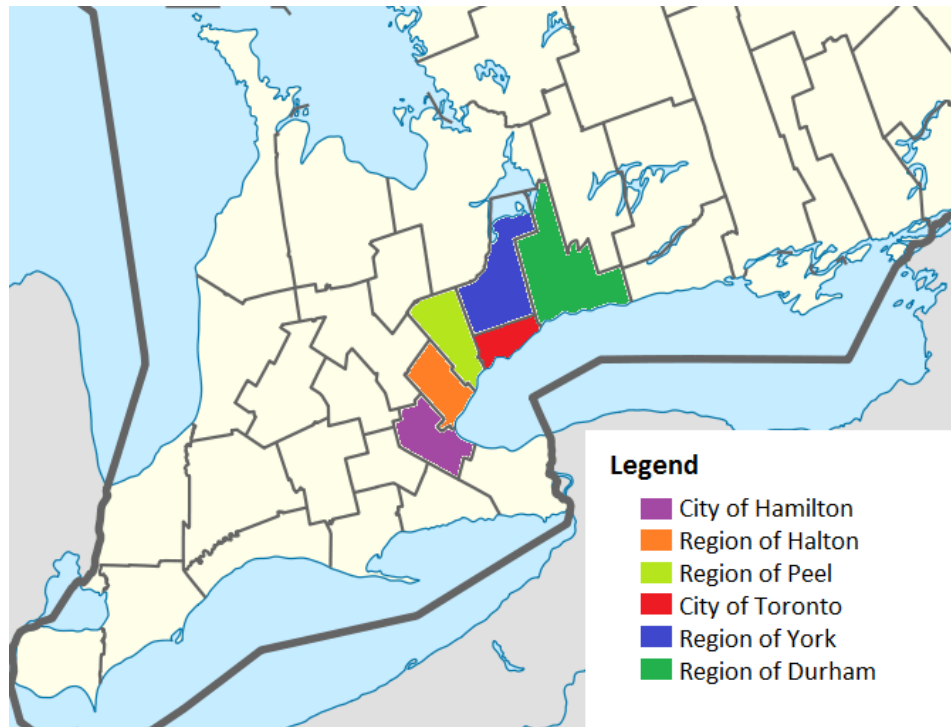


Figure 1 – A map of GTHA

1.5.2 Building stock GHG emission, and energy use

Followed by oil and gas, and the transportation sector, the building industry is known to produce the third most greenhouse gas emissions in Canada, as shown in Figure 2 [31]. Through the commitments made federally and provincially, Ontario is committed to reducing GHG emissions. This has been proven through the decrease in GHG emissions from 2005 to 2020, as shown for all provinces in Figure 3 [31]. The reduction of GHG emissions in Ontario is driven by the closure of coal-fired electricity generation plants and the move towards renewable electricity production.

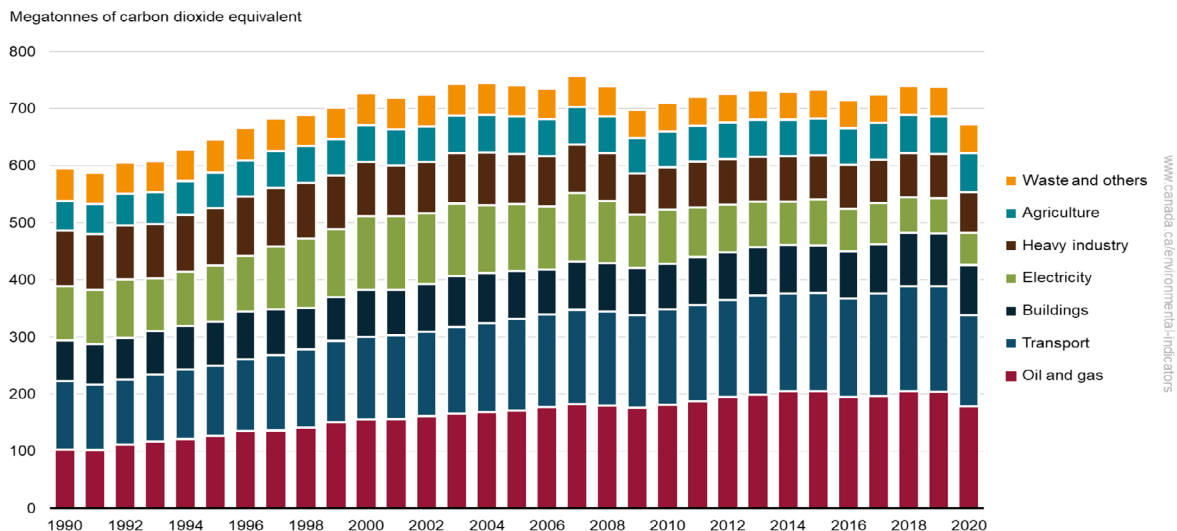


Figure 2 - GHG emissions by economic sector, Canada 1999 to 2020 [31]

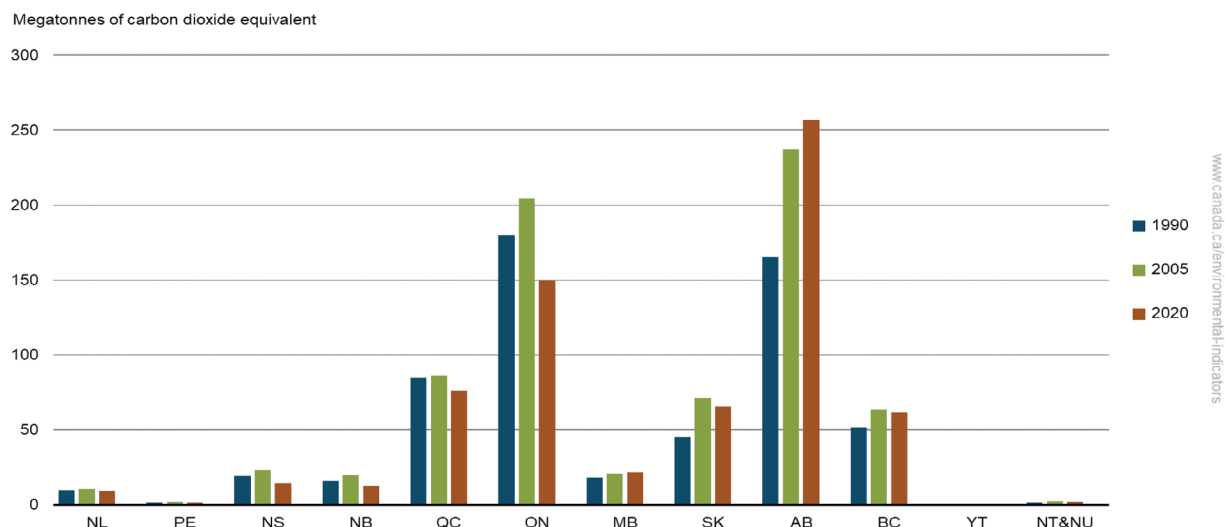


Figure 3 - GHG emissions by province and territory, Canada 1990, 2005 and 2020 [31]

Despite Ontario's commitment to reducing GHG emissions, residential buildings in Ontario account for 48% of GHG emissions produced by Canadian residential buildings, as shown in Figure 4. Existing residential building emissions by the province in 2018 show that Ontario emits almost 50% of GHG emissions [32]. More specifically, Toronto buildings account for 55% of GHG emissions, and 33% of total Toronto's GHG emissions are produced by single-family and multi-unit residential buildings, as shown in Figure 5 [33].

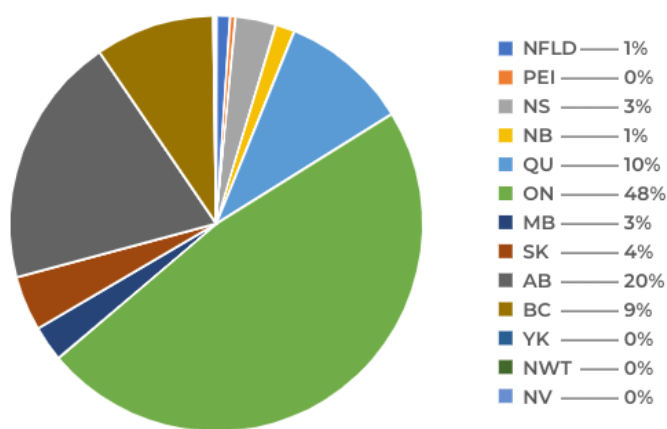


Figure 4 - Residential building GHG emissions by the province in 2018 [32]

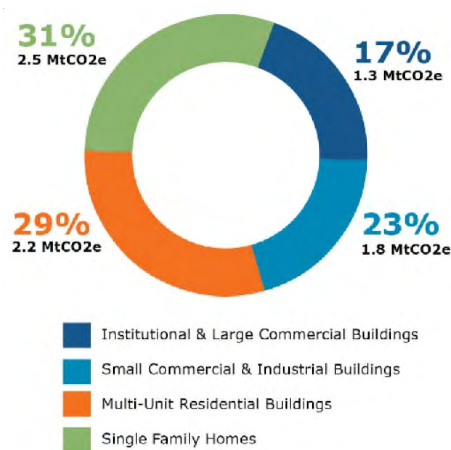


Figure 5 -Toronto's GHG emissions by building type in 2018 [33]

1.5.3 Energy Efficiency and Electrification in Focus

As the trend towards reducing GHG emissions becomes more evident, there is an increased need towards energy efficiency and electrification in the Canadian building sector. Currently, most of the GHG emissions in the residential building sector are due to the use of natural gas used for heating. Over the last decade, the Ontario government has worked closely with the federal government's initiative to align with the Paris Agreement. There are two key types of initiatives provided by the government: (1) energy audits, and (2) energy reduction programs.

Key energy audit programs:

- EnerGuide rating program to evaluate the energy consumption of a building.

Key energy reduction programs:

- “The federal government has committed \$2.4 billion to help homeowners to make energy efficient retrofits,” and “Canada’s National Housing Strategy had committed over \$14.6 billion to support creation and repair of over 143,500 energy efficient, accessible, and socially inclusive housing units.”
- “The Green Municipal Fund of the Federation of Canadian Municipalities established 6 Low Carbon Cities Canada (LC3) centres in the Calgary, Edmonton, Greater Toronto and Hamilton area, Halifax, Ottawa and Montréal, enabled by a federal endowment.”
- “Sustainable Affordable Housing initiative funds, provided by provincial and federal government for energy efficiency projects in new and existing affordable, social, and market housing units.”

1.6 Report Structure

Included in this report are a literature review on sustainability policies, the methodology of investigating perceived changes due to sustainability housing policies, and the result and analysis of the gathered data through literature review and expert interviews. The literature review includes changes made to sustainability policies in the last decade, current sustainability programs, and current and future sustainability policies. The methodology section describes the process of choosing sustainability experts, and their interview questions. Lastly, the results and analysis section of this report shows the conclusions that can be made from the experts’ interviews.

2.0 Literature Review

The literature review is based on two pillars: (1) published building sustainability policies and action plans and (2) academic publications on sustainability. The sustainability policies published are based on a general publication list by the City of Toronto, the Province of Ontario, and the Federal government. Whereas the academic publication review is based on Prisma systematic literature review.

2.1 Review of Published Sustainable Policies

An understanding of the different types of housing sustainability policies is crucial for the success of this project. Understanding the language used in the policies allows for a smoother conversation with experts during the interview process.

2.1.1 Sustainability policy changes made in the last decade

Energy and Carbon Policy Initiatives (GHG Reduction)

With the apparent rise of carbon emissions and detrimental impact on the climate, Ontario has taken adequate steps to aid residents to reduce the carbon footprint. The government of Ontario is committing \$325 million to the Green Investment Fund with the key objective of helping homeowners to lower their footprint and save money [34].

Ontario Home Energy Conservation Incentive Program offers multiple methods to learn which utility is offering different incentive programs within a defined area. This program helps to conduct energy audits and develop retrofit programs developed by Enbridge Gas Distribution and Union Gas. The objective of this program is to help 37,000 homeowners to identify energy-saving opportunities and complete retrofits. To further emphasise decarbonization, homeowners that heat their homes with electricity can participate in saveONenergy Programs, to save on energy costs. These programs will save on energy bills while reducing greenhouse gas [35].

As the existing building stock continues to be an energy sink, the Government of Ontario has invested \$92 million into multiple retrofit programs. This funding is intended to reduce the energy consumption of 35-50 high-rise buildings by installing new HVAC equipment, insulating outer walls, and installing more energy-efficient windows and lighting [36].

Affordability

In conjunction with sustainable policy changes made in the last decade, housing affordability in Ontario has faced a struggle to find reasonable accommodations. As a result, the Association of Municipalities of Ontario (AMO), has developed multiple documents showing action plans and integrated approaches to address the Ontario housing crisis. These actions stem from federal, provincial, and municipal levels of government.

At the municipal level, the most recent applicability of the local vacant home tax will reduce the number of vacant homes in a particular Municipality. This tax was imposed in the City of Toronto starting in 2023, however, it does not apply to other municipalities in the GTHA. The tax is based on the current evaluation of property, and it is taxed at 1% of that amount. [37]

2.1.1.1 Case Studies on sustainable development

Several sustainability case studies have assisted the development of sustainable practices through using federal and provincial grants. This subsection describes a few of the projects that are situated in southern Ontario.

Fanshawe College of Applied Arts and Technology, London, ON

Located west of the GTHA, Kestrel Court Student Residence of Fanshawe College used federally funded 1.25 million dollars to transform a 25-year-old complex into a net-zero facility [36]. This building serves as a net-zero-ready facility which serves as a template that can be used for other buildings.

Indwell, Woodstock, ON

The federal government supported the construction of Blossom Park Apartments with \$365,000 to build high-performing multi-unit residential buildings (MURB). The building envelope was constructed using prefabricated technology, which helped to develop local and national net-zero codes. This project also received funding from Canada Green Building Council, Canada Mortgage and Housing Corporation, Oxford County, and Passive House Canada [36].

Enwave Energy Corporation, Markham, ON

Enwave Energy Corporation developed a geothermal community to supply low-carbon heating and cooling to 300 residential homes. This project received \$350,000 from the federal government [36]. Additional aid came from the City of Markham, Mattamy Homes, and The Atmospheric Fund. Excess heat was stored in the ground during summer, and extracted from the ground in winter months, which resulted in a drop of energy for space heating. In traditional residential homes, approximately 60% of the total energy is used for space conditioning (cooling and heating). Note, space heating refers to heating only, whereas the term space conditioning refers to cooling and heating.

2.1.2 Current sustainability programs and policies

Building on the past is an important aspect of an area with diverse building stock, such as the GTHA. Many energy experts believe that improving the existing building stock is an absolute necessity to improve the environment and reduce GHG emissions. The City of Toronto has provided homeowners, builders, and investors financial support to improve energy efficiency and reduce emissions in Toronto's residential, commercial, industrial, and institutional buildings. The two dominant platforms that provide support to residents of Toronto are the City's Better Building Partnership and Better HomesTO. Table 2 shows the programs initiated by the city, provincial, and federal governing bodies to help reduce energy waste and contribute to sustainability policies.

Table 2: List of financial aid available within GTHA [38]–[41]

Program Name	Governing Body	Target Strategy (Retrofit and New Construction)	Stakeholders	Building Type	Financial Aid
Tower Renewal Program	City of Toronto	Provide site improvement guidance and financing to reduce operating costs, increase building efficiency and improve the quality of life for residents	Property owners and managers of apartment buildings	Apartments / Residential	
High-Rise Retrofit Improvement Support Program (Hi-RIS)iv	City of Toronto	Building improvements that reduce energy and water consumption	MURB Owner	MURB above 3 storeys	Local Improvement Charge financing with up to 20-year term at competitive fixed rates
Sustainable Towers Empowering People	City of Toronto	Helps in benchmarking and reporting their energy, water and waste performance.	Owners and managers		
Home Energy Loan Program	City of Toronto	Similar to the Hi-RIS program.	Homeowners	House	Provides financing up to \$75,000 and flexible terms of up to 20 years to cover the cost of energy improvements
Energy Retrofit Loan	City of Toronto	Provides financing to improve energy efficiency and reduce emissions in their buildings. Toronto community-based or not-for-profit organizations low-interest loans are provided to support up to 100% of their energy retrofit Projects.	Owners of commercial, institutional and MURB	Commercial, Retail, Industrial, Hospitals and Long-Term Care, institutional and MURB	Provides financing up to 100% of the project costs at a rate equal to the City's cost of borrowing, repayment plan of 20 years.
Affordable Housing Program	Enbridge Gas Inc.	Programs help offset the costs of retrofitting and provide ongoing efficiency savings that reduce the payback time.	Homeowners that have Enbridge Gas account in good standing.	Owners that have properties linked with Enbridge Gas, and whose account is in good standing	Provides up to \$100,000 in incentives.
Commercial Retrofit Program	Enbridge Gas Inc.	Enbridge Gas provides energy solutions and works with owners to identify energy efficiency opportunities.	Owners with Enbridge Gas services.		Implemented recommendations will offer financial incentives to cover up to 50% of the project costs to a maximum of \$100,000 per project.
Save on energy ¹	Audit Funding	The financial incentive to businesses towards the cost of various energy audits	Business owners	Commercial business owners	Funding available: Electricity survey and analysis for owners Detailed analysis of capital-intensive modifications Building systems audit incentive Electricity survey and analysis for eligible tenants
Commercial Savings by Design	Union Gas Limited	Provide designed to guide, assist and reward businesses to improve energy efficiency and environmental performance.	Business owners	Construction projects	Funds up to \$60,000 are available to optimize design plans early in the design phase implement upgrades and take advantage of cash incentives for achieving energy performance above OBC.
Space Heating Programs – Condensing Boiler Incentive Program	Union Gas Limited	Financial incentives to existing industrial facilities looking to replace an ageing boiler	Home and business owners		Incentives include: \$600 per unit up to 299 MBtu/hr \$2,000 per unit from 300 to 999 MBtu/hr \$6,000 per unit over 1,000 MBtu/hr

Canada-Ontario Housing Benefit	Provincial and Federal Government	A program initiated to help with rental payments	Tenant	Rental property (Housing)	A calculation conducted based on rent and other payments – calculation completed based on several criteria
Comprehensive Energy Management Program	Enbridge Gas Inc.	A program intended to understand key energy drivers – possibly allowing the general public to develop energy goals and energy strategies	Participants can qualify for very attractive financial incentives	Housing	Provides resources to understand the potential energy-saving strategies
Fixed Incentives -Condensing Boilers ²	Enbridge Gas Inc.	The incentive to customers and contractors towards the purchase and installation of a condensing boiler	Customer and contractor incentive	Housing	Funds available for customer and contractor incentives that install a condensing boiler (\$50 per unit to a maximum of \$500 per project)
Fixed Incentives – Condensing Storage and Tankless Water Heaters	Enbridge Gas Inc.	An incentive to customers and contractors towards the purchase and installation of condensing storage and tankless water heaters.	Customer and contractor incentive	Housing	Funds available for customer and contractor incentives that install condensing storage and tankless water heaters. (\$50 per unit to a maximum of \$500 per project)
Canada Greener Homers Grant	Government of Canada	Grants eligible retrofits such as home insulation, windows, doors, heat pumps and solar panels.	Homeowners	House	Grants from \$125 to \$ 5000 – eligible for a portion of home retrofits. Up to \$600 as a maximum contribution towards the total costs of your pre-and post-retrofit EnerGuide Evaluation.
Canada Greener Home Loans	Government of Canada	Offers interest-free financing to help homeowners to complete major retrofit	Homeowners	House	Offers interest-free financing to help homeowners to complete major retrofit loans. The loan can only be combined with the Canada Greener Homes Grant: From \$5,000 to \$40,000.
Oil and Heat Pump Affordability Program	Government of Canada	Offers households with median income or less who are heating their homes with oil to make the transition to better more efficient options.	Homeowners	House	Grant up to \$5000, to cover costs for changing your oil heating systems to a cold climate air source heat pump.

¹ SaveONenergy program is identical for the following topics: Audit Funding, Energy Managers, Energy Performance Program Incentives for Multi-Site Businesses, Existing Building Commissioning, Existing Building Commissioning, High-Performance New Construction, Process & Systems, Residential New Home Construction, Retrofit Program, and Small Business Lighting Program.

² Fixed Incentives Program is identical for the following topics: Condensing Furnaces, Condensing Make-up Air Units, Condensing Storage and Tankless Water Heaters, Demand Control Ventilation, Destratification Fans, Heat Recovery Ventilators and Energy Recovery Ventilator, High-Efficiency Boilers, and Infrared Heaters.

2.1.3 Future sustainability policies

The City of Toronto and the government of Ontario have published a list of recommended policies that can help the movement towards net zero emissions by 2050. These policies are generally sector specific and are intended to provide benefits to homeowners and business owners in transitioning to a net zero energy and carbon strategy. The implementation of these strategies will be heavily dependent on the trained and growing workforce, and governmental support.

City of Toronto policies are dependent on actions that set requirements, actions to provide support and recourses, and actions that lay the groundwork. These actions require annual performance and public disclosure, establish emissions performance requirements, and require energy audits and retro-commissioning.

2.2 Review of Published Academic Research on Sustainable Policies

To identify the impacts of sustainability policies, case studies, and the overlap between equity-seeking groups and sustainability policies, a literature review of academic papers was conducted. Table 3 shows the key research conducted to generate a list of potential articles to review on Scholars Portal Journals and ICONDA. The search led to a general output of 469 papers. The list of papers was then examined by their titles and abstracts to dictate their relevance to the research project. Forty five out of 469 papers were relevant to this research based on title and abstracts. These papers were then categorised as technical, social, and both technical and social to provide a further breakdown of the literature analysis. The technical papers focused more on energy and carbon reduction through policy implementation, whereas the social papers discussed human relationships with green policies. There were 18 technical papers, 18 social papers, and 9 papers identified as both technical and social issues.

Table 3: Prisma Keyword Search: “Or” across the columns / “And” across the rows

Sustainable	Sustainability	Green
Policy	Policies	-
Toronto	Ontario	Canada
Energy	Carbon	-
Affordable	Affordability	-

Because of the many changes to sustainability policies since 2010, only literature from 2010 onward was analysed. Most of the papers have been published after 2019 (Figure 6). There is a significant reduction of publications in 2020, due to COVID-19. Additionally, it can be presumed that the number of papers to be published in 2023 on the topic of sustainability is going to be more than in 2022. This assumption is based on the fact that within the first three months, there are already 4 publications (33% of 2022 relevant publications).

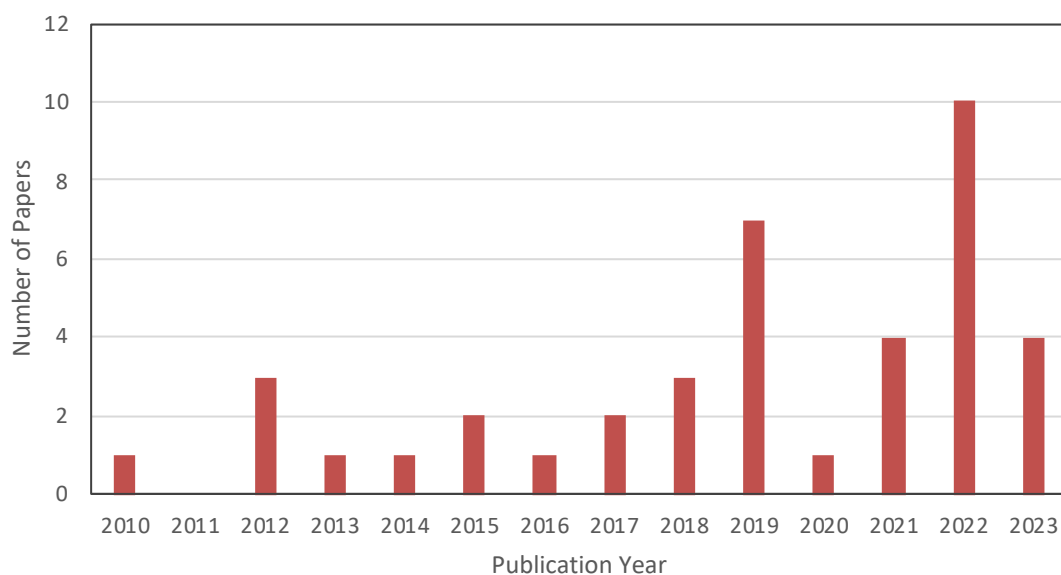


Figure 6: The number of publications analysed for this study by year.

2.2.1 Technical Papers Literature Review

Technical papers discussed the probability of sustainable power production, global warming, and current and future energy consumption and carbon production. The literature review focused on the use of policies to drive technical development for carbon reduction strategies.

One of the most dominant methods of reducing GHG emissions is by eliminating the use of natural gas at a building scale, and fossil fuels to generate energy at a plant scale. For example, a study conducted by Azam A, 2021, showed that reducing the dependency on natural gas and fossil fuels, while increasing the use of renewable energy has a direct impact on increasing economic growth and decreasing CO₂ emissions [42]. The article further describes that policymakers should further investigate and advocate for the benefits of green economic growth by increasing the potential of green Information Communication Technology (ICT) trade [42]. There are multiple opportunities to promote the adoption of green technologies for large-scale green development projects, which have the potential to transform the construction industry through building green and inclusive communities[43], [46].

From the literature search, only a few technical papers focused on Ontario's GHG emissions, as this topic requires specific energy generation data and an expert level of understanding. However, a general trend talked about in all the Ontario-related literature was the reduction of GHG emissions from 175 to 58 g CO₂e/kWh from 2010 to 2018, which is mainly due to the "phasing out of coal plants, coupled with the gradually reduced use of natural gas plants, and the increased participation of nuclear and renewables in the mix over the years" [44]. At a provincial level, many researchers believe that by increasing the use of electricity, the GHG emissions will decrease. However, given the increase in renewable energy production, the price of electricity is expected to rise initially. The speculation of rising prices falls on the development of infrastructure. For example, if only solar power was used to produce electricity, then there is a need for energy storage for grid matching. The cost of energy storage will have to be factored within the capital investment cost, leading to a rise in electricity prices. Therefore, the socio-economic strain on many Ontarians will continue despite the reduction of GHG emissions [45]. Some researchers believe that if inadequate resources are deployed to the general public, then the general public will experience a much larger economic strain [47], [49].

Through the general push towards the reduction of GHG emissions, net-zero energy buildings is a concept that was discussed quite heavily. A push towards net-zero buildings has been dominant over the last few years. Annually, net zero buildings produce the same amount of energy that they consume. Researchers believe that the only possible method of producing on-site electricity is through Photovoltaic (PV) and wind generation [50]. Each site has limited real estate to produce on-site energy, therefore buildings need to be designed appropriately [51], [53]. For example, buildings need to have a proper window-to-wall ratio to ensure there is sufficient sunlight, and solar heat gains [51].

The renewable energy focus in Ontario is dominated by solar and wind. Although nuclear energy is renewable energy, there is a by-product of nuclear waste. The pro-nuclear energy researchers have claimed that energy production of nuclear energy outweighs the environmental risk. Additionally, their claim stems from the waste products of solar PV cells and water turbines. More specifically, researchers have considered health-related negative aspects of wind energy in Ontario that may be emphasised in social media. Researchers claim that "Ontario's media may be amplifying the perceptions of wind turbine health risks within the public domain". The health risks associated with wind turbines include sleep disturbances, headaches, and concentration problems.

2.2.1.1 Sustainable global development

Globally, the sustainable forefront of technological improvements for achieving carbon neutrality is based on the United Nations Sustainable Development Summit document "Transforming our World: the 2030 Agenda for Sustainable Development". The document shows 17 Sustainable Development Goals (SDGs) (Figure 7). Based on the lessons learned individually and SDGs, each country has developed their own Best Available Techniques (BATs). These techniques are most effective when the government uses these approaches to develop policies, legislation, and requirements. The key idea that BATs need to ensure is sustainable growth (reducing industrial pollution, avoiding the use of hazardous substances, and providing chemical safety, consuming natural resources responsibly, minimising waste, recovering and recycling materials, enhancing energy efficiency, recuperating energy, and using renewable energy sources where appropriate), without jeopardizing economic growth. For the building sector, there are two main foci which have driven the SDGs: reduction of carbon production and energy efficiency. These two topics encompass the use of renewable energy, improving recovering materials, and enhancing energy efficiency. Previous research shows that the energy transition of global policy commitment has been shown to produce a sustainable environmental effect. However, many

researchers believe that more should be completed in terms of policy implementation and initiatives to meet the drastic change required to battle potential climate change impact.



Figure 7: List of 17 UN SDGs targeting sustainable movement

2.2.2 Social Papers Literature Review

The social literature review is based on the interactions of technology and infrastructure development, with employment within Southern Ontario. Included is government aid offered to increase participation from the local communities.

2.2.2.1 Focus on renewable technology

There is limited research conducted on Ontario-specific policies of environmental justice and the movement of sustainable energy impact on humans. The impacts of sustainable equality have been sidelined in the last few years as the most recent challenges in the community are revolving around social equality (i.e., race, gender, and finances). However, the limited research on energy and social justice covers the topic of human participation in renewable technology. According to many researchers, securing energy through renewables is the way to move forward. The changes to renewable technology are derived from governmental benefit programs [54].

In Canada, the major obstacle to the use and deployment of renewable energy is Canadian energy prices. The current Canadian price is amongst the lowest in the world, which makes the public rely on existing energy production and not invest in renewable energy. Moreover, renewable energy poses threats to the existing power grids. For example, renewable sources such as PV produce energy during the daytime – however, the demand is not always during the daytime. Therefore, there is a need for energy storage. One of the potential benefits of renewable energy such as PV and wind, is that recently there is a lower capital cost due to technological advancements[55].

2.2.2.2 Infrastructure growth in Ontario

In the last few years, as shown in section 1.5.1, the population of Ontario, more specifically the GTHA, is on the rise. The constant increase in population has caused a surge in the need for more infrastructure in the GTHA. The population growth has caused many researchers to conduct socioecological studies. One of the more dominant studies showed that the \$85 billion infrastructure boom from 2003 to 2013 has shown an increase in air pollution and congestion,

but also job creation. This infrastructure boom has shown degraded human health and quality of life; a deteriorating environment; and inadequate public infrastructure [56][57]. The boom of infrastructure may result in individuals with less financial means to be left behind through higher mortgage and rent. This could ultimately lead to fewer numbers of public housing and community spaces. A part of this movement is contributed directly from the government legislation and policies to develop Ontario's green belt places. The research shows that with the rise of Ontario's population, the population has wanted a more affordable place to live, which are generally in the suburbs and outlying communities, and thus lead to an increase in commute times and GHG emissions. These emissions have led to degrading air quality near major transportation infrastructure. Therefore, the intricacies of many overlapping topics have forced policymakers to develop sustainability policies to generate sustainable growth.

Although Ontario has shown a significant surge in housing infrastructure in the last couple of decades, the challenge Ontario has faced is adapting net-zero strategies at the building level. For example, the majority of the GHG reduction within the last decade is due to the reduction of fossil fuel use, not due to electrification, and deploying passive and active strategies at mass housing. In fact, in Ontario, there are several barriers when it comes to owning or building sustainable housing property. Research conducted by Singh et al., (2019), states there were three major barriers when it came to constructing net-zero housing: (1) extra capital cost compared to conventional cost, (2) lack of technical knowledge, and (3) not knowing other individuals who own a net zero home [58]. The research further suggests that policymakers should promote net-zero housing construction and engage in trust-building initiatives (operational cost savings, and environmental sustainability). There is scepticism of green technology being cost-effective in the long run. Therefore, through building public relationships and investing into green technology, the government can reassure the general public on the potential savings in the long run.

2.2.2.3 Employment

Job creation is the dominant view when it comes to social justice and the green movement. It supports the idea of the green movement creating demand in the market and allowing individuals to grow in a career that supports the demand. When it comes to adapting green infrastructure, the focus is on government subsidies and policies. For example, Boromisa, et al. (2015), believes that the implementation of a "green" concept is dependent on local circumstances (economic, political, and social) [59]. Globally, social improvement through employment is significantly skewed based on local circumstances. For example, in a more developed region, sustainability policies are intended to be shown as a method of potential growth and prosperity, however in developing, labour-intensive countries, sustainability policies are not heavily focused on job creation.

3.0 Methodology

Outlined in these sections are the interview process and analysis of data gathered through interviews with sustainability experts. During this research, extensive measures were taken to ensure the privacy of potential interviewees was protected. The research was approved by the Research Ethics Board (REB) at Toronto Metropolitan University (TMU).

3.1 Interview Process

The interview process with potential candidates was completed in two major steps: (1) reaching out to potential participants seeking their approval to be interviewed, and (2) a one-on-one interview. The first step was to provide an outline/metric that allowed the researcher to determine if a potential candidate is qualified to be interviewed. The second step was to outline the details of the interview (length, questions, and medium).

3.1.1 Reaching out to the potential participants

The ideal candidates for this project were determined to belong to either academia or industry related to the building sector. The expert's job must be related to construction, sustainable planning or commissioning, or policy creation or implementation.

For this research, it is understood that most sustainability scholars and experts may not have a deep understanding of relating sustainability policy to equity-seeking groups. Additionally, potential participants might not belong to a demographic background considered equity-seeking. Therefore, their opinions on the impacts of sustainability policies on equity-seeking groups may be biased. However, for the overarching success of the entire research project, it was essential to identify, and if possible, quantify the changes resulting from amendments, creation, and implementation of sustainability policies. Once the information had been gathered from the academic and industry experts, a future research project might focus on equity-seeking groups to identify how sustainability policy changes affects them.

For this project, the relationship with the Ontario Society of Professional Engineers (OSPE) was leveraged to hand-pick experts that were most suitable from industry as sustainability policy experts. Whereas the academic experts were selected based on a thorough investigation of different research groups and post-secondary institutions' websites. To narrow the list of academic experts, their recent contributions to the building sector were assessed. Additionally, the experts from industry were found through word of mouth and OSPE's network. Through the help of Sandro Perruzza, CEO of OSPE, Chair of the Workforce 2030 Coalition of the Canadian Green Building Council (CaGBC) and former Chair of the Construction and Design Alliance of Ontario (CDAO), connections to industry experts in the green building sector were made, and requests to be interviewed were sent to select experts..

An invitation to the potential participants was sent via email, which included a short description of the proposed project, a researcher introduction, and a Google form which asked the following questions:

Q1: Are you interested in the proposed research?

- Yes
- No

Q2: Do you agree to be interviewed for the research topic entitled "The Perceived Impacts of Engineering Sustainability Policies within the Building Sector on Equity Seeking Groups in Ontario"?

- Agree
- Do Not Agree

Q3: Would you be interested in the research outcomes of the proposed research?

- Yes
- No

Dr. Lee Weissling, Senior Research Officer at OSPE, Dr. Medhat Shehata, Associate Dean, Teaching and Outreach at the Faculty of Engineering and Architectural Science at Toronto Metropolitan University, and Nika Zolfaghari, Manager of Equity and Community Inclusion at the Faculty of Engineering and Architectural Science at Toronto Metropolitan

University, were consulted throughout this research to ensure that appropriate measures were applied during different stages (e.g., invitations for the interviews, questions asked during interviews, data collection, and data analysis) of the research. Additionally, bi-weekly meetings were held to discuss the research progress and timing.

3.1.2 One-on-one interviews

One of the most crucial components of the research was to complete one-on-one interviews with sustainability experts. This procedure allows for a deeper understanding of the perceived impacts of sustainability policies on equity-seeking groups. The potential industry and academic experts needed to have a minimum of five years work experience in the sustainable building industry. For this research, sustainability policy experts were identified as individuals that have completed extensive research work on sustainability policies.

To ensure flexibility with timing and location, all interviews were conducted via an online platform such as Zoom, Microsoft Teams, or Google Meets. The target number of sustainability experts interviewed was 20 individuals, although 10 were interviewed. Each interview lasted for approximately 20 – 30 minutes, although if the expert wanted to continue conversation, they were accommodated. During the interview scheduling phase, a package was sent to the experts to let them understand the overarching objectives of the proposed research and their role as experts.

The following interview questions were prepared as a guide for the interview and may change in the future based on the recommendations of the Research Ethics Board (REB) Committee. Interviews were recorded, with the interviewee's permission.

General Questions:

Q1: Which types of sustainability policy do you think are going to be most impactful in the housing sector? Why?

Q2: Is there a specific policy that you think may have a bigger impact than others, when it comes to inclusion of all?

Perceived Impact on Equity-seeking Groups:

Q3: In your opinion what do you think is going to be an important impact of these sustainable policies on equity-seeking groups?

Employment Questions:

Q4: What are the possible new employment opportunities for the equity-seeking groups you see with the implementation of sustainable policies in Ontario?

Q5: What kind of skills do you think people of the employee status need to learn to find employment in the sustainability housing sector?

Q6: On a scale of 1 to 10, 1 being not important at all, 10 being extremely important, how important is English proficiency within the green building sector?

Q7: Where do you see the rise in employment opportunities due to the various types of building sustainability policies?

Identifying Perceived Socioeconomic and Cultural Barriers:

Q8: In your opinion, what are the barriers to equity-seeking communities contributing to the green movement in the building sector?

Question 9 is expert specific:

Q9 (Academia Research): Have you been involved in sustainability policy implementation or research?

If yes, did you consider its impact on the equity-seeking groups?

If not, how would you consider including equity-seeking groups in your involvement?

Q9 (Industry): Have you ever been involved in sustainability policy implementation or investigation for its impact?

If yes, did you consider equity-seeking groups in your study?

If not, how would you consider including equity-seeking groups in your involvement?

Q9 (Policy Experts): Have you been involved in sustainability policy construction, implementation or investigation?

If yes, did you consider equity-seeking groups in your involvement?

If not, how would you consider including equity-seeking groups in your involvement?

3.2 Qualitative Analysis

Data gathered during the literature review and one-on-one interviews were analysed in consultation with the project Co-supervisors and Advisor. The analysis included the justification of the impacts of sustainability policies on the building sector. It provided information on the perceived importance of this research from a sustainability expert's perspective. The responses from the interviews were analysed through a classical method. Qualitative coding was used to analyse the interview transcripts, which identified commonalities that appeared in multiple interviews. The overall objective of coding was to read transcripts or view recordings of different experts' interview answers to compare the points of view on one issue. It should be noted a manual grouping of answers was completed for this study. The objective of grouping similar answers showed a stronger correlation with the experts' opinions. The output of the analysis conducted through a classic method involved a manually tabulated summary to show strong correspondences with each expert's responses. An example of manual analysis is based on the following scenario and summarized in Table 4.

The Toronto Green Standards has a very stringent ask of energy use intensity, which may result in the use of better windows, therefore, increasing the overall buying price of the property. Let's presume that four out of five experts believe that stringent ask of energy use intensity will increase property costs then it will be shown in a tabular summary as follows.

Table 4: Example Analysis of Code Based on Hypothetical Scenario

Code (Common Theme)	Individual Experts' Opinion					Outcome
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	
Code 1: Stringent ask of Energy use Intensity due to Toronto Green Standard will result in increased house prices	Yes	Yes	No	Yes	Yes	80% or 4/5 of the Experts Agree with Code 1

4.0 Results and Analysis

The framework of results and analysis is completed by first providing the answers to the questions provided in Section 3.2.1 of this report, and secondly to take a deeper dive to elaborate the implications of the answers on equity-seeking groups. It is obvious to expect inherent bias of each individual around the topic of the green economy, sustainability, and green policy structure. As a result, it is crucial to note the diversity of the interviewee for transparency. For this research, 10 experts were interviewed, and their backgrounds are as follows:

- Energy and Policy – 4 Experts (4 Engineers)
- Social and policy – 2 Experts (1 Social Worker and 1 Engineer)
- Architecture – 2 Experts
- Construction and Trade – 2 Experts

4.1 Results and Analysis – General question

Q1: Which types of sustainability policy do you think are going to be most impactful in the housing sector? Why?

The interviewee's had a similar opinion when the above-stated questions were asked. The depth and justification of the answer varied based on experience, comfort, and time they had allotted for the interview. The overarching policies in favour of approaching Net Zero carbon were noted to be the primary factor that will increase the green movement. When asked for more detail, each person had a different approach, which resulted in various methods in which equity-seeking groups can be impacted. The following answers are field dependent.

- **Energy Background Experts:** Interviewees with an energy background stated that transformation is required for the green energy sector to foster, which is shown through step or tiered energy codes and objectives. A step code is noted as a voluntary target that reduces carbon emissions and energy consumption. In a step code, the “steps” can be referred to as “goals” that need to be achieved. Using British Columbia as an example, Step 1: Requires compliance with the base requirements of the BC Building Code, and Step 2: Encourages a 10% increase in energy efficiency compared to the base code. In the GTHA, the TGS also uses step energy demand matrices (EUI, TEDI, and GHGI) which need to be met. Generally, the experts believe that the impact of the step code implementation will be a higher cost of construction. Capital investment can negatively impact equity-seeking groups as it is speculated that rental prices will increase to offset construction costs.
 - One of the energy experts believes that there is not enough talk in recent times about *building better*, which means keeping construction costs the same or lower while satisfying energy step codes. This is the most optimal solution as there is a need to conduct advanced framing and detailing options to the construction cost. The step energy code overall provides financial benefits to all, as the operational cost of the building is lower.

One of the energy experts worked at an academic institution in the GTHA. The academic expert believes that there is a need to expand our codes to accept carbon reduction strategies. The rationale towards achieving net zero standards through code amendments is the most effective. The current National Energy Building Code (NEBC), National Building Code (NBC) and Ontario Building Code (OBC) are transitioning to adopt the step code approach. Although the current issue is that the change is extremely slow. This stems from multiple different levels (construction, supply chain, labour, and engineering). The adaption of step codes allows a steady transformation toward zero carbon and does not negatively impact equity-seeking groups financially.

- **Social and Policy Experts:** The experts with social and policy backgrounds believed that there is a larger impact on carbon zero goals that can be achieved through targeting new construction. The new construction industry will be heavily dependent on advanced materials and construction practices. Currently, there is a heavy reliance on subsidies from the government to support this transition. For example, both experts noted, that there is a focus on mechanical systems towards electrification. The modification to the HVAC system towards electrification is through providing subsidies for installing Heat Pumps. Generally, once the subsidies are exhausted, the burden of technology costs fall on the owner or renter. This creates a void in the system as the operational cost for the mechanical system is dependent on energy prices, which are internationally traded, and most individuals do not understand the cost. Furthermore, they and social experts believe that the greatest value that is added through the transition towards net-net zero is creation of employment opportunities.
 - An interesting comment was made by one of the policy experts as, currently, the focus on operational

carbon (carbon emissions associated with operating a building) is providing oversight on embodied carbon (embodied carbon emissions are associated with construction and material manufacturing). To address the carbon crisis, policies need to address both embodied and operational carbon. Once “we” as a society have figured out the embodied and operational carbon, we can consider the demolition and reuse of building materials.

- **Architecture Experts:** In architecture, the measure towards carbon neutrality and net zero are noted to make the largest difference. The choices made by reputable architects are driven by the motive of a clean environment. This is because the funding is transitioning into a green portfolio and green economy. The new sources of funding are demanding the transition to a green economy via hedge fund managers and stock investors. In addition to the funding, according to the experts, the focus should be towards a Carbon Tax and an optimized solution towards carbon and energy reduction with minimal financial impact. The financial impact will be crucial for cost reduction and minimal impact on society, more specifically equity-seeking groups. The experts strongly believe that if the move towards a green economy is costly, then there is a chance that not everyone will be able to contribute to the society.
- **Trades and Construction Experts:** The current movement towards net zero is going to make the largest impact in the near future. The rationale is because that is where most companies are investing their funding in training and support of green technologies. The dominant issue with the expense of green construction is that current training does not show how to reduce the cost yet construct green. Generally, green construction ends up using more materials, which inevitably increases the cost of the building. Additionally, if green construction needs to effectively take place in the industry, then the training received through school for all individuals needs to reflect it. By mandating green technologies within schooling, the transition mandated by the government will be smooth and effective such that everyone can participate.

Q2: Is there a specific policy that you think may have a bigger impact than others, when it comes to inclusion of all?

When asked to point out a single policy, the interviewees had a similar approach, where they focused on a concept rather than pointing out a single policy. The current policies are all interdependent on one another. As a result, each policy will focus on a particular sector with the common goal of transition towards carbon reduction.

- **Energy Background Experts:** The individuals with an energy background suggested that the stepwise sustainability system will have the largest impact on society. Step codes are usually temporal and target based. The BC energy step code is referred to by experts with energy backgrounds as a good example of what to expect. In their opinion, the codes will influence a lot of construction changes. However, these changes will need the building construction industry to reflect these changes. According to the experts with energy and policy backgrounds, the policies and governmental incentives will have to contribute to a common goal of carbon reduction. The incentives need to be addressed to the appropriate people. For example, the current subsidies for heat pumps are leading individuals to electrification.
- **Social and Policy Experts:** According to experts with social and policy backgrounds, the most influential sustainability policies have to do with HVAC systems. Social background individuals believed that the electrification of HVAC systems will effectively lead to a reduction of the carbon footprint. Other than electrification, social experts felt uncomfortable answering this question.
- **Architecture Experts:** Experts with an architecture background believed that any policy that institutes step codes will help propel sustainable practices forward. Both experts with an architecture background believed that step codes allow designers to address sustainability through prescribed targets.
- **Trades and Construction Experts:** Individuals with construction backgrounds stated that each policy has to work together to achieve sustainable practices. The worst possible scenario is when you have conflicting guidelines (for example, NBC being more liberal than OBC). Through more structured and standardised guidelines, adequate targets will be addressed and a smooth transition to electrification of technology will be made. Furthermore, the largest impact of the sustainable policies will be on HVAC systems. This is because HVAC systems are essential for electrification and clean technology.

Q3: In your opinion what do you think is going to be an important impact of these sustainable policies on equity-seeking groups?

According to Boston Consulting Group (BCG), the primary reason that many companies are failing to achieve their sustainability goals or contribute towards sustainable movement is lack of local talent. The experts during the interview also strongly agreed with BCG’s overall statement. The experts unanimously agreed that the largest impact through sustainable policy implementation was said to be through educational and employment opportunities. Previous policies

and standards, such as LEED, have already increased the workforce in sustainable infrastructure. The sustainability field is developing, therefore there is an increased opportunity for local talent to learn and find employment.

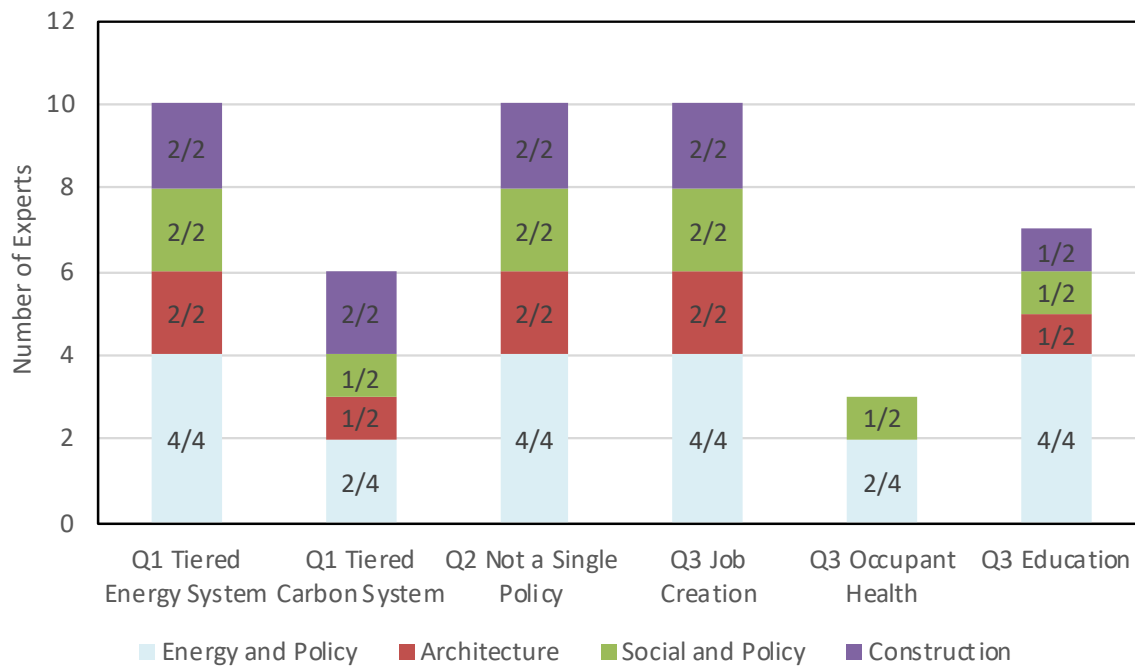
- **Energy and Policy Experts:** The experts from energy and policy backgrounds believed that job creation will be the primary opportunity associated with sustainable policies. These changes have already been a part of our society. For example, many codes and standards ask to construct an energy model. The energy models must show compliance for specific targets. As this practice is relatively new, many individuals are needed to have energy modelling skills to obtain a career. Skills development leads to educational improvement.
 - The other impact of sustainability policies on equity-seeking groups is through house and energy prices. House and energy prices will increase as more sustainability policies and targets are implemented. Generally, constructing a “green” building is noted to be more expensive, as it requires more, or better, materials compared to current common practices. Note this is only true with respect to the capital investment. The operational cost of a more sustainable building is a lot lower. One of the energy and policy experts feared the could be an increase in the gap between economic classes. This fear stemmed from the high capital cost of the initial investment discouraging lower income households from investing in green technology.
- **Social and Policy Experts:** Social and policy experts also believed that green policies in the building sector will increase employment opportunities. However, their take on employment opportunities was not just in the technical sector but in administrative jobs as well. Additionally, the rise in the sustainability sector will allow individuals an opportunity to change their career paths if desired.
 - A unique opportunity stated by a social and policy expert was regarding better indoor environmental quality. The increase in environmental quality will be important as it can foster better health and leads to faster recovery if an individual gets sick.
- **Architecture Experts:** Both architecture experts believed an increase in the employment and educational sector was needed with the rise of green policies. The job opportunities will be associated with novel skills in the green energy department. However, both experts stated the importance of education. Without the proper education, the built outcome will be extremely poor. Additionally, if there are not adequate educational opportunities given to the lower socioeconomic groups then there will be a greater disparity between the socioeconomic groups.
- **Trades and Construction Experts:** The experts believed that education is the key and will provide the greatest impact. Individuals need to know few skills to enter the industry and once an individual has entered the construction industry, their skills can be developed, leading to better employment opportunities.

Key Summary and Takeaways from General Questions:

- Policies need to work together for a common goal of sustainability.
 - All sustainable policies are market-driven (supply and demand).
 - Affordability with mass manufacturing of houses has a positive impact on build quality and affordability.
 - Governmental incentives play a major role in the implementation of technology.
- Tiered (Step) Codes will be impactful as there is an opportunity for everyone to participate and a common (usually temporal) goal is achieved.
- Carbon reduction policies and carbon tax credits will influence many investments (green portfolios) and incentivize green infrastructure.
- The sustainable construction industry will grow significantly -> resulting in huge job and skills upgrading opportunities.
- Sustainability policies provide guidance on improved occupant health.

A code-based analysis was conducted to visually represent the agreement of answers for each question (Figure 8).

Figure 8: The number of experts in agreement for common code under general questions



4.2 Results and Analysis – Opportunity question

Q4: What are the possible new employment opportunities for the equity-seeking groups you see with the implementation of sustainable policies in Ontario?

Two major routes for employment have been advised by many of the experts. The primary route is direct jobs within the construction sector (design, trades, engineering, and architecture). The secondary route is through adjacent jobs with construction (food and drinks shop owners, supply chain, manufacturing, and training).

- Energy and Policy Experts:** A major part of this question was answered during Question 3. Job opportunities will increase in the near future. Most job opportunities will be in the skilled trades sector. The number of skilled trades workers are on a steady decline and therefore there is always a demand for skill trades workers.
 - A novel employment opportunity was noted within the financial sector. The clean energy movement is directly related to finances, and without the financial backing through government subsidies and financial loans, green energy will never be developed. On that note, the expert noted that this is a common trend throughout history. The initial stages of the solar power industry had a relatively high price for solar panels, however with the constant improvement of technology the price dropped, and the efficiency of the solar panels increased. This trend will likely be followed by other green technologies.
- Social and Policy Experts:** The social and policy experts also believed that the greatest opportunity will be for skilled workers. However, both social experts pointed out the unions are being slow to provide licences as a potential risk for individuals to receive inadequate support. Furthermore, the social experts believe that equity-seeking groups will have a threat of slow acquisition of certification and licencing. They also believed that the lack of overarching study on market risk analysis is a major issue. The example used by an expert was of heat pumps. The expert referred to the multiple subsidies currently offered to install a heat pump in the effort to rely on electrification. Simultaneously there is a lack of research conducted on market supply chain of heat pumps. The lack of market research leaves the possibility for consumers having to pay more.
- Architecture Experts:** The architecture experts believed the greatest opportunity will be finding employment related directly to construction. For example, traditional “blue-collar” jobs will see an increase in skilled trades and “white-collar” jobs will see an increase in designing jobs. The key to the implementation of sustainable technology is based on having an adequate and qualified workforce.
- Trades and Construction:** These experts were in complete agreement that the sustainability movement allows individuals to develop new skills that can be further enhanced through finding new employment. The experts believe that education standards need to change, and more individuals need to receive incentives to obtain certification.

One of the construction experts believed that the educational piece needs to be improved to implement the most updated buildings.

Q5: What kind of skill do you think people of the employee status need to learn to find employment in the sustainability housing sector?

As the employment opportunities are in the sustainability sector, the range of skills required to ensure we have an adequate workforce to influence a larger change varies significantly. The most common answer provided by many of the experts was related to skilled trades. The skilled trades have the largest possible employment scope as they need to understand how to build through using sustainable guidelines. In addition to skilled trades and designer skills, the financial aspect of funding building construction plays a massive role as well. For example, the experts believed that these buildings will be constructed a lot more if there was financial backing. Some experts said that they have noted this change taking place in urban centres already.

- **Energy and Policy Experts:** The fastest method of finding employment is believed to be through obtaining skilled trade certification. The experts also believed that there is a greater need for project management and organizational-based skilled jobs on construction sites. On the other hand, if an individual wants to obtain a design position, then the core principles of maths and sciences should be learned.
 - The current training protocols are a huge cost to companies, which poses a clear barrier for smaller firms to train their employees. Current government aid does not provide sufficient backing for smaller firms to absorb training costs.
- **Social and Policy Experts:** The social and policy experts strongly believed that the largest employment opportunity will be with skilled trade workers. The important factors that need to be addressed for more workers to start working in skilled trades are the union licencing process, gender inequality, and benefits.
- **Architecture Experts:** Following the skilled trades, designer jobs (for example architecture, engineering, and project management) will need to be understood from a sustainability perspective. Constructing a single building is noted to be a difficult task and entails many industries working together. The skills required to build a building will have to be analysed with a sustainable lens. For example, electricians need to understand what the best method of wiring is to reduce the embodied carbon impact by using less material.
- **Trades and Construction Experts:** The individuals from skilled trades believed that the largest opportunity is working in construction sites. Their rationale is due to the large demand of construction work to be completed to meet market needs. The construction experts stated that there will be opportunities in all departments (skilled workers, designers, finance, and administration). Furthermore, employees will have to adapt to a society that is changing rapidly and improving constantly.

Q6: On a scale of 1 to 10, 1 being not important at all, 10 being extremely important, how important is English proficiency within the green building sector?

Many experts believed that English proficiency is essential for obtaining employment, maintaining employment, and receiving a promotion. Therefore, the experts rated English proficiency from 8-10 on the most important scale.

- **Energy and Policy Experts:** The energy and policy experts believed that everyone needs to be able to communicate their thoughts and ideas. Communication skills in the energy sector are extremely important as individuals need to read, write, and speak design terminology to work within a team.
- **Social and Policy Experts:** The social and policy experts believed that everyone needs to understand how to speak English to effectively participate in the green movement. Through English proficiency, an individual can participate at any level. Additionally, communication skills are needed as most of the training programs in Canada are conducted in English.
- **Architecture Experts:** The architecture experts believed that there is a need for English proficiency, but this is strictly dependent on the job you have. For example, “if your work is in small scale residential where you must deal with a lot of clients then you need to know English professionally”; whereas, “if you work in the large building construction where you are required to report and follow instructions of your co-workers then you need to know the basics of English such that you can communicate your thoughts and understand the instructions”.
- **Trades and Construction Experts:** The construction and skilled trades experts believed that communication skills are deeply needed in the field. Sustainability policies require the use of new green construction technology, which needs new training to be completed. Training and fieldwork with new technology require no language barriers.

Q7: Where do you see the rise in employment opportunities due to the various types of building sustainability policies?

The experts noted that the biggest increase in job opportunities will be in the skilled trade market. Despite the constant promotional work completed by the government, the skill trades are on a steady decline. The experts believed that the steady decline in skilled trades jobs will result in a slower construction rate, which may result in greater demand and lower supply, increasing housing prices.

- **Energy and Policy Experts:** According to energy and policy experts, the rise in employment opportunities will be in skilled trades. Skilled trade workers are required to construct any building effectively. The energy experts believed that current immigration channels need to be further explored to effectively fill the need for skilled trades. For example, since there is a clear need for skilled trades workers, immigration agencies need to work with contractors to bring in workers with the required skills. Integrating immigration services within the construction industry can help speed up needed construction.
- **Social and Policy Experts:** Social and policy experts also believed that the skilled trades would have the greatest employment opportunity for two reasons: (1) the construction industry relies heavily on the skilled trades work to complete a project more effectively, and (2) a construction project generally has more skilled trades and management teams working together compared to design teams.
- **Architecture Experts:** Currently, there is a huge demand for skilled trade workers in mechanical and structural building construction. The experts with architectural backgrounds believed that the gaps in the skilled trade workforce are not going to decrease in the foreseeable future.
- **Trades and Construction Experts:** The opinions of the architecture experts were identical and shared by the trades and construction experts.

Key Summary and Takeaways from Opportunity Questions:

- Although all experts believed that skilled trades will be the most impactful in constructing sustainable buildings, their justification for this differed based on the experts' backgrounds.
- There is a huge need for trained skilled trades workers in every sector; however, there are multiple issues to consider:
 - Trades licences are hard to obtain.
 - Depending on the type of position, skilled trade workers need to know how to communicate well to find employment.
 - Better marketing and recruitment across borders needs to be prioritised to capitalise on immigration channels.
- There will be plenty of employment opportunities both in primary (skilled trades, design, engineering...) and secondary (manufacturing, supply chain, finance...) employment sectors related to construction.

A code-based analysis was conducted to visually represent the agreement of answers for each question in Figure 9 and 10.

Figure 9: The number of experts in agreement for common code under opportunity-based questions

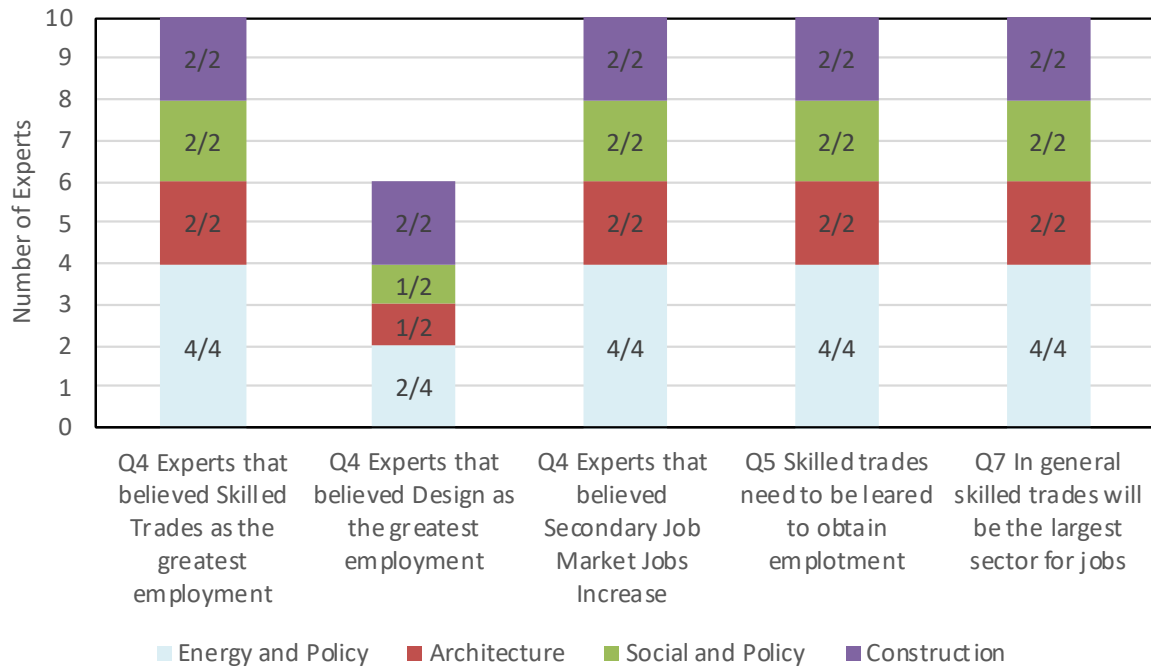
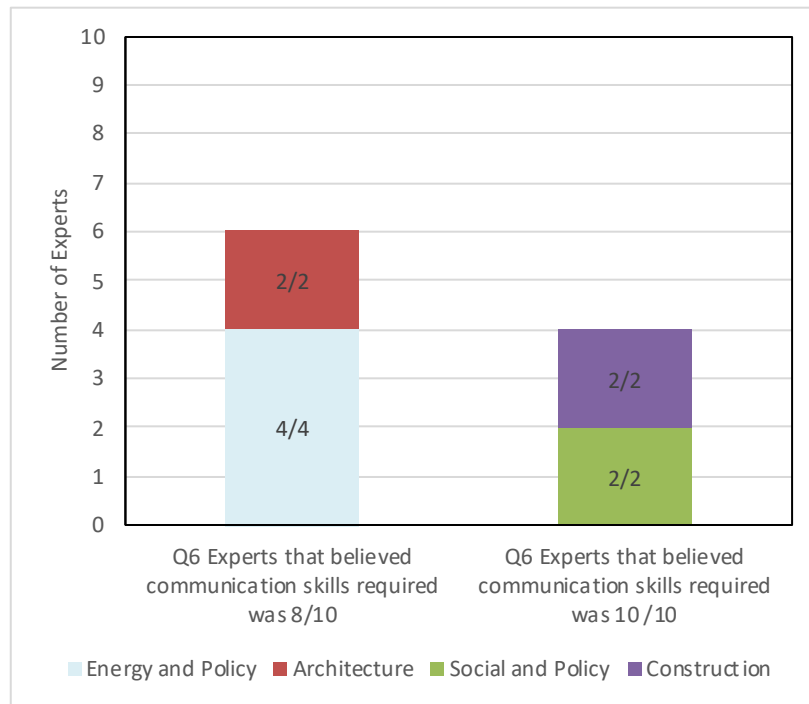


Figure 10: The number of experts assumptions on the importance of communication skills



4.3 Results and Analysis – Perceived Socioeconomic and Cultural Barriers

Q8: In your opinion, what are the barriers to equity-seeking communities contributing to the green movement in the building sector?

This question elicited multiple opinions. Perceived barriers depended on the type of participation in sustainable buildings by equity-seeking groups. For example, if equity-seeking groups are being asked to participate as homeowners, then the

issue might be financial, language barriers, or trust. Whereas, if equity-seeking groups are seeking employment in the sector, then the issue might be more towards lack of skills or financial constraints for training in skilled trades.

- **Energy and Policy Experts:** The experts in energy and policy believed that the biggest issue with equity-seeking groups' contribution to the green technology movement is the financial burden. As green technologies cost more, most equity-seeking communities may not have the capability of bearing the costs involved.
- **Social and Policy Experts:** The social and policy experts believed the biggest gap preventing involvement of equity-seeking groups in the green movement is the lack of awareness of government funded programs. For example, government subsidies are available to provide a good opportunity for equity-seeking groups to participate by being a consumer or obtaining training within the green sector.
- **Architecture Experts:** These experts agreed with social and policy experts. In addition, they commented on trust being a key issue. One expert believed that for equity-seeking groups the largest issue is a lack of trust and not knowing if there are individuals who are actively seeking to take advantage of them. For example, the expert stated an anecdote from the late 1990s.
 - *The architecture expert had found employment in the energy audit sector. The architecture expert had been appointed to the downtown Toronto core dominated by immigrants from China. In the year of energy audits, all pamphlets explaining the free energy audit process were written in English, and in the second year, the pamphlets were translated into Cantonese. The number of individuals that participated in the audit program doubled once the language changed. Therefore, this shows that building trust is essential if the government is seeking to develop a healthy relationship and gather everyone's participation.*
- **Trades and Construction Experts:** Construction and skilled trades experts believed the major barrier to participation stems from a lack of clear guidance provided by the government. Currently, there are so many programs that can help with sustainability participation, however the lack of outreach results in a lack of awareness.

Q9 Have you ever been involved in sustainability policy implementation or investigation for its impact?

Nine out of 10 experts have not been involved in drafting sustainable policies, and four out of 10 experts were knowledgeable enough to comment on the policies. All 10 of the experts had not worked on policies pertaining to equity-seeking groups. Most of the experts said they were using the policies as a framework for design. For example, using BC Step Code as a guideline to achieve energy and carbon reduction strategies in designing houses in Vancouver.

Key Summary Takeaways from Socioeconomic and Cultural Barriers Questions:

- The obvious barrier is financial:
 - Generally, the norm within the industry is "if it is sustainable, then it is expensive".
 - Capital investment is always going to be an issue when selling sustainable alternatives as they require an improved standards.
 - Government subsidies will play a huge role in providing a sustainable market share to sustainable practices.
 - Market trends will either drive the price of buildings up or down
- Trust and lack of awareness contribute to the lack of participation.
 - Multi-language flyers and ads are important – which we are seeing a lot more of and are effective communications tools.

5.0 Conclusions and Future Work

The evident climate change threats have pushed sustainability policies to the forefront of modern-day society. Sustainability policies work by adapting to the local context and govern the steps society should take to better achieve the common goal of carbon reduction. The building sector is at the centre of carbon reduction strategies for the GTHA. Included in this report are the literature review and interviews with experts to understand the perceived impact of sustainability policies on equity-seeking groups. The literature review was conducted on academic publications and government documentation to note the policies and programs available within the sustainability sector. Interviews were then conducted with ten experts specializing in Energy & Policy, Social & Policy, Architecture, and Trades & Construction.

Key results and findings:

- Based on the literature review and interviews with experts, there is a clear need for sustainability policies to be focused on technical aspects such as reducing greenhouse gas emissions or energy consumption. By focusing only on technical aspects, clear and concise targets can be provided for designers to meet standards while constructing or retrofitting a building. The focus of sustainability policies is driven through economic aspects. For example, the extra capital costs due to increased insulation used for a better thermal envelope will result in a lower operational cost due to space conditioning energy savings. As sustainability policies are heavily invested in technical specifications, it is difficult for the policies to also factor in equity-seeking groups. Furthermore, when the experts were asked about the inclusion of equity-seeking groups, they were not comfortable answering in details. This opens doors for social and technical experts to work with each other to guide policies that are better suited for the overarching goal of inclusivity of equity-seeking groups. For example, all experts agreed that the general norm with constructing for sustainability is that capital costs will increase, which, in turn may increase rents. There needs to be policies that accounts for this burden, and it should not fall on the shoulders of a renter.
- Another conclusion was made on the opportunity of individuals to participate in the sustainability movement by finding work in this sector. The primary jobs are in the skilled trades and designing jobs. In addition to the job market, there is an opportunity to obtain new knowledge through pursuing education.
 - Equity-seeking groups will need assistance to acquire additional educational skills. There are current programs such as BuildingUp to help individuals in the GTHA to get appropriate skills and mentoring.

In addition to key conclusions, there are specific findings derived from the general, opportunity-based, and socioeconomic and cultural barriers questions asked during the interviews. The following is a summary:

General questions:

- The overarching goals of meeting Canada's 2030 and 2050 carbon reduction goals will drive most of the policies forward. The design and energy experts further stated that the emphasis should be placed on the step codes to reduce energy consumption and carbon emissions. This movement towards step codes will result in many policies and incentives leading to carbon emission or energy consumption reduction. Step codes have a mandate to promote better energy-conservation in buildings.
- All policies need to work together to achieve a sustainable future. All experts stressed there will not be any focus on a single policy.
- Another factor that will play a role towards a more sustainable infrastructure are green investment portfolios. Green investment portfolios will need to require carbon reduction strategies and cleaner energy production strategies to obtain investment. According to architecture experts, new sources of funding are demanding the transition to a green economy via hedge fund managers and stock investors. In addition to the funding, the focus should be towards a Carbon Tax and an optimized solution towards carbon and energy reduction with minimal financial impact.

Opportunity-based questions:

- There will be a rise in employment due to the green movement. The rise will be directly in construction through primary jobs related to skilled trades, design, and finance. Additionally, there is a strong likelihood there will be an increase in the secondary job market which includes employment in the supply chain, manufacturing, education, and training. Both primary and secondary job opportunities will benefit equity-seeking groups, as there is an opportunity to change career paths or evolve into a surging field to find employment.

- The rise of employment within the construction industry stems from the existing building stock not being sufficient to provide housing to the public. The increase in population within the GTHA will result in an increase in building construction.
- Skilled trades will have the largest opportunity for employment. Currently, there is a huge demand in the industry for skilled trades workers. The green movement will only increase the need for them as more employers will be seeking specialised skilled trades workers to help construct green buildings.
- In addition to employment opportunities, there is a huge opportunity for everyone to learn new skills by pursuing educational opportunities to find employment in the sustainability sector.

Socioeconomic and cultural barriers:

- The social and policy experts believed the biggest gap preventing the involvement of equity-seeking groups in the green movement is the lack of awareness of government-funded programs. They believed this stems from a lack of understanding or interest in the subject, whereas the energy and policy experts believed that the biggest issue with the green technology movement is the financial burden faced by equity-seeking groups.
- An example of building trust within equity-seeking groups is that participation in an energy benchmarking survey drastically increased when the survey was provided in the mother-tongue of the participant.

Areas of future research include (but are not limited to) the following:

- This report is based on a six-month project, where the objective was to focus on the impacts of the policies on equity-seeking groups based on industry experts' opinions. However, there is always a need to identify the opinion of equity-seeking groups on green policies. Through the results of equity-seeking groups' opinions and experts' opinions, a comparison can be made to identify the gaps within the system.
- Although it is clear that new job opportunities will increase from implementing sustainability policies, there is a need to understand the distribution of new jobs projected per sector. This would be important to study so individuals can make informed decisions when seeking employment.
- A potential future study could investigate the potential impact of implementing sustainability policies on mortgages and rent. As noted through the literature review, a large component of sustainability is to examine its affordability. Furthermore, green technology is generally more expensive compared to common construction practices. Generally, the extra costs will fall on the property owner, or renter, which results in an increase in mortgage or rent payments. Additionally, in the long-run, improvements due to sustainable policies should decrease operational costs. Both capital and operational costs have an impact on affordability. Therefore, there is a need to investigate the potential impacts of implementing the sustainability policies on affordability.

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Appendix A – Potential participants interview consent form



Potential Participants' Interview Consent Form

Toronto Metropolitan University

Consent to Participate in Research

Study Title: Engineering Sustainability Policies within the Building Sector in Ontario as a Basis for Impact on Equity Seeking Groups

INTRODUCTION AND PURPOSE

My name is Yash Vyas. I am a graduate student at Toronto Metropolitan University, working with Dr. Medhat Shehata, Professor of Civil Engineering and Associate Dean, Teaching and Outreach. I would like to invite you to take part in my research study, which concerns the impact of sustainability policies within the building sector in Ontario. More specifically, this study will investigate what changes to the current and upcoming sustainability policies would mean for the construction industry from academics' and industry experts' knowledge.

The purpose of this study is to investigate the engineering sustainability policies within the building sector in Ontario as a basis to determine their impacts on equity-seeking groups. More specifically, this study will investigate what changes to the current and upcoming sustainability policies would mean for the construction industry from academics' and industry experts' knowledge. Furthermore, the proposed research will explore the overarching advantages, disadvantages, and risks associated with sustainability policies on equity-seeking groups, which includes the potential for economic growth and employment opportunities.

Appendix A1 – Shows the abstract of this research along with an introduction of the researchers.

WHAT YOU ARE BEING ASKED TO DO

You are being asked to voluntarily complete an interview with the researcher. The purpose of the interview is to understand the impacts of current and future sustainability policies for the demographics of Greater Toronto Hamilton Area (GTHA). Your expert perspective on the common trends developed through implementing the current and future research area will result, as an expert's voice on the subject matter.

POTENTIAL BENEFITS

It is hoped that the research will benefit the building construction industry in Ontario, by outlining the perceived impacts of sustainable construction policies. These impacts will form the basis to understand the relationship between sustainability policies and their impact on building construction, and people living in GTHA.

WHAT ARE THE POTENTIAL RISKS TO YOU

Some of the survey questions may make you uncomfortable or upset or you may simply wish not to answer some questions. You are free to decline to answer any questions you do not wish to answer or stop participating at any time by closing your browser.

YOUR IDENTITY WILL BE SAFE

The invitees to enter the survey act as experts in the building construction industry. The experts of this survey are manually selected based on their specialties and the impact of this research. The answers provided by the interviewees will not be shared with anyone. The answers provided will be generally assessed to obtain general trend in the industry.

HOW YOUR INFORMATION WILL BE PROTECTED AND STORED

The interview uses a Google Form to track notes taken during the interview. Google Form is provided by Google, which is a United States of American (USA) company. Consequently, USA authorities under the provisions of the Patriot Act may access the survey data. If you would rather participate with an email or paper-based survey, please contact the researchers. Please note email or paper-based surveys may allow your identity to be known to the researcher/s but if you select this option your information will be kept confidential.

To further protect your information, data stored by the researcher will be password protected and/or encrypted. All data will be stored on Google Drive. Only the researchers in this study will have access to the data. Any future publications will include collective information (i.e., aggregate data). Your responses (i.e. raw data) will not be shared with anyone outside of the research team. When the research is completed, the researcher/s will keep the data for up to 2 years after the study is over.

YOUR RIGHTS AS A RESEARCH PARTICIPANT

Participation in research is completely voluntary and you can withdraw your consent at any point during the interview process. Participants are allowed to request a withdrawal up to 7 days after the interview is conducted. If a participant wants to withdraw within 7 days after the interview is conducted, the data collected during the interview will be completely destroyed and discarded from the study. Please be advised that your participation is voluntary and that you will not receive any financial benefits in return for your participation.

The data from the interview will be kept under complete confidentiality. Additionally, if any question makes you uncomfortable during the interview, you can skip that question. Under the circumstances of withdrawal, the data provided by the participant will NOT be included in the analysis. Additionally, withdrawal from the study will not influence future relations with the researchers, Toronto Metropolitan University, and OSPE. Currently we are seeking for 20 industry experts to participate in these interviews.

INDUSTRY FUNDING AND RESEARCH TEAM

This research is conducted at TMU and funded by Ontario Society of Professional Engineers (OSPE), and Mitacs. The research team includes:

- Principal investigator: Dr. Medhat Shehata, Professor, Associate Dean, Teaching and Outreach, TMU
- Industry Research Project Liaison: Dr. Lee Weissling, Senior Research Officer, OSPE
- EDI Research Liaison: Nika Zolfaghari, Manager, Equity Diversity Inclusion, TMU
- Researcher: Yash Vyas, PhD Candidate, TMU

Questions about the Study

If you have any questions about the research now, please ask. If you have questions later about the research, you may contact:

Researcher – Graduate Student

Name: Yash Vyas, MSc, BSc

Building Science PhD Candidate

Faculty of Engineering and Architectural Science

Toronto Metropolitan University

e-mail: yash.p.vyas@torontomu.ca

Primary Investigator

Name: Dr. Medhat Shehata, P.Eng, FCSCE

Professor of Civil Engineering

Associate Dean, Teaching and Outreach

Faculty of Engineering and Architectural Science

Toronto Metropolitan University

Phone: 416 979 5000 ext 552152

Fax: 416 979 5308

e-mail: mshehata@torontomu.ca

This study has been reviewed and approved by the Toronto Metropolitan REB (REB 2023-046). If you have questions regarding your rights as a participant in this study, please contact:

Research Ethics Board

c/o Office of the Vice President, Research and Innovation

Toronto Metropolitan University

350 Victoria Street

Toronto, ON M5B 2K3

416-979-5042

rebchair@torontomu.ca

DATA DISSEMINATION METHODS

The results of the research will be published through two methods: (1) a Project Report, and (2) Research Articles. Additionally, a webinar will be conducted to spread the knowledge gained through the proposed research. More information on deliverables is noted under the expected deliverables subsection of the proposal. Summary of final project report will be sent by email to the participants (a max of 20).

ADDITIONAL NOTES FOR PARTICIPANTS

To confirm participation, please provide signature on the next page and submit the signed copy via completing the google form. Currently we are seeking for 20 experts to participate in these interviews. The either in-person or virtual interviews will last for 30-minutes. At the time of the interviews, the participants are requested to select a location with aural and/or visual privacy. This will help the participants by maintaining privacy and security, while reducing background noise and distraction.

- If the interviews are to be held in person, the participants are required to follow Toronto Metropolitan University's COVID 19 policies.

SUBMISSION OF CONSENT FORM

The research team would like to thank you for considering to participating in this project. To maintain confidentiality, please submit the undersigned document to the following google form.

(Google Form Link: <https://forms.gle/AHL83WypH8pMeLZG8>)

CONFIRMATION OF AGREEMENT

Your signature below indicates that you have read the information in this agreement and have had a chance to ask any questions you have about the study. Your signature also indicates that you agree to participate in the study and have been told that you can change your mind and withdraw your consent to participate at any time. You have been given a copy of this agreement.

You have been told that by signing this consent agreement you are not giving up any of your legal rights.

Name of Participant (please print)

Signature of Participant

Date

I agree to be audio-/video-recorded for the purposes of this study. I understand how these recordings will be stored and destroyed.

Signature of Participant

Date



Appendix A1 – Research Abstract and Researcher Introduction

Research Abstract:

The building sector accounts for 36% of end-use energy consumption in Ontario, making it the centre of urban sustainability plans and policies. Along with the increase in the emphasis on the green movement, Ontario has seen a constant rise in the equity-seeking communities' population (15.8% in 1996 to 29.3% in 2016). Recognizing that sustainability policies are encompassing all Ontario residences, the degree to which these policies could impact equity-seeking groups from sustainability experts' perspectives is of question. The objective of this study is to investigate the engineering sustainability policies within the building sector in Ontario as a basis to determine their impacts on equity-seeking groups. More specifically, this study will investigate what changes to the current and upcoming sustainability policies would mean for the construction industry from academics and industry experts' knowledge. Furthermore, the proposed research will explore the overarching advantages, disadvantages, and risks associated with sustainability policies on equity-seeking groups, which includes the potential for economic growth and employment opportunities. During this research, multiple interviews with sustainability experts from academia and the building industry will be conducted. With the focus on the impacts of the sustainable movement on equity-seeking groups in Ontario, the research is to be completed in three phases: (i) literature review, (ii) interviews with sustainability experts, and (iii) analysis of data to complete the objectives of the proposed research.

PI Introduction (Dr. Medhat Shehata, Professor, Associate Dean, Teaching and Outreach):

Dr. Shehata has been involved in the Toronto community for discovering sustainable concrete solutions for last few decades. His traditional research work falls under sustainable materials specialised in concrete infrastructure. His passion for sustainability stems from his experience as a professional researcher and childhood interest of massive structures. At a very young age, Dr. Shehata learned that concrete itself must have dual functions: both strengths to withstand pressure and durability to maintain performance over time. He became more interested in durability and now mainly focuses on developing test methods to predict the service of concrete in the field, to evaluate deteriorated structures, and to identify the best construction and repair materials. Through the fascination of sustainable infrastructure, Dr. Shehata has evolved his research to understand sustainable building policies, more specifically, the impact of implementing sustainable policies.

Researcher Introduction (Yash Vyas, Building Science PhD Candidate):

After completing his Bachelor of Applied Science from the University of Waterloo in 2018, and Master of Applied Science in Building Science at Toronto Metropolitan University in 2020, Yash has decided to continue on an academic trajectory by pursuing Building Science PhD program at Toronto Metropolitan University. Yash has three years of industry experience working in sustainable infrastructure, stormwater management, and building restoration. In his PhD research, Yash has focused on sustainable infrastructure by the use of novel materials and passive strategies, and sustainability building policies by examining current and future sustainability policies. During his PhD, Yash has pursued building science research and teaching opportunities professionally and in academia including teaching sustainable infrastructure concepts and energy modelling software to Masters students and industry professionals.

Appendix B – email sent to potential participants



Study Title: **Engineering Sustainability Policies within the Building Sector in Ontario as a Basis for Impact on Equity Seeking Groups**

For this research, the experts will be hand-picked from the OSPE's (our research industry partner) database and online review of academic and industry profiles. As the individuals are hand-picked, they will be contacted via email requesting their participation in the research project. Enclosed in the email will be a brief introduction and consent form. The following text will be emailed to the potential experts for this research.

Start of Email

Dear Expert (Name to be changed per expert),

I hope this email finds you well. I am, Yash Vyas, a Building Science PhD candidate at Toronto Metropolitan University (TMU). I am writing this email to invite you to participate in the research titled "Engineering Sustainability Policies within the Building Sector in Ontario as a Basis for Impact on Equity Seeking Groups". The key objective of this research is to investigate the changes in the current and upcoming sustainability policies. Moreover, this research will identify the overarching advantages, disadvantages, and risks associated with the implementation of sustainability policies.

I would like to invite you to participate in a short 30-minute interview, either in-person or virtually, to understand the impacts of policy changes from your perspective. I have attached the interview consent form to provide a holistic vision of the research project, and rationale for your participation. Your participation is completely voluntary. Participants are allowed to request a withdrawal up to 7 days after the interview is conducted. In the event that a participant wants to withdraw within 7 days after the interview is conducted, the data collected during the interview will be completely destroyed and discarded from the study. Additionally, your identity will not be revealed, and the interview documents will be kept in a safe place until the project is completed. The documents will be deleted, one year after completion of the project.

This research is conducted at TMU and funded by the Ontario Society of Professional Engineers (OSPE) and Mitacs. This study has been reviewed and approved by the Toronto Metropolitan Research Ethics Board (REB 2023-046). The research team includes:

- Principal investigator: Dr. Medhat Shehata, Professor, Associate Dean, Teaching and Outreach, TMU
- Industry Research Project Manager: Dr. Lee Weissling, Senior Research Officer, OSPE
- EDI Research liaison: Nika Zolfaghari, Manager, Equity Diversity Inclusion, TMU
- Researcher: Yash Vyas, PhD Candidate, TMU

Please let me know if you would like to participate in the research project by signing the interview consent form and uploading it to [Google Form](#). Currently we are seeking for 20 industry experts to participate in these interviews.

If you require any additional information, please do not hesitate to contact me. I would be more than happy to help you.

The following is the contact information of the research team at TMU.

Yash Vyas, MAsc, BASc

PhD Candidate, Building Science

E: yash.p.vyas@torontomu.ca

Department of Architectural Science

Faculty of Engineering & Architectural Science

Toronto Metropolitan University (Formerly Ryerson University)

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Toronto Metropolitan University (Formerly Ryerson University)

Phone: 416 979 5000 ext 552152

Fax: 416 979 5308

e-mail: mshehata@ryerson.ca

Kind regards,

Yash Vyas

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Yash Vyas, MAsc, BASc

PhD Building Science Candidate

E: yash.p.vyas@torontomu.ca

Department of Architectural Science

Faculty of Engineering & Architectural Science

Toronto Metropolitan University

(Formerly Ryerson University)



End of Email