TORONTO

Economic Development and Culture

Economic Potential and Workforce Requirements in Toronto's Net Zero Strategy

Evaluating Six Market Areas

February 2024

This report was only possible due to the insights, guidance and knowledge of all City of Toronto staff who provided significant feedback throughout the entire project. From the review of project scope, mountains of data, and initial drafts to considerable consultation and connections to market stakeholders, staff provided invaluable support.

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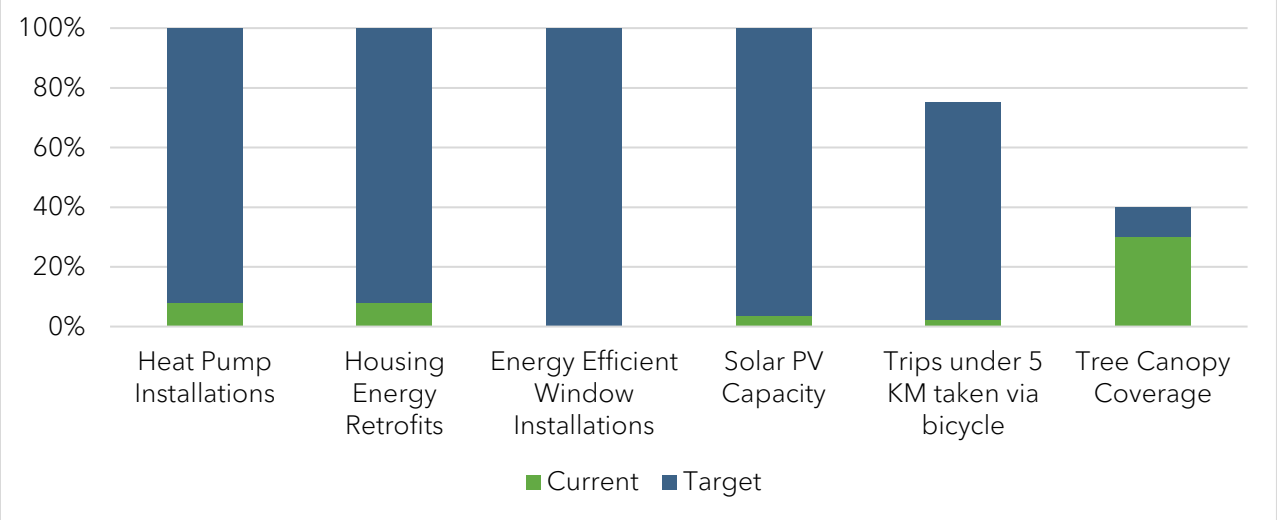
Executive Summary

This report provides an estimate of the economic impact in six green-industry markets based on achieving specific 2040 targets found in the City of Toronto's TransformTO Net Zero Strategy. This report profiles housing energy retrofits, heat pump installations, energy efficient window installations, solar PV module installations, trips taken by bikes and e-bikes, and tree canopy coverage. Each chapter focuses on one market and outlines its current state, future growth scenarios, barriers to growth for businesses, and the potential economic impact. Economic impact assessments do not necessarily reflect new job growth, as certain market area impacts (e.g., heat pump installations) will be replacing impacts from traditional markets.

Across each market area, modelling shows that current growth rates will not achieve the NZS 2040 targets. Growth will need to accelerate. Figure 1 makes clear the significant growth needed, as current states pale in comparison to Toronto 2040 targets.[1]

Figure 1: Current Status and Future Targets, Toronto NZS



If this accelerated growth is achieved, a major supply side barrier that must be addressed is the need for a rapid expansion of a skilled and trained labour force to install or plant and maintain the products. The City can help overcome this challenge by supporting the development and expansion of training and labour force attraction locally. These labour force challenges in these green markets are not unique to Toronto and may be national in scope. The City can provide leadership on overcoming labour force challenges by building collaboration with local and national stakeholders including businesses, academia and training institutions, not-for-profit organizations, labour unions and groups, other municipalities, and higher levels of government.

[1] The current status for energy efficient window installations is 0.4%, and therefore doesn't appear in the figure.

In all markets the data on the current state of the market is lacking and assumptions had to be made. The numbers used in the report are for guidance to identify supply side challenges that must be overcome to reach Toronto's NZS targets. Significant work and effort is needed to properly document and track data on deployment levels to identify if Toronto is on track to eliminate carbon pollution in Toronto in the time remaining.

Housing Energy Retrofits: Toronto's NZS 2040 target is to have all single-unit dwellings[2] in the city retrofitted to net zero. There are projected to be 445,500 relevant dwellings in Toronto by 2040. Currently there are 107 registered energy advisors in Toronto capable of conducting an assessment. With the recently announced ending of the federal Greener Homes initiative program this is likely an oversupply in the short-term. However, a major challenge to achieving the NZS target is that between 500 and 1,000 advisors will be needed when demand accelerates. To meet Toronto's 2040 targets, this market area could generate between 6,000 and 6,700 person-years of employment for the energy advisory service.[3],[4] The actual energy retrofits (which might include heat pumps and windows covered below) will also generate employment and sales.

Heat Pumps: Similarly to housing retrofits, the NZS 2040 target is to have heat pumps installed in all of Toronto' 445,000 single-unit dwellings. It is estimated that about 35,000 heat pumps have been installed. Businesses suggest that there are minimal supply barriers to achieving this target so long as there is demand certainty and consistency. Achieving the 2040 targets will result in between 9,600 and 14,500 person years of employment and total wages between $1.3 and $2.0 billion.

Energy Efficient Windows: The replacement of windows is not directly targeted in the NZS however it is a key action required for a dwelling to achieve net zero energy. To make 100 per cent of Toronto's single-unit dwellings net zero by 2040 will require an estimated 8.3 million energy efficient windows to be installed. As only approximately 32,000 energy efficient windows have been installed in Toronto, this will require significant growth, with upwards of 1.1 million window installations annually in the 2030s. This presents a significant barrier to achieving NZS targets, as only approximately 400,000 windows (regardless of the type of window) are installed annually in Toronto. This will require a substantially larger labour force at a time when the construction industry is struggling to retain and attract skilled workers. Achieving the 2040 targets will result in between 10,100 and 17,100 person years of employment and wages between $618 million and $1.1 billion.

[2] Single-unit dwellings include three dwelling types (single-detached, semi-detached, and row houses).

[3] A person-year of employment is the equivalent of one year of full-time work.

[4] Person-years of employment totals under 100,000 are rounded to the nearest hundred. Totals above 100,000 are rounded to the nearest thousand.

Solar PV: One of the NZS targets is for solar PV to be installed on all buildings (residential and commercial) "where feasible" with a 2040 target of 5,728 MW. No accurate information is available for the amount of solar PV installed in Toronto however 219.4 MW of renewable electricity (wind, solar, biogas) has been installed in the city and this is used as a proxy for solar. To reach the 2040 target, growth will need to be substantial, though businesses believe this is achievable as long as demand consistency and certainty exists. Notable barriers to achieving the target include the inconsistency of support programs historically and the lack of a skilled and trained labour force. Achieving the NZS solar target will create between 75,000 and 146,500[5] person years of employment in Toronto.

Cycling: The NZS sets a 2040 target of having 75 per cent of current car or transit trips under five kilometres shift to either bikes or e-bikes. Due to data collection challenges, this report focuses on trips of one to five kilometres. The current rates of cycling of approximately 2.2 per cent of trips between one and five kilometers falls significantly below the 2040 target of 75 per cent. The supply of bikes and e-bikes is not expected to be a barrier to achieving the NZS target, however a lack of skilled bicycle mechanics presents a serious challenge. There is no accredited or academic-supported training for bicycle mechanics in Canada and new bicycle mechanics are trained through an informal process by individual businesses. Toronto bike businesses have stated that they do not have enough capacity to train the number of bike mechanics needed to meet 2040 targets. Training programs similar to that offered in other trades is needed to meet the necessary growth of the cycling industry. Achieving the NZS cycling target will generate between 104,000 and 203,000 person years of employment, with wages between $3.4 and $6.6 billion in Toronto's cycling industry.

Tree Canopy: It is estimated that about 30 per cent of Toronto is covered by trees, with the NZS 2040 target increasing this to 40 per cent. Barriers to meeting this target within the scope of this report include a lack of certainty of future demand - which could impact the nursery supply of trees - and a lack of training regarding the proper planting and maintenance of trees. Achieving the NZS tree canopy target will result in approximately 32,800 to 34,300 person years of employment generated.

[5] This total is rounded to the nearest hundred because it is a combination of two employment estimates under 100,000.

Data Limitations

Across the six market areas, data was severely limited. Related to understanding what it will take for Toronto to achieve successful implementation of NZS, these data limitations existed for both current status and expected trajectories. Each market area had to derive basic information on the current state of the market using a number of assumptions, outlined within Appendix B. As a result, current and future trajectories within this report should be considered as a guide to identify challenges in growing this market.

An inability to differentiate between green industries/ occupations and other industries and occupations irrelevant to this work led to significant barriers to parsing job and industry data. Labour force and education data was almost non-existent, due to differences between Statistics Canada occupation classifications and the occupations of relevance to the market areas.[6] Economic impact data was similarly limited due to the lack of relevant breakdowns within industry classifications.[7]

Regarding Toronto's path to 2040 Net Zero, it is difficult to see a path to success when initial figures or projected uptake cannot be precisely estimated. If Toronto is to reach its NZS targets, the City must begin to accurately track current and historic rates of uptake. Similar improvements must be made to data accumulation within specific green industries and occupations. Specific recommendations are provided at the end of the report, but in brief, improved data must be considered through:

- Advocating with Statistics Canada to standardize relevant green industry classifications.
- Creating centralized, internal hubs for recording installations and uptake across the different market areas.

Even with the difficulties in gathering precise figures, the estimates in this report present a stark reality. Current estimated rates of uptake make clear it will be very challenging to achieve NZS targets by 2040 across the various market areas without accelerating demand quickly. However, this report also uncovered that supply side barriers to growth are manageable and can be addressed to ensure that the 2040 targets are achieved. Reaching the net zero targets will require a paradigm shift within Toronto of drastically increased rates of uptake.

[6] For example, bicycle mechanics are within NOC 73209, "other repairers and servicers," which includes piano repairers, sporting goods repairers, and vending machine repairers, among other occupations.

[7] For example, heat pump installation businesses are grouped with plumbing businesses.

1. Introduction

In December 2021, Toronto City Council adopted the TransformTO Net Zero Strategy to reduce community-wide greenhouse gas (GHG) emissions in Toronto to net zero by 2040, one of the most ambitious municipal climate plans in North America. The NZS identifies numerous actions and targets to be achieved by 2040 in the key sectors of energy, buildings, and transportation. The City of Toronto (the "City") is seeking to better understand impediments within Toronto's green industries that might limit their abilities to supply the increased demand in meeting the NZS targets.

This report provides an estimate of the economic size of six green market areas . This report uses the assumption that the 2040 targets will be met within each market area when assessing future industry size and economic impact. This report does not review any aspect of stimulating demand or offer suggestions related to growing the market but seeks to understand what challenges must be overcome for industry to match that needed growth. The six NZS targets and their associated market areas assessed within this report are:

Housing Retrofits (Registered Energy Advisors)

2040 Target: "Retrofit 100 per cent of existing residential and commercial buildings."[8]

The effective energy retrofitting of a residential dwelling is characterized by the completion of an assessment by a registered energy advisor confirming that needed measures have been taken to reduce consumption and installing solutions such as a heat pump and energy efficient windows.

Heat Pumps

2040 Target: "Convert 100 per cent of residential water and space heating to heat pumps."

A heat pump provides heating and cooling without directly burning fossil fuels and can greatly lower household emissions if the source of electricity is clean. Replacing natural gas heating with heat pumps is a key element in achieving Toronto's NZS

Energy Efficient Windows

2040 Target: "Retrofit 100 per cent of existing residential and commercial buildings."

Installing energy efficient windows is one of the top actions that help convert dwelling to net zero by greatly improving the insulating capabilities of the building. As with heat pump

[8] Transform TO Net Zero Strategy: A climate action pathway to 2030 and beyond; November 2021.
Where the original NZS suggested targets would be reached after 2040, City staff noted that timelines have been adapted to 2040.

installations, replacing traditional windows with energy efficient windows is imperative to achieving Toronto's NZS.

Solar Photovoltaic (PV) Modules

2040 Target: "100 per cent of buildings have solar PV installed where feasible. 5,728 MW(p) installed."

Transitioning energy from fossil fuels to solar and other renewable energy sources will significantly lower Toronto's GHG emissions. Installing solar PV on Toronto buildings will generate hundreds of thousands of MW-hr of energy annually.

Cycling

2040 Target: "Shift 75 per cent of car and transit trips under 5 km to bikes or eBikes."

Increasing the use of bikes and e-bikes as a standard mode of transportation in Toronto will have multiple positive impacts including reducing congestion and improving the health of residents. Cycling can defer or eliminate the purchase of EVs providing a less costly and more equitable form of transportation.

Tree Canopy Coverage

2040 Target: "Increase city-wide tree canopy cover from 30 per cent to 40 per cent."

Toronto's urban forest consists of all trees and shrubs within the city's boundary, on City-owned and managed lands (public road allowances, parks and ravines) as well as all the trees on private property. Increasing tree canopy coverage, like bikes, will have multiple benefits including reducing the urban heat island effect and making the City more resilient.

Each chapter considers one market area and defines the scope of the assessment, reviews the current state of the Toronto market and highlights the necessary growth to achieve the specific NZS 2040 target. Each chapter also presents potential market growth scenarios, followed by a review of the current industry supply chain and the industry growth required to meet the NZS target. This analysis focuses on barriers to businesses growth along the supply chain. Following this, an economic assessment of the current and the potential future market area is presented.

Growth Models Used within the Report

Each chapter presents scenarios outlining potential growth paths towards Toronto's Net Zero Strategy targets using standard economic growth models and market-specific factors (i.e., current installations and growth, size of the 2040 target). These scenarios outline growth each market area may see through 2040 and allows for the consideration of potential impacts of future policy or market demand stimulations. This report focuses on identifying potential challenges to growth and not which scenario will be realized. Not all markets use all six models if data is lacking or due to unique market conditions (i.e. no regulatory way to enforce replacements).,

The six growth models used are:

- Model 1: Current Growth Rate, Extrapolated to 2040.
- Model 2: Anticipated International Compound Annual Growth Rate, Extrapolated to 2040.
- Model 3: Historic S-Curve Growth Rates, with a slow initial uptake.
- Model 4: Historic S-Curve Growth Rates, with an average initial uptake.
- Model 5: Historic S-Curve Growth Rates, with a fast initial uptake.
- Model 6: Enforced Replacement.

These models anchor the discussion of the market area's growth by presenting specific patterns that may be seen and the requisite growth needed to realize 2040 targets.

Graphs illustrating each of the models below use heat pumps as the example.

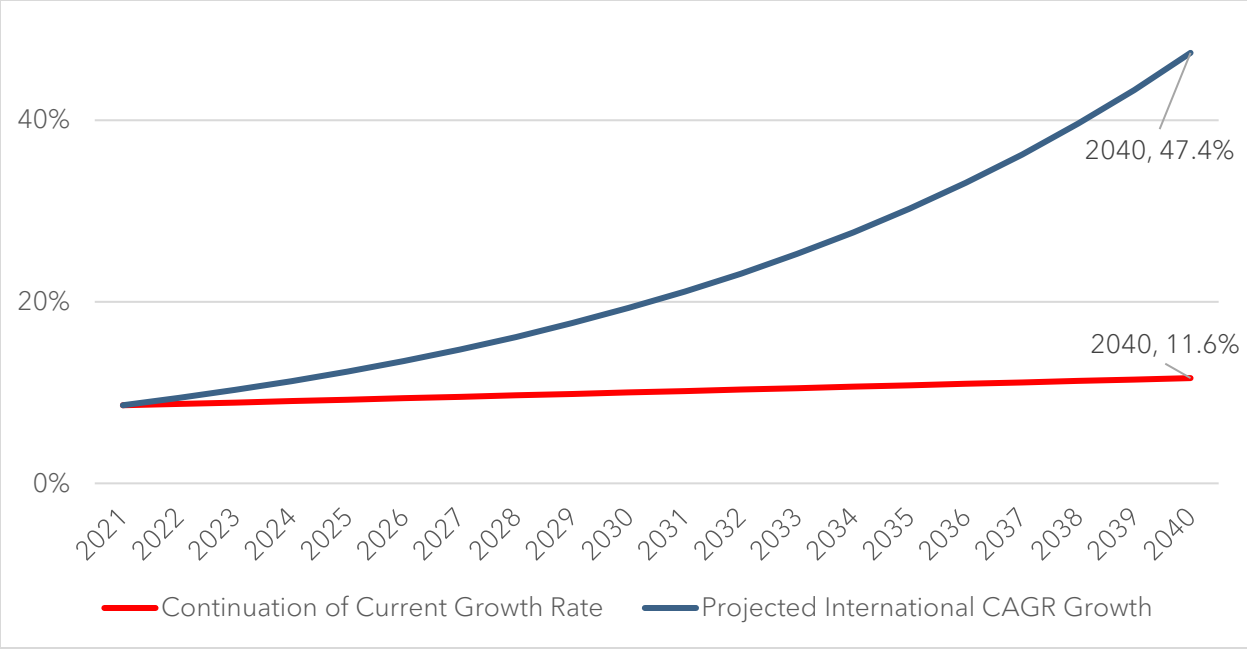
Model 1: Continued Current Growth Rate

Model 1 presents the most accurate current growth rate available and extrapolates that trend through to 2040. As historic data is inconsistent (and lacking) across the different market areas, historic rates are assumed to be linear rather than compounding. The growth rates presented are more reliably "trends" rather than historic rates, but are presented as rates to match the same language as the other models.

Model 2: Growth Rate Follows International Growth Rates

Model 2 takes anticipated international compounded annual growth rate (CAGR)[9] (typically, this projection is available from 2023-2030) and extrapolates this rate through to 2040 (see solid line, Figure 2).

Figure 2: Example: Models 1 and 2, projections using current local and international growth rates, 2021-2040



Source: McSweeney & Associates Calculations, and International CAGR from Global Industry Analysts Inc.

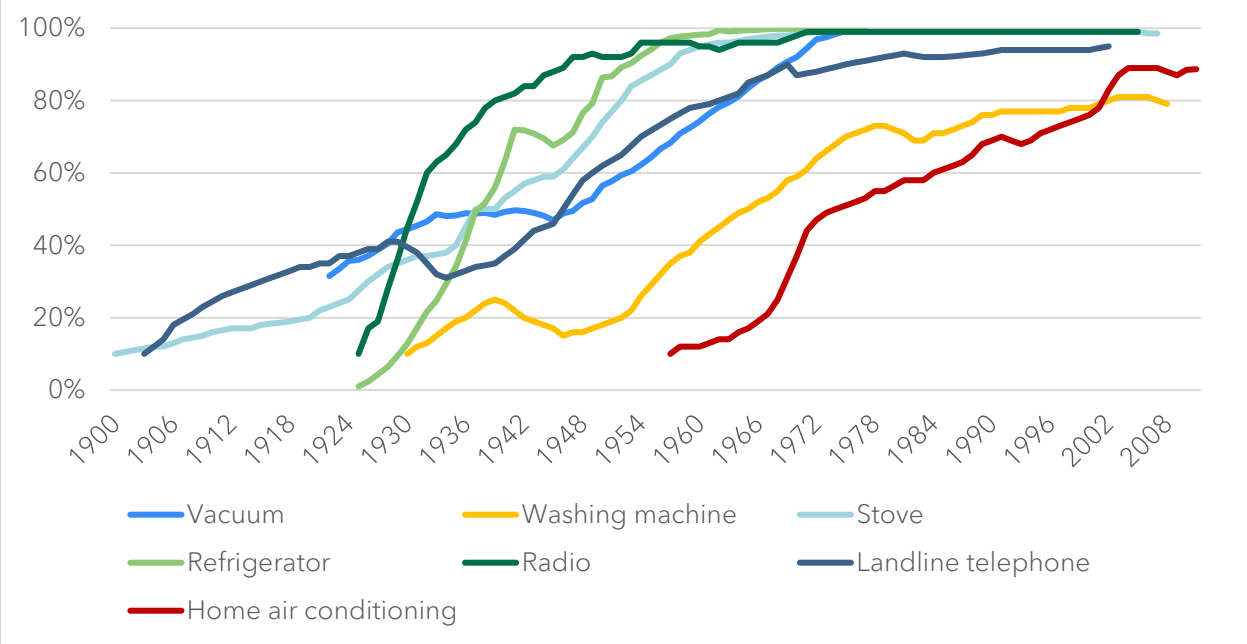
[9] Compounded annual growth rate measures average annual growth.

Models 3 to 5: Traditional Industry S-Curve Growth Rates

Deployment of new technologies does not typically grow in consistent fashion (i.e., five per cent each year) as presented in Models 1and 2 but instead go through a number of different growth phases. Historic S-curve growth rates for a variety of new technologies/markets are shown in Figure 3. [10]

Typically, there is an initial stage of slow build-up, with early-adopters purchasing the products, followed by an intermediate period of rapid growth, with a tapering off as "hold-out" laggards more slowly adopt the new product. The speed of uptake and transition, from slow initial build-up to intermediate rapid growth, is dependent on technology advancements (i.e., price reductions); consumer interest and demand and the availability of government incentives where there is a societal benefit to its introduction. This type of growth is called 'S-curve growth and uses standard S-curve models.

Figure 3: Historic Growth Rates Among a Variety of Large-Scale Industries



Source: Harvard Business Review, 2013, from Michael Felton, New York Times. Horace Dediu; Comin and Hobijn (2004); Our World in Data.

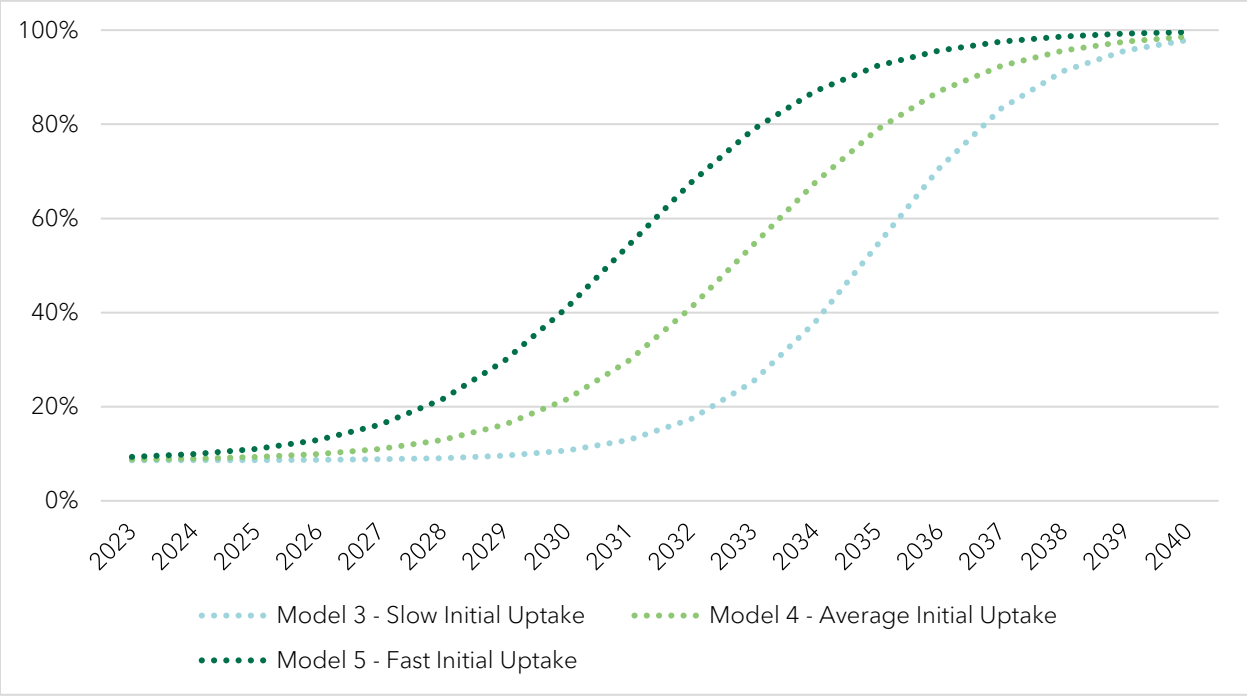
[10] Figure 2 presents two notable periods of decline. First, in the early 1930s, during the Great Depression (see landline telephones) and second, during 1939-1945, due to World War II. Given the multitude of changes that would come from an event of that scale, these potential shock events are outside the scope of this report.

Given these historic trends in other industries, three separate "S-curve" models are used in each market area, each reaching Toronto's 2040 net zero targets.

- Model 3 ("Slow Initial Uptake") presents a growth rate in line with current deployment through to the end of the 2020s, with a rapid increase in uptake after that to approach the 2040 targets.
- Model 4 ("Average Initial Uptake") is a growth trend that, through 2029, is in line with the targets from the international compound annual growth rate, before again seeing more aggressive growth.
- Model 5 ("Fast Initial Uptake") presents a trajectory based on significant initial uptake, with a marked increase prior to 2030, before tapering off through the second half of the 2030s as 2040 targets are approached.

These models are presented in Figure 4.

Figure 4: Industry S-Curve Models, 2023-2040

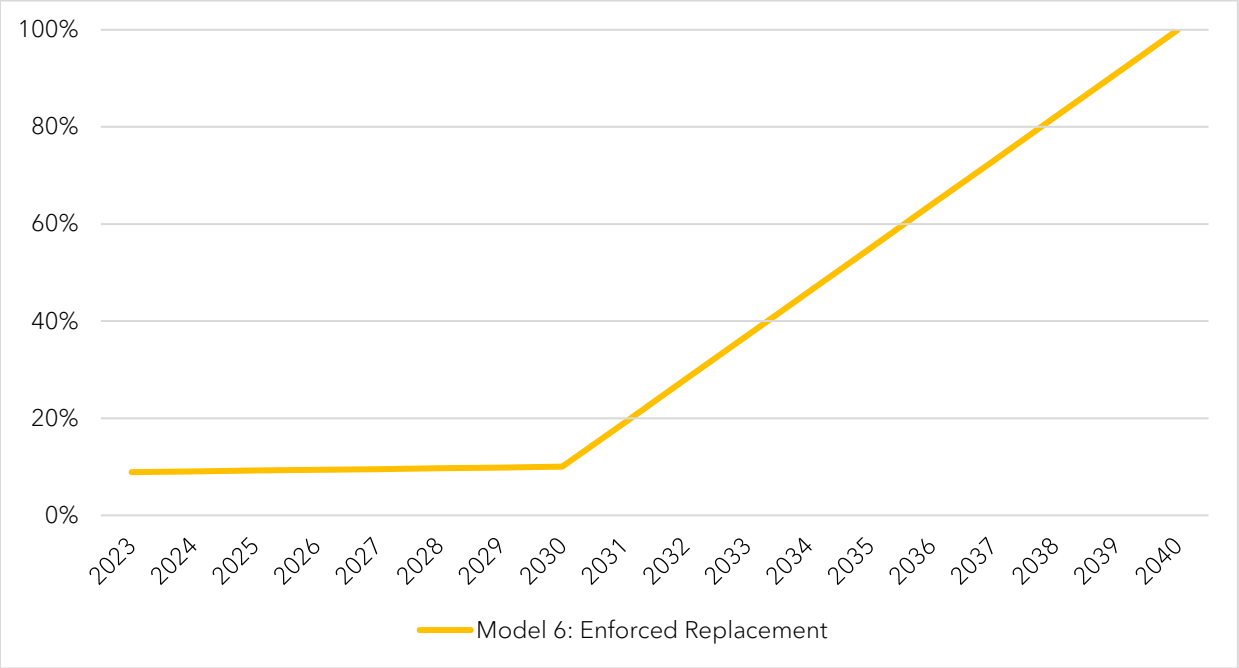


Source: McSweeney & Associates Calculations.

Model 6: Enforced Replacement

Model 6, shown in Figure 5, presents an enforced replacement through regulations which requires an existing product to be replaced when the product comes to the end of its life. A good example of a regulation to end the continued use of a product was the banning of production of chemicals called chlorofluorocarbons, or CFCs, in 2010 by international agreement. CFCs were used in hundreds of products including aerosol sprays, foams and packing materials, solvents, and in refrigeration and were destroying the global ozone layer. Model 6 needs to consider two conditions – the year when the ban comes into effect and the life expectancy of the product that is being replaced. The full replacement of all products prior to the end of their life expectancy will generally require both financial support and inspection to ensure compliance.

Figure 5: Example: Enforced Replacement Model, 2023-2040



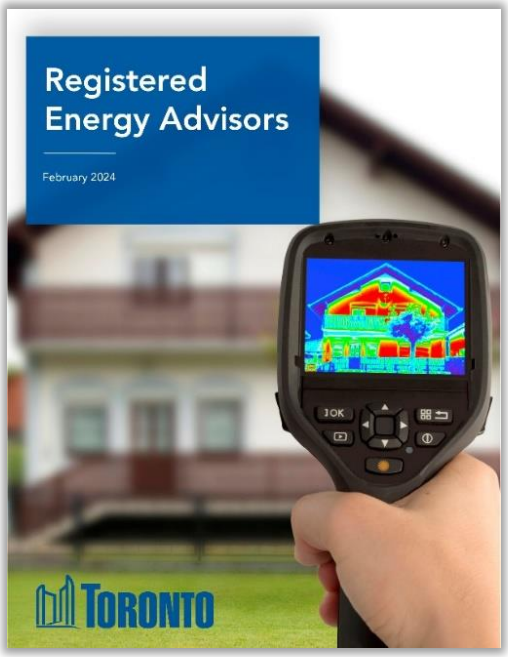
Source: McSweeney & Association Calculations.

2. Registered Energy Advisors

The TransformTO Net Zero Strategy targets energy retrofitting 100 per cent of existing buildings by 2040 to low energy standards. Registered Energy Advisors are an integral part of ensuring residential buildings meet low energy standards and hence every home will have to go through an "energy audit" to meet this NZS target. The scope of this analysis is limited to single-unit dwellings.[11]

Registered Energy Advisors

Energy Advisors are trained workers individuals who use their expertise in combination with energy modelling software to help building professionals, homeowners, and those considering a house purchase, to make better informed decisions on choosing energy-saving upgrades and retrofits along with inspecting the house upon completion to ensure that the work has been done properly. Energy Advisors must be registered with NRCAN and affiliated with an NRCan-licensed service organization.



[11] Single-unit dwellings include three dwelling types (single-detached, semi-detached, and row houses).

Current Status

Single-Unit Dwellings in Toronto

The 2021 Census identifies that there are 270,490 current single-detached homes, 71,955 semi-detached homes, and 62,915 row houses, representing a total of 405,360 single-unit dwellings in Toronto.[12]

Number of Single-Unit Dwellings in Toronto That Have Undergone Retrofitting

There is little detailed information on the energy performance of existing homes in Toronto and it is unknown how many homes have gone through a successful energy retrofit to achieve low energy standards. Due to this data limitation, the estimate of the number of installed heat pumps in single-unit dwellings (35,000 in 2021) is used as a proxy for the number of successful retrofits already completed. [13]

[12] Within this report, the combination of these three dwelling types (single-detached, semi-detached, and row houses) will be referred to as "single-unit dwellings". Where a specific source is cited, a note of the classification that the original source uses will be made, while working to align their classification with this report's.

[13] As the City of Toronto progresses toward its net zero targets, the involvement of registered energy advisors becomes crucial to provide advice and guidance to homeowners seeking to retrofit their home, including with heat pump installations. Therefore, the growth models established for heat pumps will be used as the template to project the numbers of energy advisors required for the City to achieve its "Net-Zero" targets.

2040 Market Size Target

The City of Toronto NZS's target is that 100 per cent of single-unit dwellings will be energy retrofitted to low energy standards by 2040. Accordingly, 445,500 single-unit dwellings are projected[14] to need an energy audit undertaken by a be energy advisor by 2040. The projected demand excludes residential buildings deemed in need of major repairs.[15]

Modelling is done based on the assumption that all single-unit dwellings built through to 2040 will require retrofitting to meet net zero. Provincial building codes are based on the National Building Code which is updated every 5-years. New building codes from the National Research Council aim to have all new buildings constructed after 2030 to be net-zero energy ready (i.e., easy to retrofit to be net-zero). The next opportunity to make all new homes constructed to net zero will be 2035. As there is no specific timeline mandating new builds to be net-zero, this report treats all housing units, irrespective of new or previously built, as requiring retrofitting.

The impact in Toronto of introducing regulations to make all new dwellings net zero may be in this market segment minor as the number of new single-unit dwellings built between now and 2040 is relatively small (approximately 45,000) compared to the existing stock that must be retrofitted.

Successfully energy retrofitting all 445,500 single-unit dwellings would represent market growth **of approximately 1,200 per cent.**

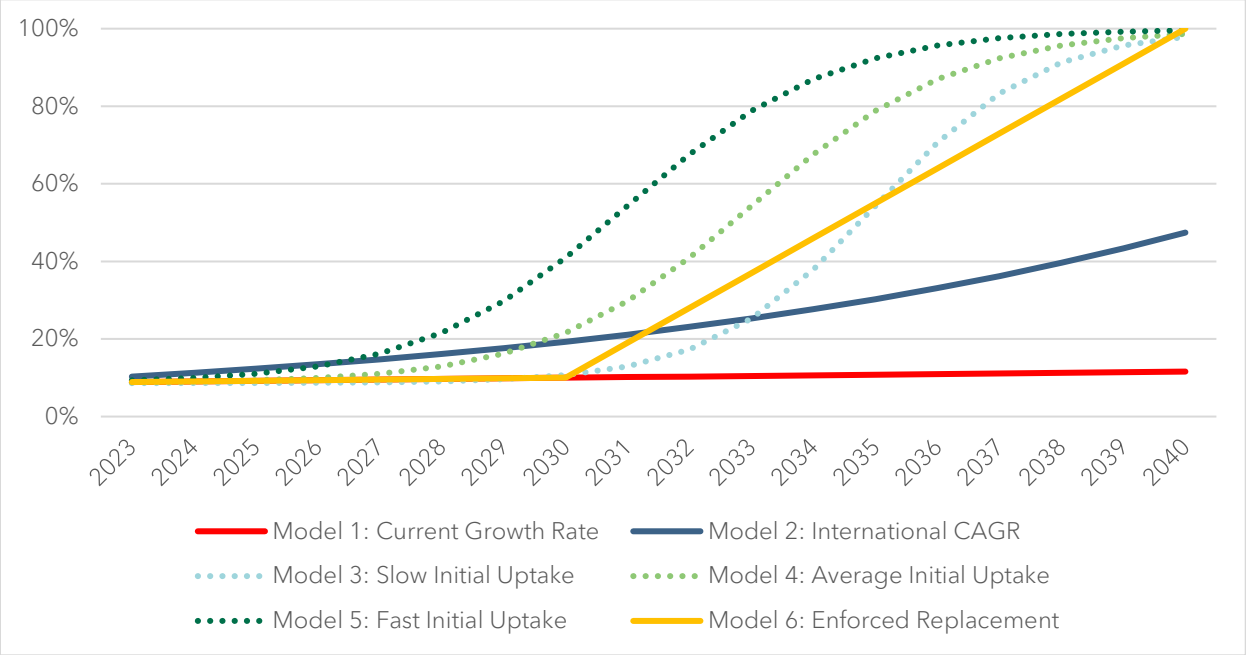
[14] Hemson Consulting Ltd. Greater Golden Horseshoe: Growth Forecasts to 2051. Prepared August 2020. It suggests that by 2041, 462,200 single-unit dwellings will exist in the city.

[15] In the 2021 Census, Statistics Canada found that 3.4 per cent of current dwellings in Toronto were deemed to need major repairs. Industry experts noted that Toronto's target should not include these dwellings due to the inefficiency of a heat pump or furnace in a home needing major repairs, and the likelihood that the dwellings will be torn down a short time after the installation of new technology.

Potential Growth Models

Due to the lack of data on the number of low energy single-unit dwellings in Toronto and how many dwellings are being retrofitted per year the growth scenarios use the estimate of the number of heat pumps currently installed as the number of current buildings successful energy retrofitted. These six growth scenarios are presented in Figure 6.

Figure 6: Single-Unit Dwelling Retrofit Market Growth Scenarios



Source: McSweeney & Association Calculations.

- Scenario 1 is based on the current heat pump growth rate of 2.5 per cent, extrapolated through 2040. This growth rate falls well short of the 2040 target.
- Scenario 2 considers the anticipated international CAGR of heat pumps (9.4 per cent), extrapolated through 2040. This growth rate also falls short of reaching Toronto's Net Zero target.
- Scenarios 3 to 5 reflect traditional industry patterns (S-curve growths) with aggressive growth rates to reach the 2040 target:
    - Scenario 3 is reflective of "slow initial uptake," with growth rates prior to 2030 in-line with current rates of growth.
    - Scenario 4 is reflective of "average initial uptake," in-line with international anticipated CAGR, followed by more rapid uptake during the mid-2020s.
    - Scenario 5 is reflective of "fast initial uptake" which sees a spike in uptake beginning in 2024.

- Scenario 6 focuses on enforced growth, occurring in the event there are no market stimulations (i.e., rebates) in place from 2024-2030, followed by the mandating of energy retrofits to meet mandated energy standards.

Workforce Status

According to NRCan, there are currently 107 registered energy advisors (REAs) in Toronto. To become an REA, individuals must pass two qualification exams, maintain and update their credentialing, and be affiliated with an NRCAN-licensed service organization. On average, each registered energy advisor (REAs do not have a specific occupation classification but are expected to be represented by either NOC 541690 or NOC 22233) is projected to perform approximately 60 complete home energy assessments[16] over the course of 12 months. The number of REAs needed to meet the demand as projected by different growth scenarios is presented in Table 1. Data limitations prevent a more comprehensive understanding of the current training capacity, or the future necessary training capacity.

Future labour force capacity, as presented Table 1, matches the annual capacity of a registered energy advisor with the potential growth trajectories outlined above. This highlights the annual number of REAs needed to meet demand for each growth pattern. The difficulty with matching future supply to current demand is highlighted in the first growth pattern column, where current growth rates suggest only 20 registered energy advisors are needed annually from 2025 to 2028. Though significantly lower than the current total in Toronto, this is reflective of current growth rates in retrofit initiatives outside of the Canada Greener Homes Grant, which is no longer accepting applications after March 2024.

Table 1: Total Registered Energy Advisors Needed, by Growth Scenario, 2025-2040

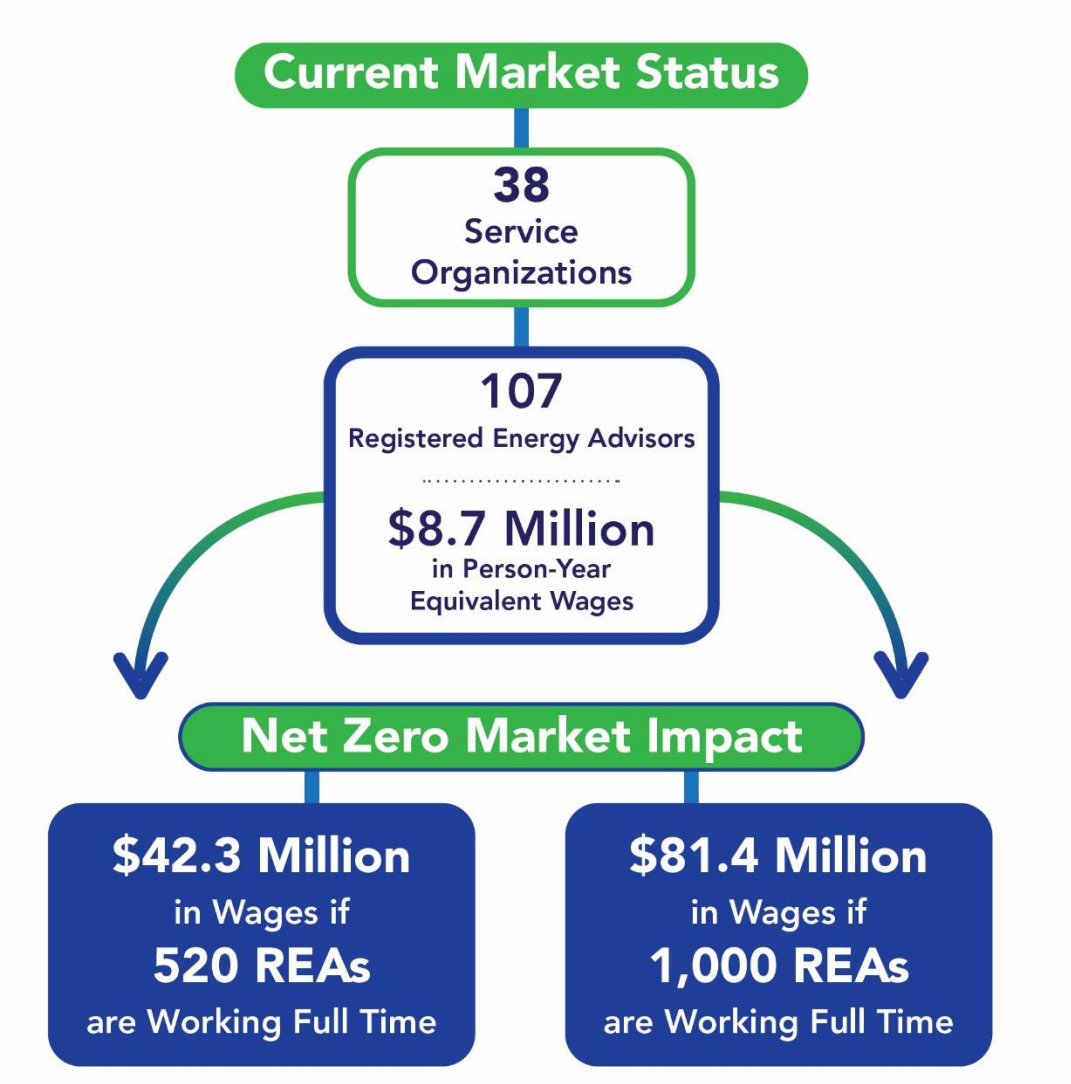
2025-2040 Total Registered Energy Advisors Needed, by Growth Scenario						
Years	Current Growth Rate	International CAGR	Slow Initial Uptake	Average Initial Uptake	Fast Initial Uptake	Enforced Replacement
2025-2028	20	90	20	80	550	20
2029-2032	20	140	160	520	580	340
2033-2036	15	190	1,000	850	230	670
2037-2040	15	270	520	230	70	680

Source: McSweeney & Associates Calculations.

[16] Based on calculations (McSweeney & Associates), it's estimated that around 6,000 assessments were expected to be conducted in the third year of the Canada Greener Homes Grant program.

Market Impact

Registered energy advisors contribute to the economy in two ways. Firstly, they create more direct jobs and wages, particularly in the realm of home retrofit initiatives. Secondly, their professional expertise indirectly contributes to the economy by providing valuable support to homeowners seeking energy-efficient retrofits. Their positive spillover effect extends to the other market areas outlined in this report. The direct economic impact is presented in the Figure below. Please note, the figure depicts salary impacts in the event energy advisors are working full-time. This is unlikely to reflect reality, as current REAs do not work full-time (evidenced by the average REA only completing approximately 60 assessments annually). However, due to data limitations this was a necessary assumption. REA wages are likely supplemented by additional work in other related fields (i.e., construction).



*Represents economic activity in the city of Toronto.
**A "person year" of employment is the equivalent of one year of full-time work.
Source: Lightcast 2023.

Conclusions

Currently, it is estimated that 6,000 single-unit dwellings can be assessed annually by the exist 107 energy advisors in Toronto. This falls well short of the necessary capacity needed to reach Toronto's Net Zero Strategy targets. These totals do suggest that energy advisors are currently working part-time, and perhaps could scale up capacity with greater, more consistent demand. However, this would still require a significant increase in the number of registered energy advisors in the city.

The most significant barriers to growth appear to be an industry in limbo with no certainty regarding future employment yet with a need to increase the size of the industry to meet future demand. Future certainty is a significant issue, as the layoffs associated with the announced ending of the Canada Greener Homes Grant show. Furthermore, with current demand for registered energy advisors being low, demand for training and accreditation is similarly low.

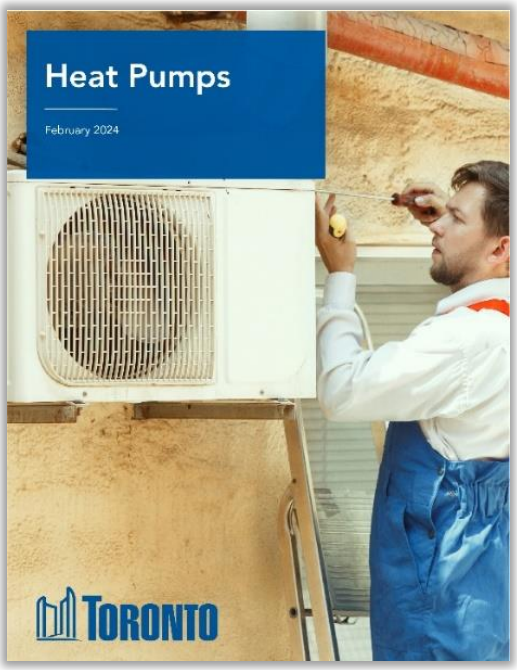
To meet Toronto's net zero targets by 2040, up to 461,100 single-unit dwellings will need to be assessed as "net zero," achieved through either retrofitting or sustainable new builds. This represents a substantial growth of 426,300 net zero dwellings in Toronto equating to a growth of approximately 1,200 per cent over current figures. For this growth to be achieved, a significant expansion in the number of registered energy advisors will be required ranging from 580 to 1,000 depending on the specific growth trajectory is observed.

However, with future need expected to rise, there will be significant demand in the future. This will require proactive training strategies and clear indications of future certainty, to ensure the requisite number of certified REAs are available.

3. Heat Pumps

One of the NZS targets is the replacement of natural gas heating with heat pumps in all residential and commercial buildings by 2040. This chapter presents an analysis of the heat pump targets by examining the supply and required growth of heat pumps. It examines associated labour force conditions, challenges, opportunities, and economic impact resulting from the implementation of heat pumps. The scope of this analysis is limited to single-unit dwellings[17] only.

Two types of heat pumps are available to install in single-unit residential dwellings: Air-Source and Geothermal. As most heat pumps currently installed in Canada are air-source heat pumps, this study focuses on the air air-source heat pump ecosystem only[18],[19].



Air-Source Heat Pump

An air-source heat pump uses the temperature of the outside air, adjusted via electricity within the heat pump, to either cool down or heat up a home. The standard physical size of a unit is no larger than a typical air conditioning unit and can attach near the side of a building, again similar to an air conditioning unit. This makes an air-source heat pump ideal for residential buildings that are either semi-detached, row, or a detached home on a smaller lot.

Geothermal Heat Pump

Ground-sourced heat pumps, rather than existing outside the home as an air-source heat pump or air conditioning unit typically does, are located inside the home. Unlike an air-source heat pump, which uses the temperature of the outside air, a ground-source heat pump (also referred to as geothermal or inground heating) has a significant amount of piping buried underground, deep enough to be able to either cool or heat the air flowing through it.

[17] Single-unit dwellings include three dwelling types (single-detached, semi-detached, and row houses).

[18] Geothermal geothermal heat pumps are incompatible with most urban areas due to space requirements to install the collection piping and the higher costs for smaller residential systems (with costs often above $40,000 per dwelling.

[19] US Department of Energy, Geothermal Heat Pumps.

Current Status

Single-Unit Dwellings in Toronto

The 2021 Census identifies that there are 270,490 current single-detached homes, 71,955 semidetached homes, and 62,915 row houses, representing a total of 405,360 single-unit dwellings in Toronto.

Heat Pumps Installed Within Single-Unit Dwellings

Natural Resources Canada (NRCan) provides percentages of uptake **at provincial levels** by housing type, which suggests that approximately 10.7 per cent of single-detached houses, 4.4 per cent of single-attached (row and town houses) and 1.4 per cent of apartments in Ontario use heat pumps. Calculated from available information[20], an estimated 34,900 single-unit dwellings in Toronto have installed heat pumps (Table 2).

Table 2: Estimate of Heat Pumps Installed by Dwelling Type, 2021

Estimated Heat Pump Usage by Single-Unit Dwelling Type, 2021			
Dwelling Type	Total Units	Heat Pumps (average Ontario rates) Installed per Dwelling Type	Calculated Current Heat Pumps Installed
Single-Detached	270,000	10.7%	29,000
Semi-Detached	72,000	4.4%	3,200
Row House	63,000	4.4%	2,800
Total (Single-Unit Dwellings)	**405,000**	**8.6%**	**34,900**

Source: Statistics Canada Census Profile, City of Toronto 2021 and NRCan Residential Sector Energy Use Data Base Tables.

[20] Calculated from Natural Resources Canada (NRCan) which provides percentages of uptake at provincial levels by housing type.

2040 Market Size Target

The City of Toronto's target of 100 per cent of homes using heat pump technologies by 2040 will mean that about 445,500 heat pumps will be installed in single-unit dwellings (305,000 single-detached, 81,100 semi-detached and 75,100 row homes) by[21] 2040. The projected demand excludes single-unit dwellings deemed in need of major repairs.[22]

The installation of heat pumps in 100 per cent of single-unit dwellings represents a 1,200 per cent market growth from 2023 to 2040.

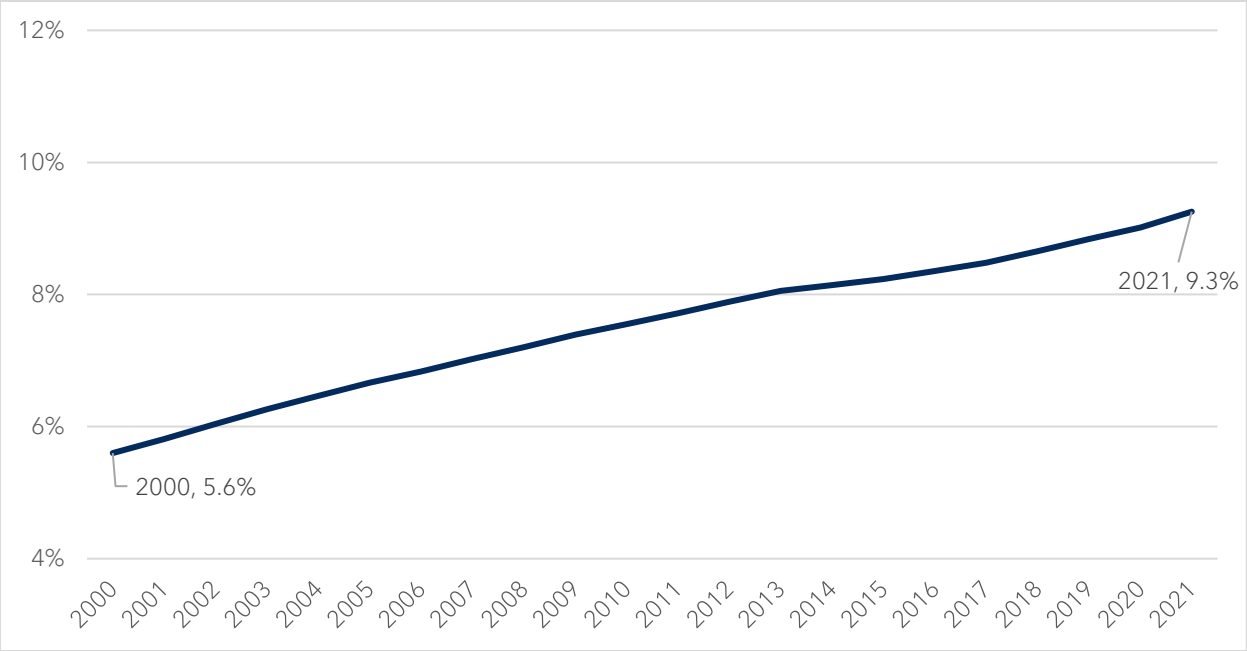
[21] Hemson Consulting Ltd. Greater Golden Horseshoe: Growth Forecasts to 2051. Prepared August 2020. It suggests that by 2041, 462,200 single-unit dwellings will exist in the city.

[22] In the 2021 Census, Statistics Canada found that 3.4 per cent of current dwellings in the Toronto were deemed to need major repairs. Industry experts noted that Toronto's target should not include these dwellings due to the inefficiency of a heat pump or furnace in a home needing major repairs, and the likelihood that the dwellings will be torn down a short time after the installation of new technology.

Potential Growth Models

Historic data is unavailable for the city of Toronto. Across Ontario, the use of heat pumps in single-unit dwellings has risen from an estimated 5.6 per cent in 2000 to 9.3 per cent in 2021 (Figure 7).[23] This represents an annual growth rate of 2.5 per cent. Due to data limitations regarding a local growth rate, this growth rate is assumed to reflect the city of Toronto's growth rate.

Figure 7: Dwellings with Heat Pumps Installed, Single-Unit Dwellings, Ontario 2000 to 2021

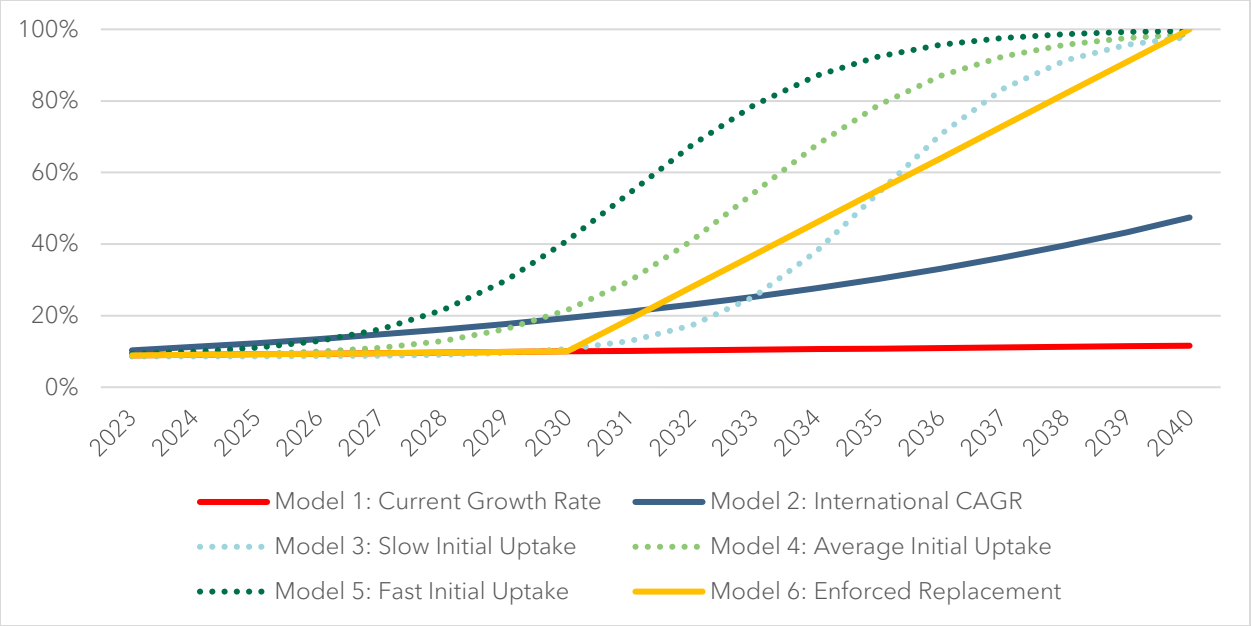


Source: Natural Resources Canada, Residential Heating Types, 2000 to 2021.

The future growth scenarios of heat pump installations in Toronto uses the six models (Figure 8) outlined in the introduction.

[23] Historic rates specific to Toronto cannot be assessed due to a lack of specific historic housing figures.

Figure 8: Heat Pump Market Growth Scenarios Market Area



Source: McSweeney & Association Calculations.

- Scenario 1 is based on current provincial growth rates of 2.5 per cent and reaches almost 12 per cent market penetration.
- Scenario 2 uses the projected international CAGR of 9.4 per cent. This growth reaches about 50 per cent market penetration.
- Scenarios 3 to 5 reflect traditional industry patterns (S-curve growths), though with aggressive growth rates to reach the 2040 targets:
    - Scenario 3 is reflective of "slow initial uptake," with growth rates prior to 2030 in-line with current rates of growth. Growth rates will need to average 33 per cent annually in the early 2030s to meet the target.
    - Scenario 4 is reflective of "average initial uptake," in-line with international anticipated CAGR, followed by more rapid uptake during the mid-2020s. Growth rates will need to average 22 per cent annually in the early 2030s.
    - Scenario 5 is reflective of "fast initial uptake" which sees a spike in uptake beginning in 2024. Growth rates will need to average 26 per cent annually in the late 2020s.
- Scenario 6 focuses on enforced growth, occurring in the event there are no market stimulations (i.e., rebates) until 2030, followed by the mandating of heat pumps to replace other technologies on a yearly basis. This is suggested as the NZS projects no new natural gas furnaces will be installed after 2030.[24]

[24] Toronto's Net Zero Strategy. Page 62.

Compound Annual Growth Rate, S-Curve Growth Rates (Scenarios 3-5)

As Scenarios 3, 4, and 5 are designed to reflect historic industry growth rates, at both the beginning stages of the demand cycle and the latter stages, demand is quite low.[25] That is because there is an initial stage of slow build-up, and a tapering off as "hold-out" laggards more slowly adopt the new product. As such, depending on the growth scenario, the emphasis on aggressive intermediate growth is quite significant. In the most extreme example (Scenario 3), growth rates from 2031-2035 would need to peak above 33 per cent to reach Toronto's 2040 targets. These figures are presented in Table 3.

Table 3: Five-Year Compound Annual Growth Rates by Growth Scenario

Five-Year Compound Annual Growth Rates by Growth Scenario			
Year	Scenario 3 Slow Initial Uptake	Scenario 4 Average Initial Uptake	Scenario 5 Fast Initial Uptake
2023-2025	0.2%	1.9%	5.7%
2026-2030	4.2%	16.7%	25.9%
2031-2035	33.2%	21.5%	11.2%
2036-2040	6.7%	2.5%	0.8%

Source: McSweeney & Associates Calculations.

[25] Models 1 and 2 are excluded from this analysis as both fail to reach 2040 targets. Model 6, as it is artificially induced and linear, is also excluded from this analysis.

Workforce Status

Based on National Occupation Classification (NOC) definitions, the following job types are considered relevant to the heat pump market:

- Assemblers and inspectors, electrical appliance, apparatus and equipment manufacturing (NOC 94202).
- Heating, refrigeration and air conditioning mechanics (NOC 72402).
- Contractors and supervisors, mechanic trades (NOC 72020).

The training period for NOC 72402 suggests a five-year lag to build an adequate labour force to meet the demand of installing products in five years' time. This includes 8,280 hours of on-the-job training and 720 hours of in-school study, with a final exam. With the market transitioning from diverse heating and cooling technologies to heat pumps, the current tradespersons capable of installing heating, refrigeration, and air conditioning units will need to be retrained. The retraining is going to require significant resources, thus adding additional costs to the businesses.

Estimates suggest that current annual rates of training are:

- NOC 94202: 784 individuals trained annually within Toronto's CMA.
- NOC 72402: 416 individuals trained annually within Toronto's CMA.
- NOC 72020: 449 individuals trained annually within Toronto's CMA.

Data limitations prevent a more comprehensive understanding of the current training capacity, or the future necessary training capacity. Regarding future employment, Table 4 compares current job totals relative to market size and then applies this figure to each of the S-Curve scenarios presented above. The table presents the average annual person-years of employment over future five-year periods, based on each of the three growth models. These are not necessarily new jobs, as many will be individuals who are currently working on traditional heating and cooling appliances.

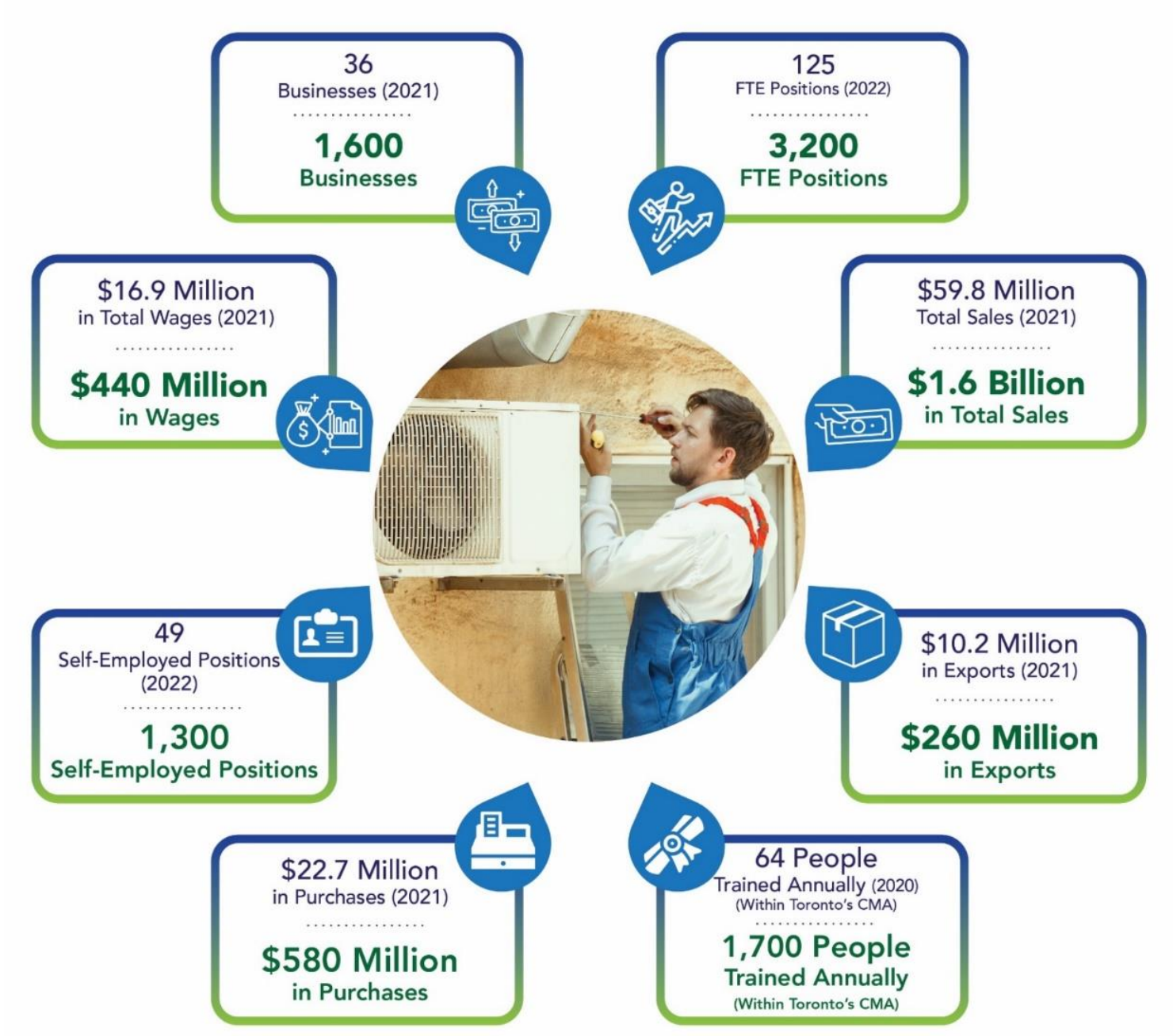
Table 4: Average Annual Person-Years of Employment Supported by Growth Model

Average Annual Person-Years of Employment Supported by Growth Model			
Year	Model 3 Slow Initial Uptake	Model 4 Average Initial Uptake	Model 5 Fast Initial Uptake
2023-2025	125	132	147
2026-2030	136	208	353
2031-2035	429	789	1,105
2036-2040	1,276	1,370	1,427

Source: McSweeney & Associates Calculations.

Market Impact

The replacement of residential heating and cooling systems with heat pumps stimulates the emergence of new businesses, employment opportunities, and avenues for export. The figure illustrates the contributions made by various components within the heat pump replacement process.



Conclusions

The growth needed to expand heat pump installations in single-unit dwellings from 35,000 to 405,000 (approximately 1,200 per cent) in sixteen years is challenging and will require collaboration among stakeholders as well as governmental interventions.

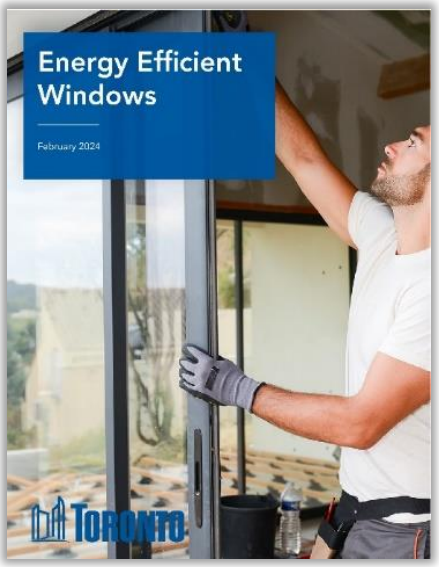
Sales growth over the past 20 years has been low (2.5 per cent growth annually from 2000 to 2021) and is significantly influenced by rebate programs though lack of annual and local data makes this hard to quantify. Over the next 16 years, demand will need to significantly increase, whether via natural demand or government support programs. To achieve this accelerated market growth, industry will need to be given certainty about future outlooks so that they can invest in expanding their business operations.

The heat pump supply chain is mature and global. Heat pump components are used in other common heating, cooling and refrigerant appliances, so it is unlikely to face manufacturing shortages except for short-term, unexpected disturbances (e.g., geopolitical challenges restricting shipping). Leading international manufacturers include Daikin, Mitsubishi, NIBE, and Carrier, all of whom have well established global manufacturing production and assembly capabilities. Distribution logistics in Canada are similarly well-suited to manage increased demand, with well-established businesses including Mitsubishi and Panasonic managing national distribution networks. Though statistics are lacking, industry stakeholders consulted make it clear that manufacturing and distribution will not be hindrances to growth if there is some market certainty to allow them to invest in capacity.

The greatest challenges will lie with labour force retraining (i.e., of natural gas fitters and furnace installers) and the lengthy apprenticeship period (up to five years) that prevents a rapid increase of a skilled labour force that can install heat pumps.

While the targets within the heat pump market area are ambitious, they are achievable from a supply side point of view. To succeed, the City should engage with businesses along the supply chain, leverage relationships with other levels of government, and work as a partner to mitigate labour supply challenges.

4. Energy Efficient Windows



Energy efficient windows are part of the package of solutions that reduce energy usage within a home by providing better insulation and improved thermal comfort. As such, along with the target of 100 per cent deployment of heat pumps, the City considers the installation of energy efficient windows to be part of its path to net zero emissions in buildings. This report uses a target of 100 per cent conversion of windows to energy-efficient windows for single-unit dwellings as larger buildings and buildings for other uses will have different considerations.

Current Status

Windows in Single-Unit Dwellings in Toronto

There are limited statistics on the window industry in Canada or information on the number of windows in Toronto. This report has had to derive basic information on the current state of the market using a number of assumptions outlined below. More research is required to understand this market and this chapter should be considered as a guide to identify challenges in growing this market.

The 2021 Census identifies that there are 270,490 current single-detached homes, 71,955 semi-detached homes, and 62,915 row houses, representing a total of 405,360 single-unit dwellings in Toronto.

Within these dwellings, Energy Star estimates that window coverage within a house amounts to 15 per cent of floor area (that is, a 1,000 square foot single-detached dwelling would be expected to have 150 square feet of windows).[26] Applying this calculation to average dwelling sizes in Toronto[27] suggest there are approximately (as of 2021) 7.8 million windows in single-family dwellings within the city of Toronto.

[26] EnergyStar for Windows, Doors, and Skylights Version 6.0 Criteria Revision, Review of Cost Effective Analysis. Also, US Green Building Council and US Environmental Protection Agency Figures.

[27] Statistics Canada Table: 46-10-0028-01, 2019.

Number of Single-Unit Dwellings in Toronto that have Installed Energy Efficient Windows

As of August 31, 2023, Canada's Greener Homes Grant has issued 1,718 grants to Toronto single-unit dwellings for window and door retrofits. Assuming an even distribution among various dwelling types, 1,136 single-detached houses, 302 semi-detached houses, and 280 row houses in Toronto have installed energy efficient windows through the program.

If each dwelling undertaking the retrofit replaced all their windows, the current number of energy efficient windows installed in Toronto through the Green Homes Grant would be approximately 32,000 (0.4 per cent of all windows). As no data seems to exist on the number of installed high efficiency windows, this number is used to represent the current status of installed windows. It is likely lower than the actual numbers.

Current Annual Window Installations

According to businesses, the average lifespan of windows is 20 years. This report assumes that five per cent of the 7.8 million windows are replaced annually in Toronto (100 per cent replaced over 20 years). This would indicate that there are approximately 400,000 windows installed annually in Toronto on existing single-unit dwellings.

2040 Market Size Target

Toronto's NZS target is that 100 per cent of homes will be at low energy standards by 2040 and this includes having energy efficient windows . Accordingly, 445,500[28] single-unit dwellings will require 8.3 million energy efficient windows to be installed. As with previous market areas, the projected demand excludes single-unit dwellings deemed in need of major repairs.

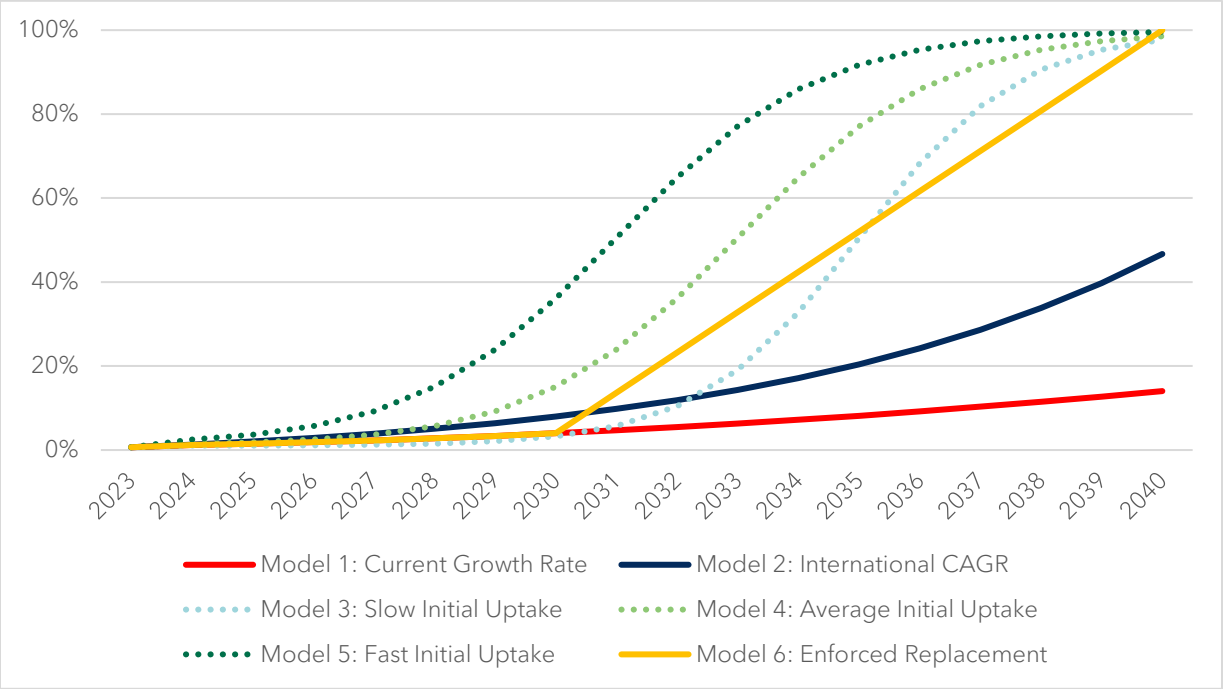
The installation of 8.3 million energy efficient windows represents a 25,800 per cent market growth over the current installation estimate of 32,000 windows.

[28] Hemson Consulting Ltd. Greater Golden Horseshoe: Growth Forecasts to 2051. Prepared August 2020. It suggests that by 2041, 462,200 single-unit dwellings will exist in the city.

Potential Growth Models

This report presents potential growth scenarios for the energy efficient windows market using the six models outlined in the introduction. These six scenarios are presented together in Figure 9.

Figure 9: High Efficiency Window Market Growth Scenarios, 2023-2040



Source: McSweeney & Association Calculations.

- Scenario 1 is based on the current growth trend seen through the Canada Greener Homes Grant, adjusted for the scheduled shutting down of the program in 2024, and reaches about 15 per cent market share by 2040.
- Scenario 2 follows the anticipated international CAGR rate, with significant growth in the 2030s. Current international CAGR suggest ranges from 6 to 9 per cent, but with future growth rising to upwards of 20 per cent annually. This growth rate also falls short of reaching Toronto's Net Zero targets, though by 2040 it achieves about 45 per cent of the market.
- Scenarios 3-5 reflect traditional industry patterns (S-curve growths), though with growth rates to reach the 2040 targets.
    - Scenario 3 is reflective of "slow initial uptake," in-line with current rates of growth through 2031.

    - Scenario 4 is reflective of "average initial uptake," more in-line with international anticipated CAGR, which begins to see more rapid uptake during the mid-2020s.
    - Scenario 5 is reflective of "fast initial uptake" which sees a spike in uptake beginning in 2024.
- Scenario 6 shows the enforced growth that would see, beginning in 2030, energy-efficient windows being mandated to be installed. However, the time frame of 10 years is less than the life expectancy of windows. Within this scenario, until 2030 Toronto would see growth similar to current rates, with a leap in 2030 to a projected 10-year, linear replacement figure.

Table 5 presents estimated four-year average annual energy efficient window installations using the four growth scenarios that reach the 2040 target. Delaying growth will require significant growth through the 2030s. Regardless of which growth scenario used, the rate of future installations will need to rise dramatically from the current estimated number of windows currently installed to reach the 2040 target.

Table 5: Average Annual Energy Efficient Windows Installed, by Growth Scenario

Average Annual Energy Efficient Windows Installed, by Growth Scenario				
Year	Scenario 3: Slow Initial Uptake	Scenario 4: Average Initial Uptake	Scenario 5: Fast Initial Uptake	Scenario 6: Enforced Replacement
2024-2027	53,000	26,000	450,000	27,000
2028-2031	417,000	92,000	760,000	230,000
2032-2035	1,100,000	920,000	580,000	790,000
2036-2040	370,000	790,000	180,000	805,000

Source: McSweeney & Associates Calculations.

Workforce Status

According to the National Occupation Classification (NOC) definitions, the job type "residential and commercial installers and services (NOC 73200)" is relevant to the energy efficiency market. Although new skill sets among the current labour pool are not needed, a significant lingering issue is the volume of new window installers that would be required to meet 2040 targets. Currently, it is suggested that there are approximately 1,700 window installers (of any kind of window, not just energy efficient models) working within the construction sector, enough to satisfy current demand. However, to reach 2040 targets annual installations will need to double or triple current window installation rates. Given construction businesses are currently facing staff shortages, it would appear unlikely that this demand could be satisfied easily. This is a significant hurdle to reaching the 2040 targets, as in the event demand rises, the labour pool would be unlikely to be large enough to satisfy that demand, delaying projects significantly.

Local window installation businesses affirmed that installing energy-efficient windows does not necessitate additional skills compared to regular windows. While training pathways are available within the industry for window installers, there are concerns regarding the program's capacity to scale up and meet the demand for increased installation.[29] Data limitations prevent a more comprehensive understanding of the current training capacity, or the future necessary training capacity.

As in the previous section on heat pumps, estimates of future workforce impacts can be assessed. By comparing current market size to jobs and applying that to future estimates, Table 6 presents potential workforce size scenarios. It should again be noted that these do not equate to new jobs, as many of these positions will be filled by individuals currently installing traditional windows.

Table 6: Average Annual Person-Years of Employment Supported by Growth Model

Average Annual Person-Years of Employment Supported by Growth Model			
Year	Scenario 3: Slow Initial Uptake	Scenario 4: Average Initial Uptake	Scenario 5: Fast Initial Uptake
2024-2027	20	42	94
2028-2031	56	241	562
2032-2035	505	1,024	1,432
2036-2040	1,554	1,680	1,757

Source: McSweeney & Associates Calculations.

[29] Fenestration Canada, Installer Certification Program.

Market Impact

The replacement of residential windows with energy-efficient alternatives not only enhances energy conservation but also fosters the growth of new businesses, job opportunities and avenues for export. The figure below illustrates the contributions made by different components within the window replacement process.

Represents Market Area Economic Impact

Represents Economic Growth Potential in 2040

*Represents economic activity in the city of Toronto.

**Source: Lightcast 2023

Conclusions

By 2040 the city will have 445,500 single-unit dwellings and will need to have installed 8.3 million energy efficient windows to meet the NZS target of all buildings achieving low energy standards. This represents a 28,500 per cent growth in the number of high-efficiency windows in Toronto. This report estimates that less than one per cent of total windows in Toronto are replaced by energy efficient windows annually and there is limited information on the current number of installed high efficiency windows. Demand will need to significantly increase to reach this Net Zero Strategy target.

The current labour force skillset does not present limitations to growth as the skills needed to install a high efficiency window will be comparable to that of a regular window and only minimal retraining may be needed. However, moving from a possible market size of 400,000 windows to more than 1,000,000 windows replaced annually may pose significant challenges.

While windows are assembled globally – the manufacturing of glass panes is predominantly done in China - windows are often manufactured locally due to their weight, and this may present some local economic opportunities. On a global scale, the supply chain for energy efficient windows faced slowdowns during the COVID-19 pandemic due to shipping and glass manufacturing shut downs, with US building materials dealers noting that delays in receiving windows were the most typical reason that building constructions were delayed in 2022.[30] In 2023 these supply chain challenges began to ease with many manufacturers beginning to source l components from multiple suppliers and increased investments in automation.[31] It is unlikely that manufacturing capabilities will restrict growth capacity on the city's pathway to net zero in buildings.

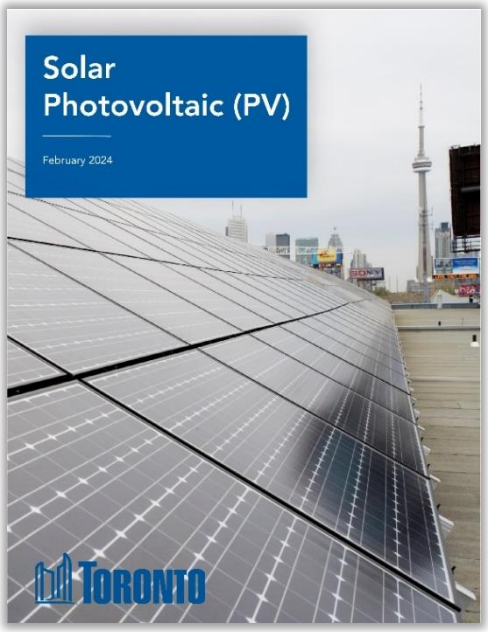
Energy efficient window installation targets are achievable if the installation labour force grows significantly and uptake begins to rise significantly in the 2020s. To succeed, the City should develop relationships with industry stakeholders along the supply chain, build up the labour force, and work with other relevant stakeholders to develop better means of data assessment.

[30] Glass Build America: The Glass, Window and Door Expo. Backlogs Ease, but a Potential Demand Surge May Be Coming. August 2023.

[31] Ibid.

5. Solar PV

Toronto's NZS identifies that transitioning energy production to solar and other renewable energy sources will have a significant effect on lowering Toronto's GHG emissions. The NZS target is to have solar PV systems installed on 100 per cent of buildings (residential and commercial) "where feasible"[32] and that this would result in 5,728 MW of installed PV capacity by 2040.[33] This report focuses on the total installed capacity.



Current Status

Current Solar PV Capacity on Buildings in Toronto

Statistics regarding solar PV capacity in Toronto is lacking. Limitations on how Toronto Hydro releases data on renewable energy currently prevent stakeholders having an accurate picture of solar PV installations.

Toronto Hydro annual environmental performance reports release data on the total renewable energy installed yearly but does not break this data down into system size or renewable energy type (i.e., wind, biogas, or solar PV). Summing these annual figures suggests that 219.4 MW of renewable energy generation has been installed in Toronto by the end of 2022. As the actual amount of solar PV installed is not available, this report uses the total renewable energy installed provided by Toronto Hydro and note that this is an overstatement of the current amount of solar PV installed in Toronto.

2040 Market Size Target

The NZS target is 5,728 MW of solar PV installed on rooftops by 2040. This will require the additional installation of at least 5,509 MW.

The installation of 5,509 MW of PV would represent market growth **of 2,500 per cent.**

[32] Toronto Net Zero Technical Report, 2021.

[33] Toronto Net Zero Technical Report, 2021.

A Note on Future Innovations in Solar Technologies

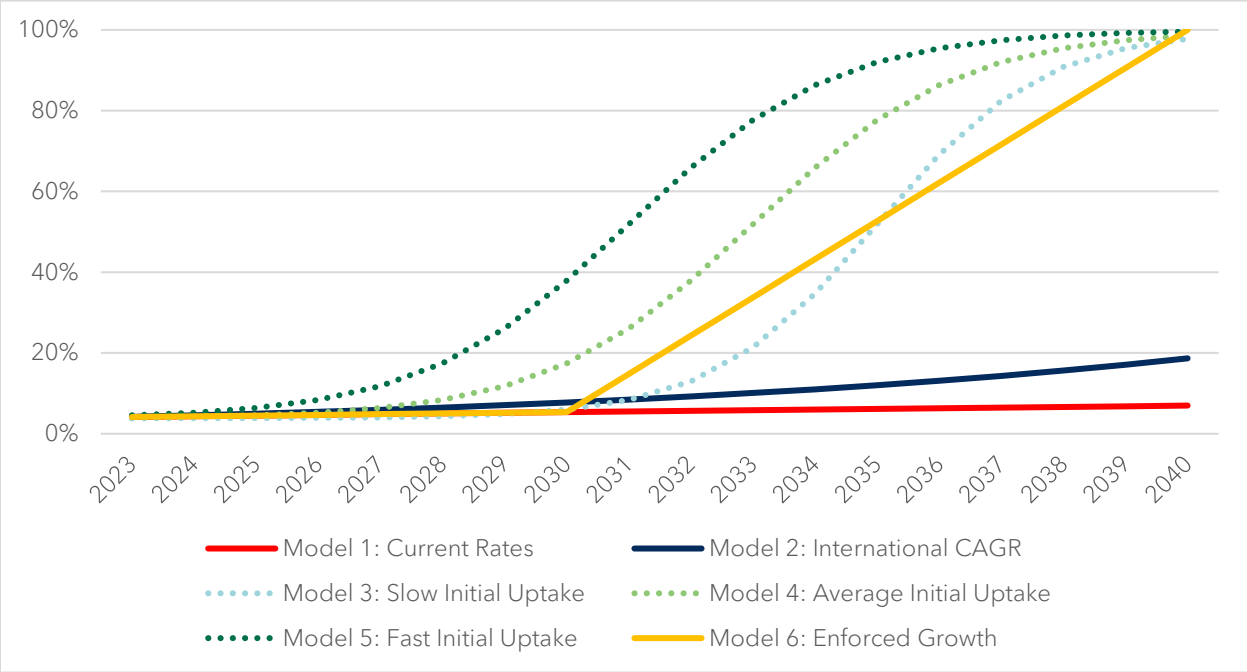
Solar modules made in 2018 are 17 per cent more efficient in capturing solar energy compared to modules made in 2010, a trend that is expected to continue. As well, building integrated PV (BIPV) provides significant opportunities to harvest more energy in Toronto.

These technological improvements and innovations may have a significant future impact, but no specific calculations related to them have been included in this report.

Potential Growth Models

This report uses the six models outlined in the introduction for the Solar PV market and they are shown in Figure 10.

Figure 10: Solar PV Market Growth Scenarios



Source: McSweeney & Association Calculations.

- Scenario 1 uses the average annual growth rate over the last four years (2.9 per cent). This Scenario fails to reach seven per cent of the 2040 target.
- Scenario 2 uses the anticipated international CAGR (9.2 per cent) and it similarly falls short of reaching Toronto's Net Zero targets, though reaching 20 per cent of the target.
- Scenarios 3-5 reflect more aggressively traditional industry patterns (S-curve growths). As with other market areas, the longer it takes to rise above current

growth rates (2.9 per cent), the sharper growth will need to be when the growth phase begins. The required growth rates in these 3 scenarios are shown in Table 7.

Table 7: Annual Growth (CAGR) per Period by Growth Scenario

Annual Growth (CAGR) per Period by Growth Scenario			
Year	Scenario 3 Slow Initial Uptake	Scenario 4 Average Initial Uptake	Scenario 5 Fast Initial Uptake
2023-2025	0.4%	4.3%	11.5%
2026-2030	9.0%	27.3%	35.3%
2031-2035	44.1%	24.4%	12.1%
2036-2040	7.2%	2.7%	0.9%

Source: McSweeney & Associates Calculations.

- Scenario 6 shows enforced growth where solar installations are mandated to be installed beginning in 2030. However, the mechanism for this enforced installation requirement has not been identified in this report as it is not replacing other technologies or building components (unlike the replacement of natural gas furnaces or windows).

Workforce Status

The following job types are considered relevant to the Solar PV market:

- Contractors and supervisors, electrical trades and telecommunications (NOC 72011).
- Electricians (NOC 72200).
- Roofers and shinglers (NOC 73110).
- Residential and commercial installers and servicers (NOC 73200).

Three occupations, including electricians, roofers and shinglers, and residential and commercial installers and servicers, have data regarding the number of individuals being trained annually. This information is presented in Table 8. These occupations need retraining due to the shift towards energy-efficient practices. Many businesses facilitate labour force training internally, primarily through "learning on the job" approaches. However, some businesses have expressed that training provided by accredited training institutions would be advantageous for the industry as a whole. A better understanding of how many of the current annual training completions are of relevance to the solar PV market is unavailable at this time. Many individuals who are completing training are working in entirely different sectors. As well, data limitations and a lack of clarity regarding future business needs prevent a more comprehensive understanding of the future necessary training capacity.

Table 8: Average Annual Training Completions, Occupations of Relevance

Average Annual Training Completions, Occupations of Relevance			
Years	Electricians (except industrial and power system)	Roofers and shinglers	Residential and commercial installers and servicers
2009-2012	131	85	341
2013-2016	285	150	564
2017-2020	236	144	669

Source: Lightcast 2023.

Market Impact

If Toronto successfully attains its Net Zero target and introduces an additional 5,509 MW of solar PV, estimates suggest that roughly 160,000 person-years[34] of employment will be created during the implementation process. The employment breakdown includes:

- 77,000 local jobs for installation, operation and maintenance.
- 13,000 non-local jobs for the extraction of raw material.
- 69,500 jobs, a mix of local and non-local, for the manufacturing of solar PV components and modules, which currently predominantly occurs offshore but could potentially shift to local production.

Occupations associated with solar installations make a substantial financial impact due to the relatively high wage earnings in these fields. For example, in 2022, median salaries for relevant occupations were as follows:

- Contractors and supervisors in electrical trades and telecommunications: $73,620.
- Electricians: $83,140.
- Roofers and shinglers: $57,760.
- Residential and commercial installers and servicers: $47,040.

Since 2007, these occupations have collectively witnessed significant growth in Toronto, with a combined growth rate of 23 percent. The number of positions has risen from 7,683 to 9,454 during this period. Notably, each of the four occupations has demonstrated positive growth rate.

[34] A person-year of employment is the equivalent of one year of full-time work.

Conclusions

Less than 219.4 MW of solar PV has been installed in Toronto. The NZS target is 5,728 MW of solar PV installed in Toronto by 2040, representing a growth of at least 2,500 per cent.

Currently sales of solar PV remain low, with growth averaging three per cent per year. While there is poor annual historical data, the past periods of rapid growth were stimulated by government/utility support programs. Specifically, the cancellation of the Feed in Tariff (FIT) program in 2016 resulted in a 71 per cent decrease in solar sales. Over the next 16 years demand will need to significantly increase to reach Toronto's 2040 targets. Solar PV is now at "grid parity" in many places globally - where solar is competitive to the rates that consumers pay their utilities - and globally the industry is experiencing dramatic growth. Industry in Toronto requires, to meet this demand without major disruptions and upheavals in the supply chain, confidence and certainty from the major market supporters on the future installed market size.

Solar PV's international supply chain appears capable of supplying Toronto's market demand. Canadian stakeholders were clear that supply capabilities worldwide are so significant compared to the size of Toronto's market that meeting local demand will not be an issue unless geopolitical or environmental issues create supply chain disruptions. The Toronto region also has a small solar PV manufacturing cluster that could supply a greater percentage of the local demand if supported.

Conversations with local solar businesses suggest that no significant challenges exist to scaling up local installation companies to meet demand. While individual businesses might be unable to add to their own labour force or obtain adequate financing at a pace needed to meet significant sales increases (i.e., a 44 per cent annual increases using Scenario 3) the industry as a whole can be expected to grow as needed.

However, the attraction and training of a labour force to meet the increased growth rates may be a significant challenge as this is already noted as impacting the growth of the US solar PV market. Many of the skills found in the solar labour force are found in similar trades such as roofers or electricians but those trades are already experiencing shortages. At this time, the need for formal training of the labour force done by training institutions compared to the current practice of relying on internal, informal on-the-job training is unknown.

For the solar PV market the City of Toronto should consider a review of its regulatory process to speed the installation process and reduce costs, review the need to support training of installers, and provide certainty where possible regarding future demand expected within Toronto.

6. Cycling

At present, motor vehicles are one of the greatest single sources of air pollution in Toronto.[35] To lower GHG emissions and reduce the number of passenger vehicles operating in Toronto, the City has set 2040 targets to have:

- 75 per cent of all trips under two kilometres walked.
- 75 per cent of current car or transit trips under five kilometres shift to either bikes or e-bikes.

This chapter looks at the market growth of increasing the use of bikes and ebikes. Note that walking is outside the scope of this report.

Data Limitations

A challenge in assessing the NZS target for the cycling market is that the breakdown of distances("trips under two kilometres", and "trips under five kilometres") in the NZS target is not aligned to how the City's transportation surveys report distance data. In the survey, trip-related data is reported for distances "under one kilometre" or "one-to-five kilometres". As existing data does not align with Toronto's NZS targets, a proxy target is used of "75 per cent of trips between one and five kilometres shifting to cycling. (bikes and e-bikes)."

[35] Transform TO Net Zero Strategy.

Current Status

Current Number of Bicycles in Toronto

The City of Toronto Cycling Study, conducted in July 2019, reported that there are 1.1 bicycles owned in Toronto for every resident over the age of 15. Another study estimated that the there is an average of 1.7 non-electric bicycles and 0.1 electric bicycles per household.[36] These studies indicate that the current total number of bicycles in Toronto is between 2.1 million and 2.7 million.

Current Number of Cycling Trips Between One and Five Kilometres Annually

A 2016 survey of transportation modes, applied to Census 2021 population counts, indicates that approximately five million trips are taken by Toronto residents daily.[37, 38] Another report found that 33 per cent of trips taken within the Greater Toronto-Hamilton Area is between one and five kilometres. This provides an estimates that **Toronto residents take 602.9 million trips annually between one and five kilometres.** [39]

- Further analysis suggests that 0.9 per cent of *all trips* are currently cycled,[40] amounting to 45,000 daily cycled trips.
- Finally, 80 per cent of **all current cycled trips** , or 36,000 trips, are between one and five kilometres.[41]
- Therefore, it is estimated that there are 13.2 million trips between one and five kilometres cycled annually as of 2021 **(2.2 per cent of total trips between one and five kilometres).**

[36] Nanos, City of Toronto Cycling Study. July 2019.

[37] Transportation Tomorrow.

[38] Those under 19 are not legally allowed to drive a vehicle by themselves. As such, any automobile trips taken by this cohort will be done with an adult and captured within this data.

[39] Cycling Potential in the GTHA, Transportation and Land Use Planning Research Laboratory, Ryerson University. October 2016.

[40] Cycling Potential in the GTHA, October 2016.

[41] Cycling Potential in the GTHA, October 2016.

2040 Market Size Target

Taking into consideration future population projections[42], Toronto residents will make 864.1 million trips between one and five kilometres in 2040. To meet the NZS 2040 target there will need to be approximately 648.1 million trips taken via bicycles and e-bikes annually.

Achieving the NZS target in 2040 will mean 648.1 million trips between one and five kilometres will be cycled annually.

This represents market growth **of 4,800 per cent.**

Potential Growth Models

Four growth models are used for the cycling market.

1. There is inadequate data on Toronto's travel mode trends to present Model 1 "business as usual" projections.
2. Model 6 was not used as there is no apparent regulatory mechanism to enforce cycling in the same way that enforcement might be possible in other markets.

Providing guidance on which "S curve" model Toronto might follow in a specific market requires a more thorough analysis of potential demand stimulation initiatives and is beyond the scope of this project. However, for bikes, the growth in commuter cycling has largely been tied to infrastructure and safety improvements. The more bike infrastructure there is – the more people will use their bikes. The experiences of other municipalities can provide an indication of potential growth scenarios that Toronto may be able to achieve if supply side challenges are resolved.

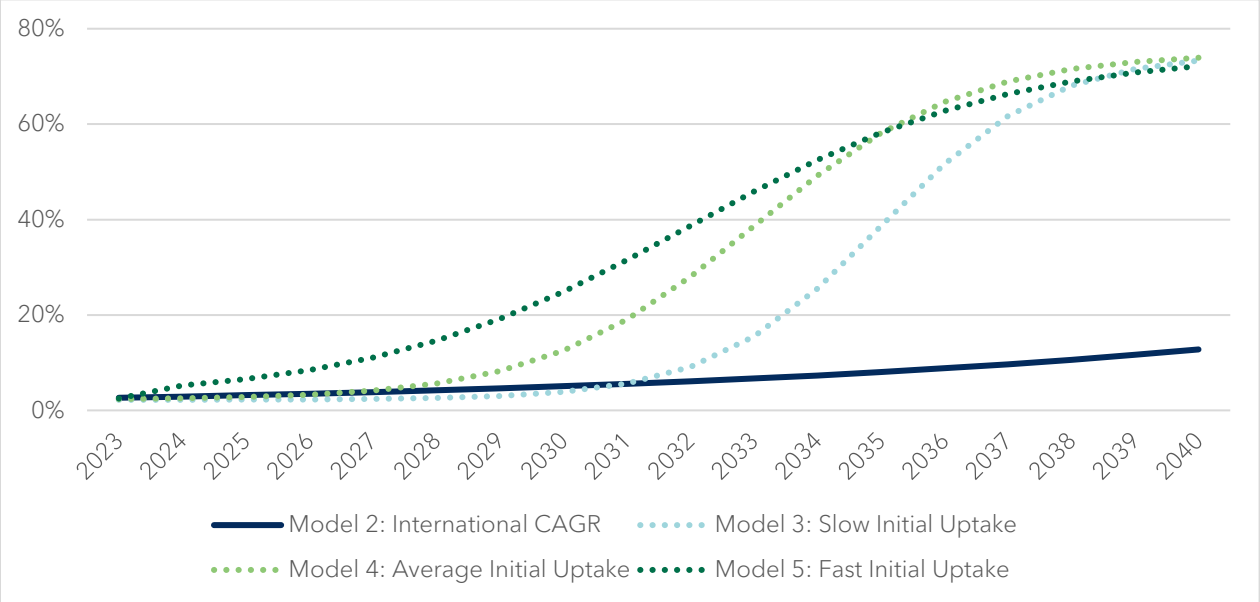
European municipalities that have invested heavily in cycling infrastructure provide valuable case studies.[43] For example, the number of all trips taken by cyclists in Paris in 2001 was less than one per cent in 2001 and had only grown to 1.6 per cent by 2010 – an average annual increase of about seven percent. Yet between 2018 and 2019 the number of cyclists in Paris

[42] Ministry of Finance Census Divisions Population Projections.

[43] Please note, the percentages of trips taken within this section are not distance-specific, due to data availability limitations.

rose by 54 per cent[44], and it increased between 2020 and 2021 by 70 per cent.[45] By 2021 the number of cycling trips in Paris had dramatically risen to approximately 15 per cent of all trips.[46] This rise has coincided with Paris building more cycling lanes than any other city in Europe over that time period along with both supply and demand side support programs. The four growth scenarios are presented in Figure 11.

Figure 11: Cycling Market Growth Scenarios



Source: McSweeney & Associates Calculations.

- Scenario 2 (using anticipated international CAGR - 9.7 per cent - extrapolated) falls well short of reaching Toronto's Net Zero targets, barely surpassing 10 per cent of all trips by 2040.
- Scenario 3 (reflective of "slow initial uptake") follows a trajectory through 2030 similar to rates of growth seen in municipalities around the world where cycling infrastructure is not prioritized, and then needs to see explosive growth to meet the 2040 target.
- Scenario 4 (reflective of "average initial uptake") sees growth in line with the anticipated international CAGR before seeing more aggressive growth rates starting in 2029, comparable to rates Paris saw from 2018 to 2021.
- Scenario 5 (reflective of "fast initial uptake") sees aggressive growth rates comparable to what Paris saw from 2018 to 2021, starting in 2025-2026 - earlier in the decade than scenario 4.

[44] People for Bikes. How Paris Raised Bike Ridership 54 Percent in One Year. 2020.

[45] The Local France. Number of cyclists in Paris soars as car journeys decrease. 2019.

[46] France Today. The Paris Bicycle Boom. 2021.

Workforce Status

The primary occupation deemed significant in the cycling market is that of Bicycle Mechanic (NOC 73209 - other repairers and services). Unfortunately, occupation data within this classification is moot because NOC 73209 includes a variety of unrelated occupations (camera repairer, piano repairer, sporting goods repairer). Research indicates that the cycling retail and service sectors in Toronto have the capacity to service around 53,000 bicycles per year. Local retail businesses unanimously expressed the belief that there is currently an insufficient number of bicycle mechanics available to accommodate substantial increases in demand. In line with the Net Zero targets, projections suggest that by 2040, Toronto could need bicycle mechanics ranging from 3,000 to 12,400.

Acknowledging the wide range and its reliance on rough approximations, this report opts to use the average figure of 7,700 mechanics for forecasting future scenarios. This translates to one mechanic for every 83,461 trips made by residents annually.[47] Table 9 uses this estimation to project the necessary number of bicycle mechanics, annually, for each five-year period spanning from 2021 to 2040, categorized according to potential growth rates.

Table 9: Mechanics Needed per Year, at a Rate of One Mechanic per 83,461 Cycling Trips

Average Mechanics Needed, at a Rate of One Mechanic Per 83,461 Cycling Trips				
Growth Trajectory Scenario				
Year	Scenario 1: International CAGR	Scenario 2: Average Initial Uptake	Scenario 3: Slow Initial Uptake	Scenario 4: Fast Initial Uptake
2021-2025	220	200	180	920
2026-2030	390	620	260	3,500
2031-2035	650	3,700	1,800	6,300
2036-2040	1,100	7,200	7,700	7,500

Source: McSweeney & Associates Calculations.

Canada lacks an organized or accredited training program specifically tailored for bike mechanics. Instead, the training of bike mechanics occurs primarily through individual employers. Businesses cite various constraints that limit their ability to train new mechanics (one or two mechanic annually). The training constraints include:

- Overall capacity (i.e., time and space).

[47] This number is only used to allow for annual estimates presented in Table 9. As better data becomes available, more accurate approximations should be available and replace the projections outlined here.

- Cost to train a new mechanic.
- Challenge in attracting good candidates.

These constraints are further compounded by low wages for trained bike mechanics and employees within the bike industry in Canada, as well as the seasonal and volatile nature of the labor market, which is susceptible to changes in the global supply chain.

As of 2023, the City estimates there are approximately 129 bike repair, service, and retail shops in Toronto. If each of these businesses were to train one new mechanic annually, only 129 mechanics would be added to the labour force each year, resulting in a total of 2,193 additional mechanics by 2040—far below the required number. Recognizing the inadequacy of in-house training to meet future demands, the following alternative training approaches need to be considered:

- The designation of bicycle mechanics as a skilled trade.
- Providing training incentives to businesses to lower training costs and increase training capacity.
- Standardize skills development and training.
- Increase marketing to build awareness of bicycle mechanics as a viable career path.

These findings echo a study completed by the Centre for Active Transportation, in partnership with the City of Toronto, which focused on bike industry labour force development.[48]

[48] The Centre for Active Transportation. Micro Mobility Workforce Development Report. June 2023.

Market Impact

The potential growth of cycling markets tied to Toronto's Net Zero objectives carries significant local importance, as shown in the Figure below. The impact analysis presented here focuses on the retail and repair segments of cycling businesses.

Conclusions

Although 74 per cent of Toronto households owned at least one bicycle in 2019, many of these bikes are not used for commuting. Of the 602.9 million trips taken between one and five kilometres in 2021, only 2.2 per cent (13.2 million trips) were cycled. To reach the Net Zero Strategy targets by 2040, 648.1 million trips between one and five kilometres will need to be taken by bicycle, a growth of 4,800 per cent.

As with other market areas, local Canadian distributors who were consulted felt that supply will not be a barrier in meeting the 2040 target. The global bike industry is mature with extensive supply chains able to meet a large global market.

One limitation to growth that potentially exists is in the distribution network within the city. Some industry members feel that the space needed to seasonally stock products required to meet a drastic increase in demand could present challenges due to the shrinking industrial employment lands in Toronto and the high costs of retail space. Many cycling retailers store their stock in their retail space as finding warehousing space close is challenging. Alternative solutions (i.e., centralized warehousing outside the city) may be necessary. This should be a short-term challenge that the growing market will help to correct.

A significant barrier to growth was noted by the retail businesses regarding the quality and quantity of bicycle mechanics. To meet the Net Zero Strategy target of 650 million cycling trips annually will mean a substantially increased demand for bicycle maintenance. Current estimates suggest approximately 200 bicycle mechanic positions exist in Toronto while there will be a need of approximately 7,700 bicycle mechanics by 2040 if the NZS cycling target is met. Businesses stated that even if they trained to full capacity in-house every year, there would still not be enough mechanics to satisfy demand, leading to critical backlogs.

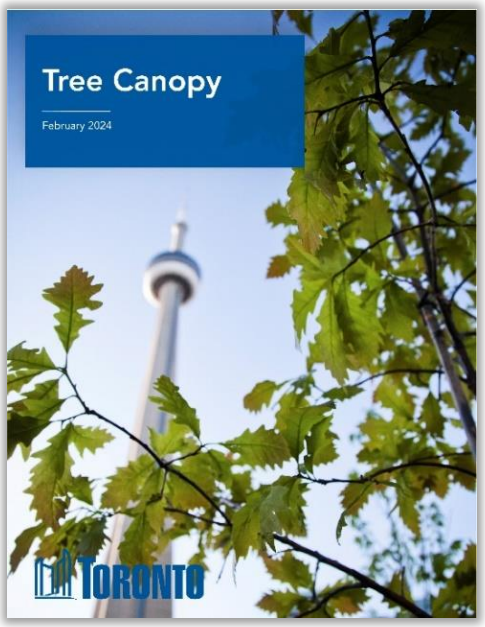
Given this potential barrier to achieving the NZS cycling target, the City should be proactive in considering ways to support the training of bike mechanics and labour force attraction for this industry. The Toronto cycling industry consulted repeatedly mentioned that they are aware of the challenge along with potential solutions but lack the resources to develop the solutions on their own. This may be a challenge that is national in scope and therefore requires collaboration with higher levels of government.

7. Tree Canopy

Toronto's tree canopy needs to increase to 40 per cent of Toronto's total area from the current 30 per cent to meet the NZS 2040 target.[49] This would remove carbon dioxide from the environment while reducing the urban heat island effect and flood stresses.[50],[51] Toronto's urban forest consists of all trees and shrubs within the city boundary, on City-owned and private property. The urban forest is estimated at 11.5 million trees, with the City managing about 5 million trees on public land and 6.5 million trees owned and managed by private owners.

Urban Heat Islands

The urban heat island effect occurs due to buildings and paved surfaces amplifying and trapping heat more than natural ecosystems. This effect can be overcome by trees and other vegetation in green spaces, which provide shade and increases evaporative cooling. Daytime temperatures in urban areas can be as much as seven degrees higher than temperatures in outlying areas.



Current Status

Tree Population and Total Canopy Coverage Area

In 2018, Toronto's urban forest was estimated at 11.5 million trees, with a canopy cover of between 28.0 (179. km^2) and 31.0 (195 km^2) per cent. This consists of about five million trees on City property (streets, parks and ravines) and about 6.5 million on private property.

[49] Canopy coverage includes trees and shrubs, however, to remain consistent with previous Urban Forestry publications, it is referred to as simply "tree canopy" coverage in this report.

[50] Transform TO Net Zero Strategy, Technical Report.

[51] Knowable Magazine. What can cities do to survive extreme heat? October 2022.

2040 Net Zero Strategy Target

To meet the NZS 2040 target Toronto's tree canopy will need to cover an area of 252 km^2 - an expansion of between 57 km^2 and 73 km^2. Based on the current canopy cover area and number of trees this would require an additional 4.6 million trees. It is important to note that this does not represent the number of trees that need to be planted due to several factors including:

- Natural reseeding that occurs in parks and ravines.
- The mortality rates of trees.

The size of the tree that is planted and how rapidly it grows.

Trees planted are typically three- to seven-year-old saplings with a trunk diameter of one to five inches. They will take many years to grow into the mature trees that provide maximum canopy coverage. Proper maintenance of trees to ensure they grow to maturity is imperative when considering expanding the tree canopy.

An additional 4.6 million trees and shrubs are estimated to be needed to raise tree canopy cover to 40 per cent in Toronto.

Potential Growth Models

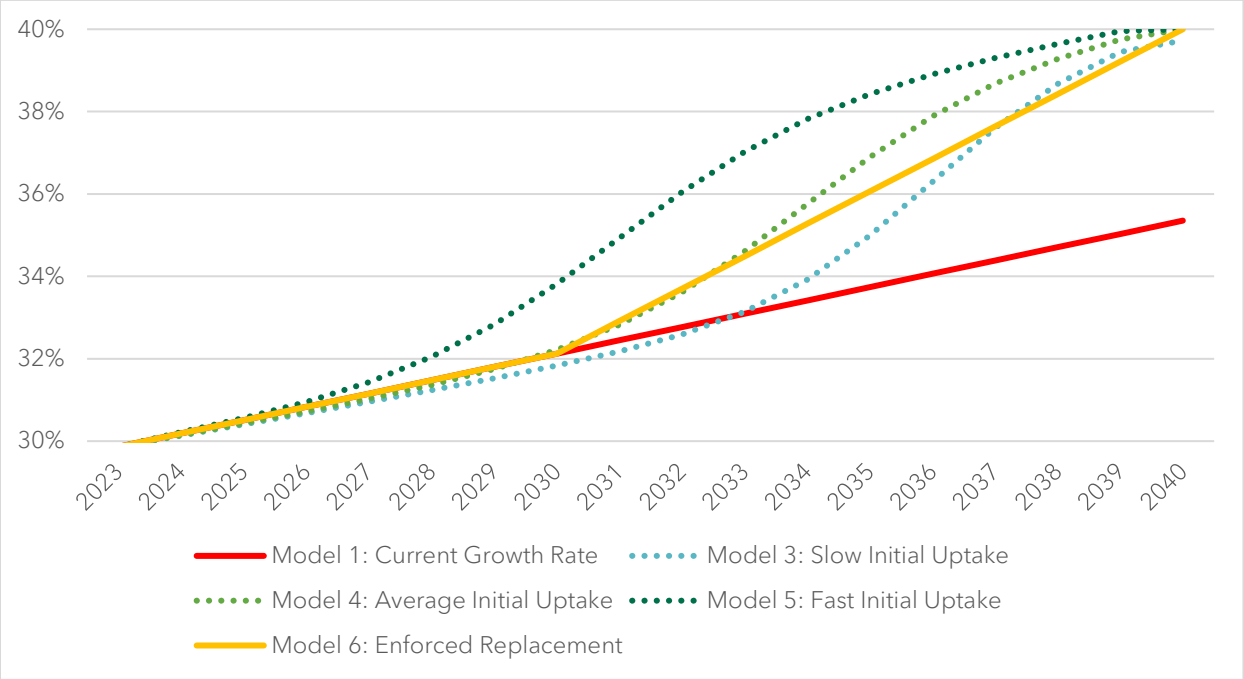
One of the challenges in evaluating potential growth scenarios for Toronto's tree canopy is that there are two very dissimilar sections to this market that operate differently when it comes to "purchasing." The City-owned trees operate in a controlled marketplace governed by primarily budget and policy issues while the private property market operates with more complex consumer purchasing considerations. As contracts for City-planted trees are previously agreed to and static, it is assumed that this rate will not change. The S-Curve growth trajectories do not reflect a change in demand on public property, only private property.

The growth scenarios outlined below attempt to quantify the number of trees needed to be planted in Toronto to meet the NZS 2040 target. However, they should be considered as rough estimates to identify potential supply side challenges that need to be overcome. Items not covered in the growth models include:

- A tree planted in 2030 will have more impact on canopy coverage and carbon sequestration by 2040 than one planted in 2038 (whereas, for example, a heat pump will provide the same amount of heat over its life).
- The growth scenarios used account for the mortality of trees (estimated at 3.3 per cent annually in Toronto) but they do so on a 1:1 basis (i.e., one tree lost is replaced by one new tree. of equal value). However mature trees have a higher impact than newly planted saplings on the heat island effect due to their shading coverage and respiration rates.
- These scenarios use a consistent mortality level, though it may rise (i.e., more trees die) as the impacts of climate change become more severe.

This report uses five of the six models outlined in the introduction to show potential growth scenarios for the tree canopy as the international growth scenario is not relevant.

Figure 12: Tree Canopy Growth Scenarios



Source: McSweeney & Association Calculations.

- Scenario 1 (an estimate of the current growth rate extrapolated through 2040) based on the rates from 2008-2018 (net growth of 130,000 trees annually on both City owned and private property) would result in approximately 35 per cent canopy coverage by 2040.[52]

- Scenarios 3-5 depict S-curve growth rates in private ownership uptake, while maintaining City-managed tree planting rates at the current levels.[53]

    - Scenario 3, characterized by "slow initial uptake," projects a rate of planting below the current private property growth rate prior to 2030. This scenario anticipates a potential slowdown in demand for new trees as available land becomes challenging to acquire.

    - Scenario 4, indicating "average initial uptake," is in-line with current rates of growth, followed by more rapid uptake during the mid-2020s.

    - Scenario 5, showing "fast initial uptake", presumes a spike in uptake beginning in the mid-2020s.

[52] An estimated 118,000 trees and shrubs are planted annually by Toronto's Urban Forestry department.

[53] City-managed tree planting rates are dependent on City budgets and previously agreed upon contracts with specific growers. Budgetary decisions are outside the scope of this report. It is assumed that current contracts will remain steady through the life of the Net Zero Strategy.

- Scenario 6 represents enforced growth beginning in 2030. This scenario could occur if budget is allocated to achieve specific targets to increase the quantity of living trees in the city (planted – died). Enforced growth could occur on either private or public property, depending on how enticement and enforcement is undertaken.

Challenge: The Importance of Planting Trees Early in the Net Zero Strategy Timeline

Scenarios 3, 4, and 5 mirror historic industry growth rates of consumer-driven markets. Within these Scenarios, the number of trees planted on public property remain static, while the growth rate applies to private property trees.[54] Depending on the growth scenario, the emphasis on aggressive intermediate growth is quite significant. In the most extreme example (Scenario 3), the largest single year increase in private plantings would be 416,064 (seen in 2036 and 2037). While this increase in 2036 and 2037 would see a technical success in the number of trees planted by 2040, the impact on climate change and actual canopy coverage would be minimal, as the trees would still be young in 2040. It is possible that to achieve the City NZS targets for increasing the tree canopy coverage that only an aggressive tree planting initiative as shown in Scenario 5 will be successful.

[54] Model 1 is excluded from this analysis as it fails to reach 2040 targets. Model 6, as it is artificially induced and linear, is also excluded from this analysis.

Workforce Status

The following job types are considered relevant to the tree canopy market:

- Silviculture and forestry workers (NOC 84111).
- Logging and forestry labourers (NOC 85120).
- Landscape and horticulture technicians and specialists (NOC 22114).
- Public works maintenance equipment operations and related workers (NOC 74205), and
- Contractors and supervisors, landscaping, grounds maintenance and horticulture services (NOC 82031).

The above-mentioned occupations are responsible for growing seedlings in nurseries and tree farms, transplanting on public and private lands, and maintaining and removing dead trees and shrubs. Stakeholders have emphasized the importance of standardized training, similar to the ISA-Certified Arborist Municipal Specialist, for individuals tasked with preserving Toronto's urban forest. Many stakeholders view education and training for laypeople and private property owners as essential components.

A considerable labour shortage exists in the forestry sector in Canada, which also extends to Toronto's urban forestry cluster. Addressing this labour force deficit is imperative for Toronto to achieve its Net Zero Strategy targets for expanding the Tree Canopy. In light of these findings, careful consideration must be given to methods for enhancing both institutional training and on-the-job training opportunities.

The Toronto region hosts several forestry training programs that attract students from across Canada and worldwide. The two notable training institutions are: the University of Toronto's Faculty of Forestry and Humber College's Urban Arboriculture programs. According to available data, over the past decade in the greater Toronto area, occupations pertinent to businesses in this market have witnessed approximately 390 graduations annually. Nonetheless, this figure does not accurately reflect the annual number of graduations directly influencing Toronto's forest management strategy.

While the local academic training programs are in a good position to absorb additional students to meet the Toronto industry's needs, there is a significant labour shortage in the forestry industry in Canada and this extends into Toronto's urban forestry cluster. This labour force shortage will need to be addressed for Toronto to meet its NZS goals for Tree Canopy expansion. Given these findings, considerations will need to be given as to how to increase both institutional and "on the job" training.

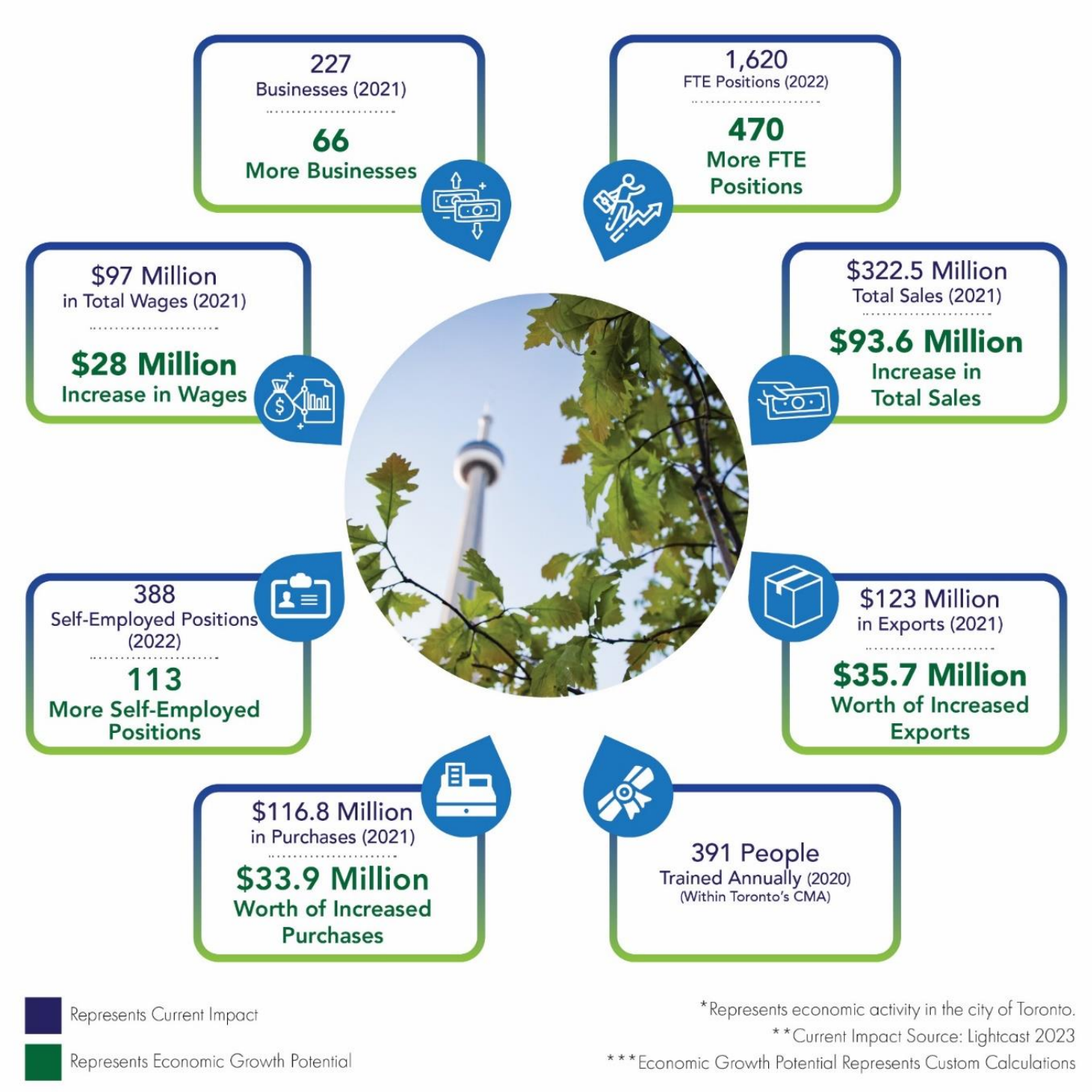
Market Challenges Outside the Scope of this Report

Toronto's urban forest is a unique market within this report due to it being a "living" market. Several challenges exist outside the scope of this report are noted here:

- The type of tree species planted will dictate success related to the 2040 targets. If a species ill-suited to Toronto's environment is planted, it grow poorly with a high mortality rate. Planting trees well-suited to Toronto's environment will lead to a robust urban forest. Toronto's climate is changing – trees planted today will need to be able to survive in the climate of the 2060s for them to reach maturity. Educating private property owners considering tree plantings is crucial.
- Climate change is already impacting the health of Toronto's urban forest. Increases in disease and mortality rates within Toronto's urban forest is leading to greater difficulties maintaining trees. More investment in maintaining trees on public and private property will be required in the future.
- The location of tree plantings has an impact on the benefits it provides. Planting additional trees in areas where trees are heavily concentrated will have less impact than planting in an "urban desert." But "urban deserts" often require more investment in maintenance and care.
- Increasing the tree canopy requires more land. According to Toronto's 2018 Tree Canopy Study, the greatest amount of available land for tree canopy expansion is found on private property, particularly those zoned for residential use. This creates potential policy conflicts with intensification and the desire for more housing in the city. Providing support and education to property owners on the value of tree planting on their property may be an essential element to achieving this NZS target.

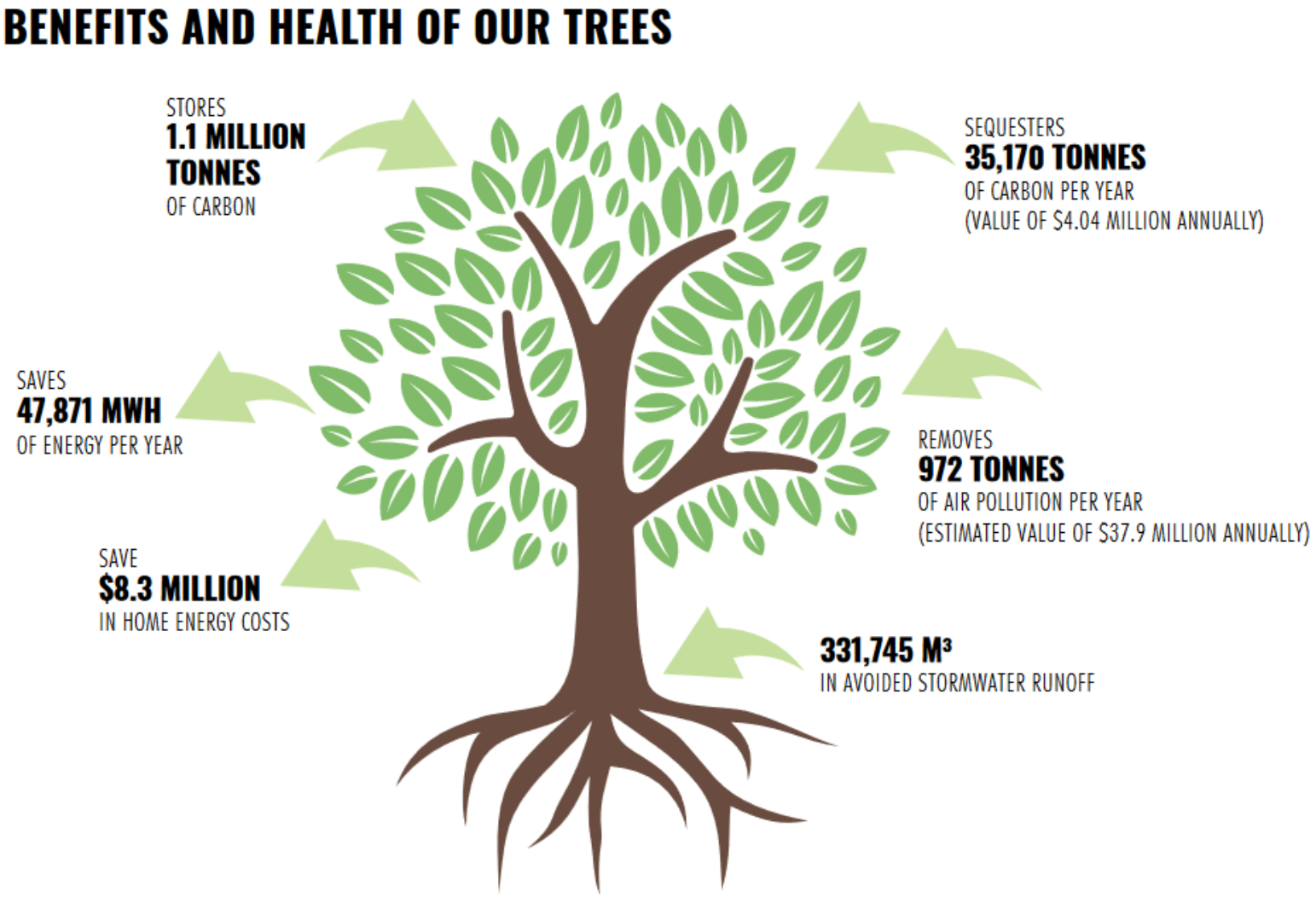
Market Impact

The growth of tree canopy cover in line with Toronto's Net Zero Strategy targets not only fosters the emergence of new businesses but also creates employment opportunities and avenues for export. The figure below outlines the contributions made by various components within the expansion of tree canopy cover.



Community Impact

Beyond conventional economic indicators such as jobs, wages, and sales, Toronto's urban forest delivers significant additional benefits to the city and its residents. According to the City's Tree Planting Strategy, the current urban forest holds a structural value of approximately $7 billion and yields over $55 million worth of environmental benefits and cost savings annually. These figures have the potential to increase significantly with planned increases in canopy coverage, especially amidst the worsening impacts of climate change on urban centers. The figure below outlines the current benefits to the city derived from its urban forests.



Source: Toronto Tree Planting Strategy

Conclusions

An estimated 11.5 million trees make up Toronto's urban forest, with approximately 40 per cent on City property and 60 per cent on private property. To achieve the NZS target of 40 per cent tree canopy coverage will require this to increase to approximately 16.1 million trees based on the modeling done in this report. While the model used in this report is not precise it does suggest that an estimated quarter million trees will need to be planted annually in the city to meet the 2040 target and that many of these must be planted on private property.

Industry stakeholders consulted were clear that local growers have the capacity to supply the number of trees required annually provided there is clear direction and commitments on the purchasing of trees. Unlike other market areas in this report, within the urban forestry industry there is a long lag between when an order is placed and when it is received. A solar PV module or a heat pump can be manufactured in days, growing trees for planting can be a three-to-seven-year process. Seeds planted in 2025 may not be ready for planting until 2030 or later. This reality presents a more pressing timeline compared to other industries, as any "ramp up" period will be much slower. Moreover, as tree canopy presents a "living" market area, any delays in planting new trees will result in less canopy cover per tree in 2040 with the resulting decrease in ecological benefits.

While there is adequate training available locally for arborists and tree nursery staff to meet future labour needs there is a general forest industry labour force shortage. Various local stakeholders consulted spoke on the challenge of attracting qualified arborists. This may increasingly cause challenges as more effort will be required to maintain Toronto's urban forestry in the future due to climate change impacts.

Stakeholders stated that proper planting and maintenance is an essential part of a strategy to increase the tree canopy. While the City has dedicated staff and resources to maintain trees on public property this can be challenging for trees on private property. Providing support, including education to private property owners, is considered essential by many stakeholders to achieve the 40 per cent tree canopy target.

To achieve the 2040 tree canopy target, Toronto should address demand side challenges, ensure there is a sufficient supply of the correct species of trees for planting annually (which may require order placements years in advance), and educate and provide support for property owners on proper planting and maintenance strategies that will increase the longevity of the trees they plant.

8. Conclusion and Recommendations

Conclusion

In December 2021, Toronto City Council adopted the TransformTO Net Zero Strategy to reduce community-wide greenhouse gas emissions in Toronto to net zero by 2040. At the time, the NZS was one of the most ambitious municipal climate plans in North America. The NZS identifies targets that need to be achieved by 2040 in the key sectors of energy, buildings, and transportation.

This report, Economic Potential and Workforce Requirements in Toronto's Net Zero Strategy, quantifies the economic impacts that the Net Zero Strategy will have in six green-industry markets. The research and analysis within the report reveal that current rates of uptake across each of the six markets are low in comparison to what is required to reach the 2040 targets. To understand what impacts growth to achieve the targets may have on businesses, modelling was undertaken to present up to six potential growth scenarios for each market.

Modelling showed that current local and international growth rates will not reach the NZS targets in 2040 in all six markets. In the event demand rises to meet the NZS targets, this report identifies potential barriers to businesses' ability to meet this demand.

Manufacturing and distribution businesses in all six markets are confident that products will be available to meet the required NZS demand in the various growth scenarios modelled in this report.

However significant barriers loom with the local industries' abilities to install (or plant in the case of trees) these products. While these challenges can be overcome given adequate time it will require significant resources to ensure there is a large and skilled labour force in place to meet the necessary deployments levels to achieve targets.

Labour force issues are not unique to Toronto or to the green industries, however they present unique urgency to resolve for the green industry due to climate change. The City will need to prioritize collaboration with various local stakeholders including businesses, not-for-profit organizations, skill training institutions, unions and labour groups, neighbouring municipalities, and higher levels of government to resolve.

In the event that the supply side barriers to growth are overcome and demand can be stimulated to increase deployment levels in each of the markets, the 2040 NZS targets can be achieved.

Challenges and Recommendations

Challenge 1: A lack of available industry-standard data

a. A lack of green-industry-specific data within Statistics Canada's National Occupation Classification (NOC) and North American Industry Classification System codes.

b. Limited-to-no-data available on current uptake.

c. Lack of data sharing among relevant organizations.

d. Lack of alignment between certain NZS targets (i.e., cycling targets) and how data is collected for the market.

e. Statistics Canada data suppression at the 6-digit level in areas smaller than provinces

Markets impacted: All.

Recommendations:

1. Advocate with Statistics Canada to standardize window manufacturing and installation, (separating energy efficient windows from traditional windows) NOC/NAICS codes in a way that is trackable at the local level.
2. Advocate with Statistics Canada to introduce NOC/NAICS codes for solar PV and other renewable technologies.
3. Advocate with the federal government to convene a green industries economic statistics summit to resolve the lack of data on the industries.
4. Create centralized, internal data hubs for recording installations and uptake across the various markets.
5. Connect with other governmental organizations and relevant organizations to determine how to best share data related to climate action progress and success.
6. Align NZS targets with how data is collected related to that target.

Challenge 2: A mismatch between supply and demand within the market.

Markets impacted: All.

Recommendations:

1. Work to build collaboration with national and local industry stakeholders to produce green industry roadmaps to resolve supply side challenges to achieve climate change targets.
2. Determine the best approach to engage, collaborate and support the organization of the supply chains in the various markets in order to manage supply side challenges.
3. As no Canadian window manufacturing or cycling industry associations exists, build relationships locally and nationally within each sector and support the formation of industry led collaboration.

Challenge 3: Potential misaligned timelines between 2040 Targets and lifespan of technologies.

Markets impacted: Registered Energy Advisors, Heat Pumps, Energy Efficient Windows; Tree Canopy.

Recommendations:

1. Internally review phase out timelines and discuss with target market businesses whether current phase out strategies accurately reflect appliance lifespans.
2. Consider accelerating the elimination of natural gas furnaces.
3. Be prepared to increase government support to replace natural gas furnaces and windows before their end of life.
4. Present a demand scenario of heat pumps (15 to 20 years) and energy efficient windows (20 years) if traditional life span replacement is followed by house owners.
5. Manage a decision-making process between the suppliers and the users to synchronize growing and planting operations and plant species selection.

Challenge 4: A lack of standardization and clarity regarding training standards and qualifications.

Markets impacted: Registered Energy Advisors, Solar PV, Tree Canopy, Cycling.

Recommendations:

1. Review the skills development pathways within each market and consider the need to support increasing or developing local training infrastructure.

2. Establish a City-led public directory of businesses in each sector and identify in it their relevant business and professional credentials.
3. Provide information to the public regarding what certifications are available for businesses and the value of the credential.
4. Support a labour force attraction campaign to assist in increasing capacity in the industry.

Challenge 5: Inconsistent rules (and uncertainty regarding rules) of bike repair.

Market impacted: Cycling.

Recommendations:

1. Review local regulations regarding the operation of bicycle repair businesses and, if appropriate and in consultations with the industry, consider a program requiring businesses to meet minimum repair quality standards.

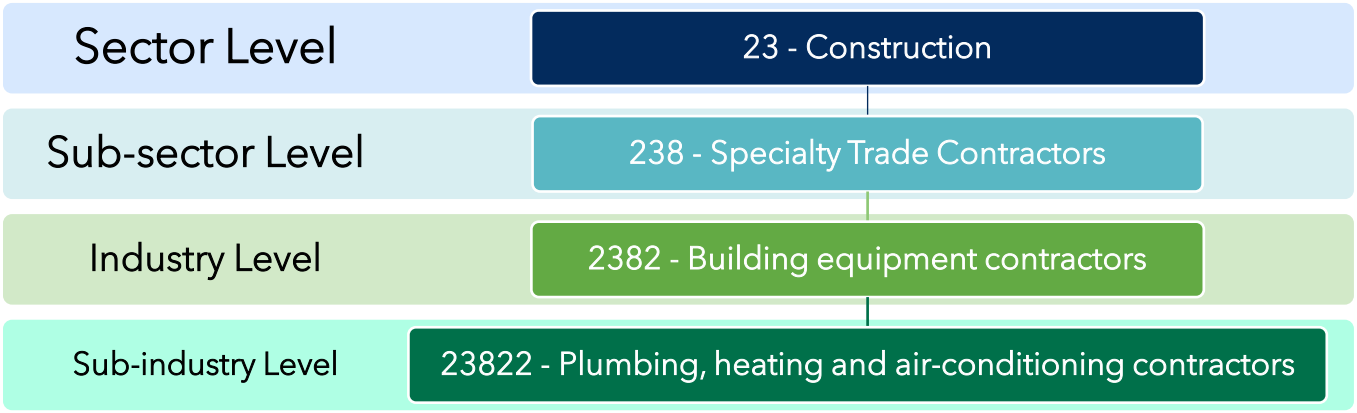
Appendix A – NAICS and NOC Breakdown

Economic impact data provided in each of the chapters relied heavily on data from Statistics Canada, primarily using the North American Industry Classification System and National Occupational Classification. These datasets allow for detailed statistical analysis of jobs, businesses, and industries in standardized fashion across industries. While lacking in terms of specifics needed for this report (see challenges and recommendations), they do provide overarching analysis of hundreds of Canadian occupations and industries.

North American Industry Classification System

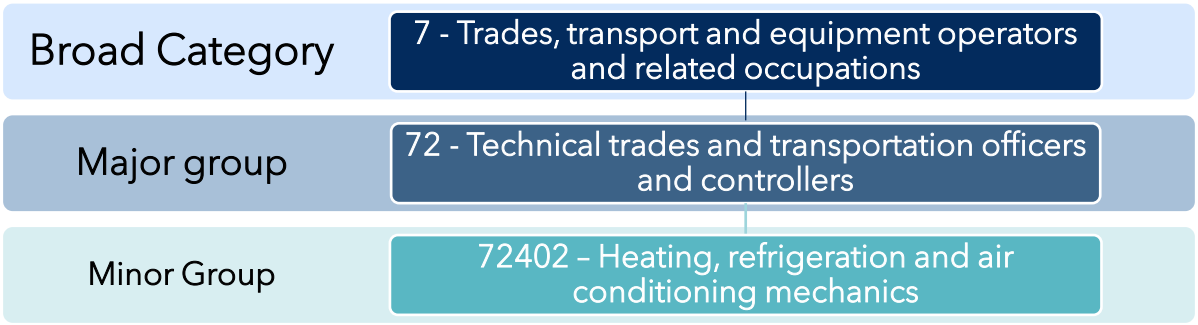
The "North American Industry Classification System" (NAICS) of classifying industries is used for this report. The NAICS is an industry classification system developed by the statistical agencies of Canada, Mexico and the United States. Created against the background of the North American Free Trade Agreement, it is designed to provide common definitions of the industrial structure of the three countries and a common statistical framework to facilitate the analysis of the three economies.

The largest groupings or aggregations of industry categories are called sectors, which are broken down into sub-sectors, which are then further broken down into industries. An example of this breakdown follows:



National Occupational Classification

The National Occupational Classification (NOC) is Canada's national system for describing occupations. While NAICS codes refer to the type of business, NOC codes refer to the specific occupation with which an employee is tasked. For example, within a heat pump installation business, there may be a mechanic (NOC 7313) but also a receptionist (NOC 1414). Both positions would be represented within NAICS 238220 but have separate NOC codes. As with NAICS codes, NOC codes begin with broad categories then become more specialized.



Appendix B: List of Assumptions

As has been discussed throughout the report, a lack of reliable data hampered the analysis. However, using a variety of assumptions, this report was able to produce benchmarks and estimates of current uptake, future targets, and economic impacts for each market area. In an effort to be transparent, below is a list of the major assumptions made within the report.

Relevant to the Whole Report:

- The proportional number of single-detached, semi-detached, and row houses, relative to the total number of single-unit dwellings will remain static as the overall housing stock expands.
- Housing stock will increase in linear fashion from 2023 to 2041.
- Toronto's population increases between 2023 and 2041 will match the Ontario Government's projections.
- The proportion (i.e., percentage) of Toronto single-unit dwellings in need of major repairs (and therefore ineligible for assessment in this report) will remain static through 2040.

Registered Energy Advisors:

- Homeowners undertaking retrofit initiatives will make use of registered energy advisors (whether due to compulsory legislation/bylaws, or by choice).
- The number of successful retrofits is the same as the number of installed heat pumps.
- In the future, homeowners undergoing a heat pump installation will undertake other necessary retrofit initiatives.
- A minimal number or no new dwellings will be built to net zero standards before 2040 (therefore all dwellings will require retrofitting).
- Based on year-to-date applications, 6,000 home energy assessments would be conducted in the third year of the Canada Greener Homes Grant in the city of Toronto.
- Energy advisors are currently at capacity in meeting current demand (i.e., more demand would require additional energy advisors).
- Energy advisors currently undertake 60 home energy assessments annually.

Heat Pumps:

- Air-source heat pumps will be the primary heat pump installed.
- Heat pump installation rates in Toronto are comparable to provincial figures.

- In the event growth becomes enforced, political pressures will shorten the replacement timeline of currently-installed heating and cooling appliances, from 15-20 years per traditional furnace to only 10 years.
- The number of individuals who completed training to be contractors and supervisors, mechanic trades (NOC 72020) did not include any individuals who completed training to be heating, refrigeration and air conditioning mechanics (NOC 72402).
- Within NAICS 238220 (plumbing, heating and air-conditioning contractors), the ratio of plumbers compared to heating and air-conditioning contractors is the same for labour and market impact.
- Each business within the 4-digit industry classifications (which includes businesses unrelated to this market area) of relevance pays the same total wages and has the same total sales, exports, and purchases.
- As the size of the market grows, the number of market area businesses, wages, FTE positions, sales, and other impacts will all grow at proportional rates.

Energy Efficient Windows:

- There are an average of 23 windows per single-detached, 15 per semi-detached, and 7 per row house dwelling in Toronto.
- When a homeowner undertakes an energy efficient window installation, they will replace all windows in their dwelling.
- Every Canada Greener Homes Grant associated with window and door retrofits resulted in the installation of energy efficient windows in all windows in a dwelling.
- The Canada Greener Homes Grant window replacements represent all historic energy efficient window replacements in Toronto.
- In the event the two previous assumptions are incorrect, because one overestimates and one underestimates current rates of installation, their inaccuracies counteract each other.
- In the event the installation of energy efficient windows becomes enforced, political pressures will shorten the replacement timeline of currently-installed windows, from 20 years per traditional windows to only 10 years.
- Current replacement of windows in Toronto is evenly distributed on an annual basis. That is, as windows last an average of 20 years, 5% (1 in 20) of dwellings in Toronto have windows replaced annually.
    - This replacement figure (5% - 400,000 windows) matches the capacity of current businesses/the labour force.

- Each business within the broad 4-digit industry (which includes businesses unrelated to this market area) of relevance pays the same total wages and has the same total sales, exports, and purchases.

Solar PV:

- Rooftop solar PV represents all renewable energy currently installed in Toronto.
- Historic rates of person-years of employment relative to energy generation will remain the same as installations increased in Toronto.
- Median salaries for relevant occupations were consistent regardless of whether the individual was working on solar panels or within a different industry.

Cycling:

- The number of bicycles per-resident in 2019 remained the same through 2021.
- The rates of use per transportation method (i.e., the number of bicycle trips relative to automobile trips) in 2016 were similarly maintained through 2021.
- Toronto residents and residents of the Greater Toronto-Hamilton Area take trips of similar length.
- In 2040, the number of daily trips, and the relative lengths of those trips, will be the same per resident as current figures.
- Cycling retail and repair businesses employ, on average, two to three mechanics and can train an additional one to two annually.
- Each business within the broad 4-digit industry (which includes businesses unrelated to this market area) of relevance pays the same total wages and has the same total sales, exports, and purchases.
- Within the 4-digit retail industry, the number of "other repairers" (i.e., piano repairers), was negligible.

Tree Canopy:

- Tree size averages will remain the same as the urban forest is expanded.
- Tree mortality rates will remain the same through 2040.
- The City will not agree to additional increased purchasing contracts, even if private growth rates do not rise as hoped.
- Land availability will not prevent future tree plantings.
- Each business within the broad 4-digit industry (which includes businesses unrelated to this market area) of relevance pays the same total wages and has the same total sales, exports, and purchases.

TORONTO

Economic Development and Culture

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February 2024