From:	Dianne Saxe
To:	Executive Committee
Subject:	Re: EX17.1 - supporting materials, please confirm receipt
Date:	October 19, 2020 4:30:54 PM
Attachments:	ACT Energy York October 1, 2020 .pdf Webb-Ryerson-Toronto Energy best practices approach-draft-Sept 3-2020a.pdf Transform TO Waste Diversion.pdf Report on Transportation goals for TransofrmTO - FINALOct 9, 2020 (v2).pdf Transform TO Energy Report October 1, 2020 .pdf ClimateACT - TransformTO Buildings Report.pdf

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Dear Cathrine,

Here are the supporting reports, in a reduced size format

Thank you

Dr. Dianne Saxe
SaxeFacts.com
Law and strategy, Climate, Energy and Environment
Green Economy Heroes podcast

2015-2019, Environmental Commissioner of Ontario

Toronto, ON M4V 2T2, Canada
416 962 5882
dsaxe@saxefacts.com
Social media: https://linktr.ee/Dianne.Saxe

> On Oct 19, 2020, at 3:35 PM, Executive Committee <exc@toronto.ca> wrote:
>
> Hello Ms. Saxe,
>
> We are not able to accept communications in a drop box. Please provide in different format such as a PDF.
>
> Best regards,
> Cathrine
>
> -----Original Message-----
> From: Dianne Saxe [mailto:dsaxe@saxefacts.com]
> Sent: October 19, 2020 3:13 PM
> To: Executive Committee <exc@toronto.ca>
> Subject: Re: EX17.1 - supporting materials, please confirm receipt
>
> CAUTION: This email originated outside of City of Toronto network.
>
> ----------
> Do NOT click links (embedded links) or open attachment(s) unless you trust the sender and know the content is safe.
>
> Report PHISHING: Forward the original email as an attachment to the Malware Support Team (email: fightspam@toronto.ca)

> ---
>
> Thank you. Please find below my written submission to the committee, which consists of an overview slide presentation and a series of supporting reports. Thank you. Please confirm receipt.
>
>
> https://www.dropbox.com/t/Dtu7xd9ciY2aACNl
>
> Thank you
>
>
>
> Dr. Dianne Saxe
> SaxeFacts.com
> Law and strategy, Climate, Energy and Environment Green Economy Heroes podcast
>
> 2015-2019, Environmental Commissioner of Ontario
>
> Toronto, ON M4V 2T2, Canada
> 416 962 5882
> dsaxe@saxefacts.com
> Social media: https://linktr.ee/Dianne.Saxe
>
>> On Oct 14, 2020, at 11:03 AM, Executive Committee <exc@toronto.ca> wrote:
>>
>> Hello:
>>
>> Further to your email, this is to confirm you are registered to speak
>> to the Executive Committee on Item EX17.1 - (Towards Recovery and
>> Building a Renewed Toronto)
>>
>> During the Declared Emergency in the City of Toronto, City Hall is closed to the public and City Council and its Committees are meeting by video conference.
>>
>> If you would like to share a written submission with the Executive
>> Committee please email it to exc@toronto.ca and it will be circulated
>> to the Members and made available as part of the meeting records
>>
>> Below are details and instructions about how to connect to the meeting by phone, by tablet or smartphone, or by computer, as well as information about Speaking to the Committee. If you plan to join the meeting by telephone, please provide us with the telephone number you will be using to connect to the meeting.
>>
>>
>> If you need a disability-related accommodation to participate or for
>> assistance on meeting day please email exc@toronto.ca
>>
>>
>>
>>
>> Connecting to the meeting on October 21, 2020
>>
>> Registered speakers can join the meeting by telephone, smartphone, tablet or computer. All

speakers will address the Executive Committee by audio only, so no video camera is required to participate.
>>
>>
>>
>> The meeting starts at 9:30 a.m. The meeting will be open to registered speakers at 9:00 a.m. Please join early so that any connection issues can be resolved before the meeting starts.
>>
>>
>>
>> 1. To join the meeting by telephone:
>>
>> • Call 416-915-6530
>> • Enter access code: 133 089 7076
>> • Event password (if requested): 1234
>> • You will be muted upon joining the meeting. When it is your turn to speak, we will unmute your microphone.
>> • You will be able to listen to the meeting on your phone so you will know when your time to speak is coming.
>>
>>
>> If you plan to join by telephone, please reply to this email account with the telephone number you will be using to connect to the meeting. This will allow the host to identify you in the list of attendees when it is your turn to speak.
>>
>> When connected by telephone, you are able to listen to the meeting and speak to the Committee, but will not see the proceedings.
>>
>>
>>
>> 2. To join the meeting online using a tablet or smartphone:
>>
>> • Download the Cisco Webex Meeting app from the Google Play Store or Apple App Store. Allow Webex to access your microphone and phone if necessary.
>> • Click "Join Meeting"
>> • Enter meeting number: 133 089 7076
>> • Event password (if requested): 1234
>> • Enter your name and email address
>>
>>
>> Please use the same name and email address as you used to register. This will allow us to identify you in the list of attendees when it is your turn to speak.
>>
>> • Choose how you want to connect your audio.
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>> If you are connecting via Wi-Fi, you can select "Use Internet for audio" and use your built in

microphone and speakers, or a headset.
>>
>>
>>
>> Otherwise, select "Call me" and enter your area code and telephone number. You will receive a phone call from Webex (usually from a phone number with an American area code); answer the call.
>>
>>
>>
>> • You will be muted upon joining the meeting. When it is your turn to speak, we will unmute your microphone.
>> • When you join the meeting you will join as an attendee and will not have access to turn on your video or audio. You will be able to see and hear the meeting.
>>
>>
>> 3. To join the meeting online using a computer:
>>
>>
>> Go to Attendee url:
>> https://toronto.webex.com/toronto/onstage/g.php?MTID=eead0b52092910c6c
>> 3c2cff9a7df423ff
>>
>>
>> • Enter your
>> First name:
>>
>> Last name:
>>
>> Email address:
>>
>> Event password: 1234
>>
>>
>>
>> Please use the same name and email address as you used to register. This will allow us to identify you in the list of attendees when it is your turn to speak.
>>
>>
>>
>> • You will be muted upon joining the meeting. Please connect your audio by selecting the phone icon near the bottom left of your screen.
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>> <image002.png>
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>> • Select Use computer for audio, and use your built in microphone and speaker, or a headset.
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>> • If you are unable to connect your computer audio, select the "Call me" option and enter your area code and telephone number. You will receive a phone call from Webex (usually from a phone number with an American area code); answer the call.
>>
>>
>> <image004.png>
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>>
>> If you have difficulty connecting to the meeting, please email
>> exc@toronto.ca
>>
>>
>>
>> Once connected
>>
>> You will be able to see and hear Members and City staff if you join online, or hear the meeting if you join by phone. Before the meeting starts, you may hear sound checks with meeting participants and other discussion.
>>
>>
>>
>> Speaking to the Committee
>>
>> 1. The Chair will call your name when it is your turn to speak, and staff will unmute your microphone. Your video will not work; you will speak to the Committee by audio only. Try to limit background noise especially any audio of the meeting from the YouTube livestream, so that Members can hear you clearly and without feedback. This includes muting or turning off televisions, or radios.
>>
>> 2. You will have 5 minutes to speak to the Committee. The Chair may advise you when your time is almost up.
>>
>> 3. It is not possible to provide you with a specific time or information on how long you may have to wait before it is your turn to speak.
>>
>> 4. After you have spoken, Members may ask you questions.
>>
>> 5. Once you have finished speaking and answering any questions, staff will re-mute your microphone. You are welcome to disconnect from the meeting once you have spoken.
>>
>> 6. After you disconnect, you can continue watching the meeting on YouTube athttp://www.youtube.com/torontocitycouncillive.
>>
>>
>> Please note the following important information about being a speaker
>>
>> 1. When you speak to the Executive Committee, your name, e-mail, mailing address, and the name of the organization you represent (if applicable) become part of the record of the meeting.
>>
>> 2. Your name will appear on the "Speakers List" which will be posted online at 8:30 a.m. on meeting day at:
>> http://app.toronto.ca/tmmis/decisionBodyProfile.do?function=doPrepare&

>> decisionBodyId=1944#Meeting-2020.EX17
>>
>> 3. You will appear in the live broadcast of the meeting and your name will be listed in the meeting minutes. Video broadcasts are archived and continue to be publicly available.
>>
>> 4. For certain items, such as re-zoning, Official Plan Amendments or other planning matters, we will share your information with third-parties like the Local Planning Appeal Tribunal as required by law.
>>
>> 5. For additional tips on the online tool Webex to participate in
>> virtual public meetings, consultations and other engagement
>> activities, please visit
>> https://www.toronto.ca/community-people/get-involved/public-consultati
>> ons/participate-in-virtual-engagement-events/
>>
>> Privacy Statement
>> We collect your information under the authority of the Toronto Municipal Code Chapter 27, Council Procedures or any other applicable procedural By-law. As permitted under Section 27 of the Municipal Freedom of Information and Privacy Act (MFIPPA), we collect this information to create a public record. Information in public records is not subject to privacy requirements. Have questions? Call or write to us at 416-392-4666 or exc@toronto.ca.
>>
>>
>>
>> -----Original Message-----
>> From: Dianne Saxe [mailto:dsaxe@saxefacts.com]
>> Sent: October 14, 2020 10:41 AM
>> To: Executive Committee <exc@toronto.ca>
>> Subject: EX17.1
>>
>> Dear Executive Committee staff,
>>
>> On October 21, I would like an opportunity to speak, please, on item EX17.1, in relation to the work done by Climate ACT.
>>
>> Thank you
>>
>>
>> Dr. Dianne Saxe
>> SaxeFacts.com
>> Law and strategy, Climate, Energy and Environment Green Economy Heroes
>> podcast
>>
>> 2015-2019, Environmental Commissioner of Ontario
>>
>> Toronto, ON M4V 2T2, Canada
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>

Climate Advisory Committee for Toronto

ENERGY OPTIONS

MARK WINFIELD, JENNA RITCH AND RAIDIN BRAILSFORD
FACULTY OF ENVIRONMENTAL AND URBAN CHANGE

YORK UNIVERSITÉ UNIVERSITY

Key Themes (all jurisdictions):

- Building energy efficiency
- Building heating and cooling options
- Renewable energy development (mostly rooftop solar
- Community/district energy plans/microgrids
- Innovative financing tools

Climate Advisory Committee for Toronto

District/Community Energy/Microgrids

- Often framed as an energy security/climate resiliency/adaptation issue
- Toronto already advanced in downtown area (ENWave, Institutional (University and UHN) systems on heating and cooling
  - CEP initiatives tend to be site-specific.
- Extensive district heating/cooling/CHP systems in European cities (Vienna, Munich)
  - Electricity DER/Storage/Renewables market integration a work-in-progress.
- Community utility models in North America
  - Alectra Powerhouse and DER capacity market
  - Brooklyn microgrid & Vancouver Neighbourhood Energy Utility
  - DER aggregation and electricity markets (California)
- Discussions re: 'smart' cities, but limited integration.

CBC.ca

Alectra

Climate Advisory Committee for Toronto

City Authority/Capacity

1. Seek authority from province to set building EE, PV-ready standards above OBC, as per BC Step Code, US states

2. Data access from utilities for energy and CC planning purposes

3. Modelling capacity to assess options and emissions, cost impacts

Climate Advisory Committee for Toronto

Governance

1. Toronto Hydro role microgrid and DER developmen
2. Accountability for city staff and agencies on climate change goals
3. Coordination with utilities (ENWave, Enbridge, Toronto Hydro) and other actors around future role of gas grid, heat pumps, RNG, hydrogen
4. Role of Atmospheric Fund
5. Establish an Energy Service Company (ESCO) to ease customer journey by providing financing and contractor recommendations

Climate Advisory Committee for Toronto

Financing

- PACE (Property Assessed Clean Energy) model common in US
- Portland - 1% retail sales surcharge (*Clean Energy Community Benefits Fund*)
- New York – proposed emission trading system for buildings subject to emissions cap

Figure 2: Visualization of a Energy Service Company (Brown, 2018)

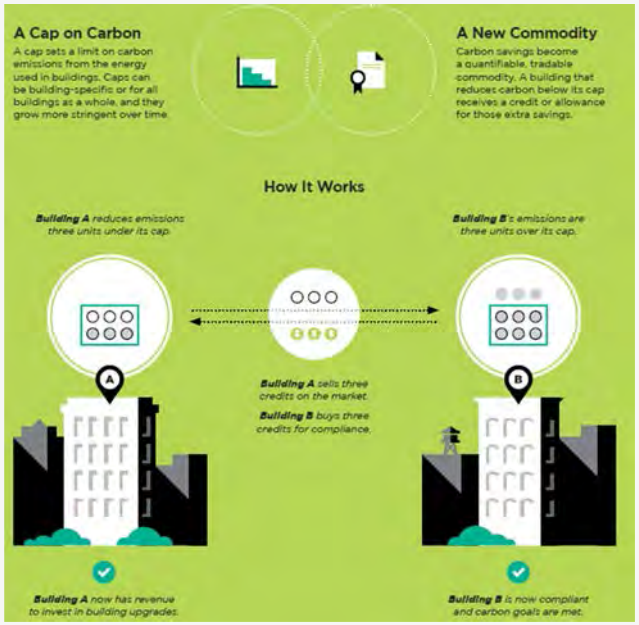


Figure 1: What carbon trading may look like in New York City (Urban Green Council, 2020)

Climate Advisory Committee for Toronto

A best practices approach for Toronto to meet 2030/2050 climate/low carbon energy goals (*Draft*)

Dr. Kernaghan Webb, LLB, LLM., LLD, Professor of Law & Business, Ryerson University, &
Director of Ryerson University Institute for the Study of Corporate Social Responsibility $
with assistance from Zaker Khan, MScM student, $
for the Climate Advisory Committee for Toronto $
September 3, 2020 $

Climate Advisory Committee for Toronto

Ryerson University

Institute for the Study of Corporate Social Responsibility

TED ROGERS SCHOOL Law & Business

Challenges

- In a federal/provincial/municipal/non-state actor multi-level governance context, the City of Toronto does not “control all the levers” re: meeting climate change energy goals. Toronto’s position and capabilities concerning clean energy is unique, as is those of other cities, making comparisons of best practices difficult.
- As a statutory creature of the province, on issues of energy (and otherwise), Toronto is particularly dependent on Government of Ontario decisions and actions, as well as on provincial physical energy infrastructure (e.g., OPG, Hydro One) and legal infrastructure (e.g., OEB legal regime)
- Recent experience suggests that neither the federal government (2006-2015) nor the provincial government (2018 to present) can be counted on to be reliable/consistent “climate change green energy players”
- Notably, since 2018, provincial decisions have jeopardized & have the potential to significantly undermine achievement of City of Toronto green energy/climate change goals (e.g., carbon emissions from Ontario’s electricity sector are set to almost triple over the next decade, as gas-fired generation largely fills the void left by major nuclear refurbishments & dismantling of green energy programs)
- COVID, and the associated downturn of the economy, and with it, attendant decreases in Toronto revenue as well as possible “in-progress” and “post-COVID” alterations in individual/business decision-making and behaviour add an extra layer of uncertainty re: Torontno planning to meet climate change energy goals

…on the positive side…..

- Within Canada, Toronto has considerable political and economic influence:
  - based on population alone, if Toronto were a province it would be the fifth largest in Canada; and
  - as the financial/economic capital of Canada, Toronto's decisions/actions significantly impact the rest of Canada
- In 2017, Toronto adopted the TransformTO strategy, and therefore the City has achieved important foundational political buy-in and momentum towards meeting 2030/2050 climate change energy goals
- There is considerable low-carbon energy supportive infrastructure already in place in Toronto
  - e.g., Toronto Renewable Energy bylaw, Tower Renewal Program, Eco-Roof Incentive Program, Green Standard, guidelines for Net Zero Districts & MURB backup power, etc.
- ….and there is associated considerable positive multi-stakeholder low-carbon momentum in the City (e.g., Enwave/Brookfield Deep Lake Water Cooling System, Better Building Partnership, Toronto Atmospheric Fund/Efficiency Capital Corporation, Community Energy Plans, BOMA/LEED stds, etc.)
- New cleantech innovations are being developed and operationalized every day and the costs of key cleantech components have gone down considerably (e.g., storage costs have dropped 76% since 2012)
- There appears to be considerable appetite for within-City and beyond-City multi-stakeholder coalitions, partnerships, alliances and innovations concerning clean energy (more on this below)
- Regardless of any political/ideological differences among players, in Ontario we are witnessing a widely accepted, ongoing transition taking place from a centralized energy production/transmission/ distribution model to more of a hybrid model with multiple de-centralized as well as centralized energy production/distribution emphasizing more "clean" energy sources, as well as an ongoing transition to enhanced energy efficiency/decreasing the number of "wasteful" energy consumptive activity

Suboptimality & sustainable governance 3

*"*In short [due to roller coaster economies, unpredictable international factors, fragmented multi-level government responsibilities, evolving technologies, strong economic interdependence, etc.] *the task of developing and implementing effective public policy responses has become exceedingly challenging* in the twenty-first century. ***We need to acknowledge*** the topsy-turvy, less-than-perfect world in which public policy takes place ***and devise approaches that operate effectively in*** *these* ***suboptimal*** *conditions….."*

*"…. **sustainable governance involves a combination of governmental and nongovernmental institutions, processes, instruments, and actors**…. [A]lthough* **collaboration** *is a common feature of sustainable governance,* ***so too is a certain amount of "creative tension"****…"* %

"In the use of a diverse, multivariable approach to governing, ***the failure of any one approach does not necessarily mean an overall implementation failure*** *but rather that* ***another actor****, instrument, institution, or process* ***is in a position to "pick up the*** # ***slack"*** *or otherwise act as a check and balance concerning a particular behaviour."* -- Webb, 2005 #

Related concepts such as polycentric governance, multi-level governance, collaborative governance, etc., address aspects of the Toronto clean energy situation, but do not synthesize into a holistic, systematic, forward looking state/non-state governance approach and framework as does sustainable governance #

Suggested two-pronged sustainable governance approach (1) (

- Point of departure: economics and the regulatory environment are the two main drivers for action on green energy. The two-pronged approach set out here attempts to draw on both of these drivers, working within the acknowledged constraint that Toronto is but one player of many that is acting in the energy context.
- **Approach One** (externally focused, working with others): using the aforementioned influence that Toronto has as Canada's political and economic municipal leader:
  - Vertical: ***convene a federal-provincial-municipal-private sector-civil society conference*** with the & objective of developing a pan-Canadian multi-stakeholder agreement on ***an optimal multi-actor aligned and supportive Canadian low-carbon energy framework, roadmap and timetable*** (the formation of the Climate Advisory Committee for Toronto suggests willingness of Toronto-based academic institutions to take on a major convening role in this respect)
  - Horizontal: similar to other jurisdictions such as Australia with its Re-energise Australia, local government jobs summit, and showing cross-Canadian municipal solidarity on climate change issues such as that exhibited by the U.S. National League of Cities, in possible partnership with the & Canadian Federation of Municipalities and its leadership (with the federal government) on energy & efficiency (or a subset of Canadian municipalities who are leading on energy issues), as well as non-Canadian municipal leaders (e.g., building on the C40 Mayors' *Agenda for a Green and Just Recovery*), ***convene a conference on autonomous municipal climate change low carbon energy leadership capabilities*** and from that ***create a cross-Canada municipal low carbon energy alliance/agreement*** similar to the Danish DK2020 project (potential for ACT/university support)

Suggested two-pronged sustainable governance approach (2) (

- **Approach Two** (Toronto level):
  - Conduct interviews with Toronto-relevant players (government, private sector, civil society) regarding ***identifying/removing regulatory-related barriers*** that are inhibiting optimally effective and efficient Toronto- level low-carbon energy activity with a view to *putting in place an optimal Toronto-level* ***regulatory regime*** for low carbon energy (institutions, instruments, processes, actors).
    - Example: While cities may not be able to do much to affect the price of a solar panel or battery pack, they can certainly help reduce "soft costs"—especially for rooftop solar. In USA, the ***permitting, inspection, and interconnection process*** for installing a typical residential solar array accounts for around **one-third of the total cost**, which averages between $3.00 and $3.50 per watt. Contrast that with Australia, where average residential solar prices have **dipped below $1.30 per watt**—in large part due to a permitting and interconnection process that treats residential solar arrays more like household appliances than like major pieces of grid infrastructure.
  - Conduct a Toronto-level gaps/opportunities clean energy analysis as a basis for ***developing optimal autonomous Toronto-level clean energy economic activity***: examples: distributed energy resources, transactional energy systems, energy cooperative virtual net metering, procurement, & innovative financing, much of which can be integrated into community energy planning (see next slides)
  - *All Approach Two work could be undertaken with ACT/university support, and will by necessity involve an exploration of the degree of legal autonomy Toronto currently has to undertake the envisaged green energy activity (e.g., through properly constituted bylaws, policies, standards, Energy Transfer Agreements, etc.), and an exploration of how or what enlarged autonomy to act Toronto might be able to secure from the province and otherwise to undertake the envisaged green energy activity*

Opportunity: Distributed Energy Resources

- Distributed Energy Resources are electricity-producing resources or controllable loads that are directly connected to a local distribution system or connected to a host facility within the local distribution system.
- Since 2006, nearly 2,000 distributed energy resources, including solar PV, CHP, energy storage and wind, have connected to Toronto's distribution system. However, FIT (an important early driver of Distributed Energy Resources) is no longer available.
- With the support of relevant federal and provincial government actors, *there is an opportunity for Toronto to exercise leadership in* ***facilitating/incentivizing (and structuring) more development/implementation of Distributed Energy Resources*** (DERs) by DER owner/operators:
  - This also involves coordination with transmission system operators, distribution owners, distribution system operators
  - consistent with the Market Renewal Program, this would involve ***authoriziation (with appropriate regulatory oversight) of local electric distribution (LED) utilities such as Toronto Hydro to own and manage Distributed Energy Resources*** such as behind-the-meter generators (there are DER procurement markets; DER-specific regulated rates; DER bifurcated rates; microgrids/virtual power plants & DER aggregators; transactive energy systems)
  - ensure that anti-trust (market power) aspects are addressed with respect to Toronto Hydro
  - consistent with the Market Renewal Program, ***authorize (with appropriate regulatory oversight) non-LEDs*** (e.g., third-party developers of industrial/commercial space, homebuilders) to own and manage DERs
- Consistent with the sustainable governance concept, a combined rivalrous LED/non-LED model may spur optimal activity. ***Toronto could convene actors to explore how DERs could be optimally deployed, and on that basis take the lead in developing the appropriate operating framework*** (potential for ACT/university support)

Opportunity – Transactive Energy Systems

- TESs are systems of economic & control mechanisms (market) that allow the dynamic balance of supply & demand (power balance) across entire electrical infrastructure using value (bids and offers) as the key operational parameter
- If properly structured and technical issues can be addressed, TESs can incentivize local energy production and distribution.
- The Ryerson Urban Energy Centre (with partners) is currently exploring how this might work in practice, ironing out technical/technological issues.
- In 2017, an Australian company announced the startup of the country's first blockchain-powered residential electricity trading market in a Perth community. Residents in the community can now trade the electricity generated on their rooftop, and stored on batteries in their garage without the need for an energy retailer. When someone is not using their share of electricity produced they can sell their share of the energy produced to their neighbours. The system uses blockchain technology to allow residents to trade electricity amongst themselves at variable prices, providing an incentive for more developers to install rooftop PV on strata-titled developments. #
- *The City of Toronto could play an important role in convening relevant players so that barriers are removed and structures/incentives are in place so that TESs could be optimally deployed in the region*. (potential for ACT/university support)

Opportunity – Renewable Energy Cooperatives & Virtual Net Metering innovations *

- The public utility model (in place in Ontario) divides the energy players at the meter, as defined by the OEB. All ratepayers operate behind the meter (BTM) in an unregulated environment; the IESO system operator, local utilities, bulk power suppliers and Hydro One Network transmitters operate in front of the meter under OEB regulatory oversight.
- Effective 2019, Renewable Energy Cooperatives (REC) have the opportunity to be a supplier to the ratepayer, operating behind the meter. The rules that govern possible REC behind the meter energy activity fall under Net-metering (NM), The current solar economics do make this model viable, for projects of a certain scale, if the ratepayer is a long-term stable entity.
- In the United States, Virtual Net-metering (VNM) rules "have created a tsunami of community-owned 'Solar Gardens' across 17 US states."
- The Toronto Renewable Energy Co-operative estimates that if Virtual Net Metering were introduced, it would create a ten-fold increase in distributed solar generation within years. Introduction of VNM would require the cooperation of provincial and municipal players.
- The City of Toronto could play a major role in facilitating the convening of the relevant actors so that such a VNM could be put in place (potential for ACT/university support) $

Opportunity – Procurement/Suppliers/Partners

- Explore the feasibility, and if proven feasible, implement a City of Toronto policy regarding procurement, suppliers and partners that they be certified to ISO 50001 and ISO 55001 $
- ISO 50001 -- standard specifies the requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy security, energy use and consumption
- ISO 55001 – standard pertains to asset management, the main objective of which is to help organizations manage the lifecycle of assets more effectively. By implementing ISO 55001 organizations will have better control over daily activities, achieve higher return with their assets, and reduce the total cost of risk.
- Essentially, the City of Toronto would be leveraging their financial influence on non-state actors. A transition period would likely need to be put in place before the policy would fully come into effect
- For smaller organizations, a streamlined version of the two standards could be developed, and technical and other assistance provided to support organizations
- To the extent possible, the City of Toronto and its related entities should also align with the two standards
- The City of Toronto could convene relevant stakeholders to explore and (if feasible) to implement this (potential for ACT/university support)

Opportunity – Creative Financing

- Community bonds are a social finance tool, used by not-for-profits and co-operatives, that generate both a social and financial return. This tool allows an established organization to leverage their community of supporters to help finance the purchase of a fixed-asset, like energy storage equipment.
- The City of Toronto's Green Debenture Program leverages the City's low cost of borrowing to finance capital projects such as pertaining to energy generation, transmission and distribution that contribute to environmental sustainability. $
- TD Bank, Export Development Canada and Province of Ontario (among others) have also issued "climate bonds"
- Federation of Canadian Municipalities' Community Efficiency Financing program has put in place a new $300M initiative to help municipalities and their partners' design, implement and scale-up innovative financing programs for residential energy performance
- Federal COVID financial assistance tied to addressing climate change
- There are many other social bond/environmental bond/climate bond and other innovative financing initiatives in place and in development
- The City of Toronto could convene relevant parties to explore the above and determine how best to leverage this financing capability in support of green energy projects in Toronto and beyond. (potential for ACT/university support)

Conclusions: A best practices approach for Toronto to meet * 2030/2050 climate/low carbon energy goals *

- Acknowledge the challenges Toronto faces as but one clean energy player in a broader multi-actor, multi-level suboptimal governance context.
- But also recognize and harness the distinctive influencing/leverage capabilities and clean energy leadership role that Toronto already has demonstrated, in order to devise a two pronged sustainable governance approach to meeting clean energy goals which is directed at:
  - (1) influencing/shaping the external actor/instrument/institutional environment while
  - (2) at the Toronto level directly deploying the powers that the City has at its disposal to achieve clean energy goals)
- Explore opportunities for distributed energy resources, transactional energy systems, energy cooperative virtual net metering, procurement, & innovative financing, much of which can be integrated into community energy planning
- As a high profile megacity with a record of leadership on climate change issues, tap into this profile to convene multi-stakeholder conferences on an issue by issue basis, with the goal of the conferences always being development of governance structures that optimally facilitate deployment of green energy activity and eliminate barriers to same.
- There is considerable potential for ACT/university support for much of the above

Achieving Transform TO's Diversion Goals:

Best Practices and Lessons Learned: %

Calvin Lakhan, Faculty of Environmental Studies

YORK U

Contents

Chapter 1: Goal Setting and Priority Issues

The diversion strategy outlined in this report is designed to assist the City of Toronto in meeting their diversion goals of 95% by the year 2050, while also promoting a sustainable waste management system that attempts to maximize economic, environmental and social outcomes.

At present, the City of Toronto's residential diversion rate is approximately 60%, most of which can be attributed to the city's Blue Bin recycling program for printed paper and packaging. However, future increases in diversion are unlikely to come from the Blue Box program, as package light weighting and the proliferation of difficult to recycle materials has actually resulted in decreasing diversion performance over time.

This necessitates the question – where will our next diverted tonne come from? The purpose of this project is to identify opportunities for the city to work towards their diversion goals, while also providing guidance for how the city should navigate a rapidly changing waste management landscape.

The following are the initial steps recommended to the City as a means to not only achieve their diversion goals but do so in a way that leverages experiences from other jurisdictions as well. Recommendations include:

1) Identify new waste streams that can be targeted for future diversion. The city presently offers household programs for printed paper and packaging, organics and household hazardous waste. However, material streams such as textiles and durable goods (furniture, appliances etc.) are either managed by third party collectors or disposed of in a landfill. Future increases in diversion are likely to come from these additional waste streams

2) Identify opportunities for collaboration with third party waste collectors to help drive diversion, while offloading operational and administrative costs. As an example, the vast majority of end of life textiles generated by the city is managed by charitable operators (Diabetes Canada, Salvation Army etc.). By working with these third-party collectors, the city will be able to simultaneously increase diversion and service coverage, without bearing the costs associated with program delivery

3) Assist the City in developing programs and behavioral intervention strategies to increase diversion among Toronto's multi residential buildings. More than 50% of all households in the city are characterized as multi-residential. While the vast majority of these buildings do offer recycling and organics programs, they recycle at less than 1/6th the rate of single-family households.

4) Assist the city in developing promotion and education materials to encourage diversion among Toronto's demographically diverse communities, placing a particular emphasis on cultivating awareness and increasing participation among the city's rapidly growing ethnic households.

5) Assist the city in developing programs and suggesting infrastructural changes that can be used to promote waste diversion in the city's public spaces.

6) Identify opportunities for methane mitigation

7) Provide recommendations for increasing diversion in the city's IC&I sector

8) Provide guidance for conducting LCAs to measure carbon impacts of city initiatives.

9) Help the city prioritize which materials to target for recovery. Much like identifying priority waste streams, understanding which individual materials to recover is critical in ensuring an optimal outcome. As an example, attempting to increase glass recovery is of little economic or environmental benefit, while recycling aluminum offers the city the best "bang for their buck" (low net cost to manage, extreme carbon savings from recycling relative to virgin aluminum). Not all recycling or diversion is made equal, and it is actually detrimental to try and recycle everything, everywhere.

This report concludes with a discussion surrounding the challenges and barriers to the city achieving its diversion target. Of note, this report relies heavily on experiences and best practices from other jurisdictions, with a specific emphasis on Ontario. Many of the recommendations made, have been taken (or adapted from) Ontario's Continuous Improvement Fund, which have helped finance more than 300 studies on municipal recycling (Blue Box) over the past decade. CIF funded projects are intended to improve recycling performance (where performance is defined as a combination of recycling rates, cost containment, accessibility and education/awareness) and develop recommendations that can be adopted by other municipalities (i.e. best practices in multi-residential recycling, waste audit guidelines etc.). While CIF funded projects are specific to Ontario's Blue Box program, many of their recommendations can be readily adapted to other waste streams as well. In addition to a review of CIF initiatives, this report has also taken examples from the broader literature (both academic and non-academic) that have been shown to be successful at promoting diversion and other environmental outcomes. With that being said, it is important to recognize that no two jurisdictions are alike, as every place has site and situation specific factors and conditions that can affect the efficacy of various diversion strategies. Toronto in particular is fairly unique to other municipalities in Ontario, given the proportion of households characterized as multi-residential, a rapidly changing demography and infrastructural heterogeneity (servicing waste in the downtown core is fundamentally different that servicing waste in the suburbs of Scarborough). These conditions were taken into account when making the recommendations found in this report.

Chapter 2: Identifying New Waste Streams for Recovery – Where will our next diverted tonne come from?

Despite continued investments in the city's waste management infrastructure and service delivery, diversion rates for residential waste streams have largely been stagnant over the past five years, and in fact, is trending downwards for the first time in almost two decades. While the reason for this stagnation is heavily debated – some point to the proliferation of light weight packaging, while others suggest municipal inefficiency and lack of supporting legislation – the reality facing the city is that it is becoming increasingly difficult to divert the "marginal tonne". Where will our next diverted tonne come from? What will it cost? And what will be the environmental, economic and social impacts of promoting diversion in these areas? What makes this issue particularly salient is that the City of Toronto has committed to a long-term diversion goal of 95% by the year 2050, and waste management is expected to play a critical role in helping the city achieve both its carbon reduction and waste minimization goals.

While it is often difficult to predict where future increases in diversion (if any) are likely to come from, there is enough data to suggest that encouraging incremental diversion through existing residential recycling programs (such as Blue Box) is highly unlikely.

2.1 The next tonne will not come from printed paper and packaging (Blue Box)

Historically, residential recycling programs for printed paper and packaging has been the biggest contributor to Toronto's overall diversion figures. At present, more than 50% of all residential waste diverted in the City comes from the Blue Box program. While Ontario's Blue Box program has been an enormous success and should be heralded as a pioneering initiative with respect to recycling and stewardship, it is unlikely that future increases in recycling and diversion rates will come from recycling. As noted above, the reasons for this are complex and involve a multitude of factors, however, the most commonly accepted explanation can be attributed to the "evolving tonne" of what we find in the Blue Box – increasingly, packaging producers are moving towards light weight, composite plastics, while generation of printed paper has fallen precipitously since the early 2000s. Infrastructure for the recovery of printed paper and packaging was largely designed around "core materials" -newsprint, OCC/OBB, Metals, Glass and PET/HDPE. At present, multi-resin, light-weight materials are extremely difficult to capture at a material recycling facility, and even when they are, the net cost per tonne can exceed $2000. This, coupled with deteriorating end markets for recyclables resulting from the "Chinese Sword", has seen Toronto struggle to adapt to a rapidly changing packaging mix, resulting in rising operational costs and stagnant recycling rates. Further compounding this issue, is that contamination rates for the residential Blue Box program are in excess of 20%. The City's decision to adopt a single stream recycling system (using one large cart for all recyclables instead of a Blue and Gray Bin), increased quantities of material diverted, but resulted in significantly higher contamination rates. Since 2005, Toronto's net cost per tonne for managing residential packaging waste has more than doubled, while recycling performance for the Blue Box program peaked in 2015 and is now trending below 60%.

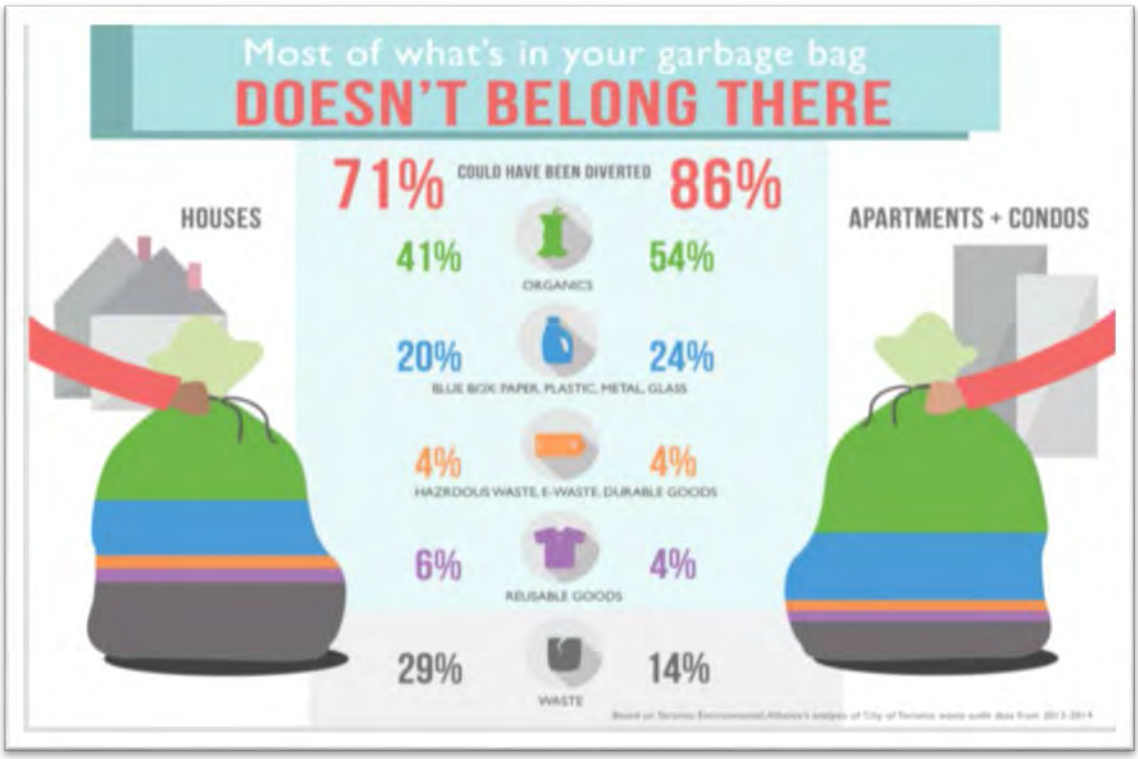
To make a long story short – Toronto has essentially maxed out on what they are able to economically recover through the Blue Box. Recycling rates for "core materials" are in excess of 90%, and households are already doing a great job of diverting materials that they readily recognize as being recyclable. While it is possible that future increases in diversion may come from composite/light-weight materials, doing so would have an enormous financial impact on the cost of recycling. As noted in chapter 6, not all recycling is made equal, and there is an opportunity cost associated with attempting to recycle

materials that are costly, but have nominal economic value as a commodity, and questionable environmental benefits when recycled.

2.2 Organics is the next target waste stream

Given that large future increases in diversion are unlikely to come from the Blue Box, the next logical choice would be to target the organics stream. Recycling rates for printed paper and packaging have actually decreased between 2015 and 2020 and are unlikely to improve as a result of a rapidly changing packaging mix. With that being said, a significant % of what Torontonians put in their garbage is made up of materials that can be readily diverted, particularly organics.

Figure 1 below shows how much of Torontonians garbage is actually made up of divertible material:



While the Green Bin program has existed in the city for more than a decade, there is a significant opportunity to increase diversion (and achieve waste reduction) through initiatives that keep organics out of landfills (food waste avoidance, source reduction etc.). This is particularly true of the city's multi-residential households, where participation rates in the green bin program are less than 20%, resulting in the vast majority of organics being disposed of in the garbage.

Programs that educate and inform households about minimizing food waste and avoiding food spoilage should be a critical element of the city's promotion and education strategies for increasing diversion. This must also be accompanied by ensuring that households have access to the appropriate resources and infrastructure to ensure participation in the city's organics program. One of the foremost challenges associated with organics diversion, particularly in multi residential buildings, is a lack of available space for an organics bin. This issue is exacerbated by the fact that many households do not want to store organics waste for an extended period indoors, as there are issues surrounding smell and sanitation. It is integral that the city match the waste generation needs of households with the most appropriate collection mechanism – as an example, organic carts are really only appropriate for single family households who have access to curbside organics collection. By contrast, organics "totes" (small bags or plastic receptacles that can be stored in the refrigerator or freezer) may be more appropriate for multi-residential households where available space is at a premium.

In a study conducted by York University and Clorox in 2019, educating both consumers and retailers about how packaging choices affect food waste has the potential to play a significant role in helping drive organics diversion. Depending on the packaging materials being used, there is an opportunity to increase shelf life, both at the store and in the home, allow for discretionary consumption (the ability to use what you want and then re-seal a package), and provide long term storage for semi-perishable food items. A recommendation of the study was that retailers and municipalities work collaboratively to develop a "food waste avoidance" campaign, so that consumers can make informed choices about how packaging affects food waste, and where to put that packaging at end of life (often time, the packaging that helps avoid food spoilage are made of materials that are difficult to recycle).

The City of Guelph has engaged in multiple promotion and education initiatives (working with both retailers and the University of Guelph) to help residents better understand the environmental and economic impact of food waste. Results from waste audits conducted both prior and after the education and awareness campaign showed a significant reduction in avoidable food waste generated by households. The ability for households to "quantify" what food waste was costing them in terms of their grocery bill was a significant deterrent to both bulk purchasing (buying more than the household or individual needs) and avoidable food waste. Helping households conceptualize how much food waste they generate, and what that costs them (in both environmental and economic terms), is critical in helping encourage diversion behavior.

It should be noted that while the City of Toronto has already signaled their intention to make organics a top priority moving forward, investing significantly in developing organics processing infrastructure and expanding program access, these efforts are both resource and time intensive. While the organics stream is likely (and should be) where future diversion is likely to come from in Toronto, it is time for the city to think beyond the Blue and Green Box, and examine how to achieve incremental diversion through non-conventional waste streams

2.3 Textiles and Furniture – A Missed Opportunity

2.31 Textile Waste

At present, there are no legislative mandate for municipalities to manage textile waste. As a result, most municipalities across both Ontario and Canada do not include textiles as part of their diversion programs, largely due to a lack of both collection and processing infrastructure.

Textile waste is estimated to make up between 5-10% of the Toronto's overall waste stream, with more than 1 billion pounds of textile waste going to Ontario landfill sites every year. This represents a significant missed opportunity for the City, as diverting textiles (particularly through reuse) results in more carbon diverted (per tonne) than all other Blue Box materials with the exception of Aluminum. In addition to the potential carbon benefits, the cost of collecting and managing used textiles can be minimized (or avoided all together), should the City choose to work with third party textile collectors.

2.311 Collaborative Relationships with Third Party Collectors

Traditionally, the role of collecting and managing residential waste has fallen on the City (or contracted out by the city). For Blue Box, Green Bin and Orange Drop (MHSW) programs, the City of Toronto is responsible for both program development and delivery, and the costs associated with providing these services can be quite significant (and ultimately, it's Torontonians that pay that bill either through increased property/utility rate taxes or increases in the cost of consumer goods for which stewardship fees are attached).

While textile collection is technically designated as a Blue Box material under the 2002 Waste Diversion Act, no municipality in Canada accepts or collects textiles as part of their residential waste diversion programs (*programs serviced by the municipality). This is largely due to the lack of processing

infrastructure for textiles and the fact that the used textiles are not generated with regular or predictable frequency by households (it would be difficult for municipalities to develop a collection service schedule, as textiles are durable goods).

However, textiles, unlike most other waste streams, are a high value commodity, with numerous organizations from across the for profit/not for profit sector collecting used textiles. Despite the absence of a legislative mandate, service providers compete to collect textiles due to the potential financial incentive. Given that non municipal actors are willing to manage end of life textiles, what role can municipalities play in facilitating this collection in a way that maximizes both environmental and economic outcomes?

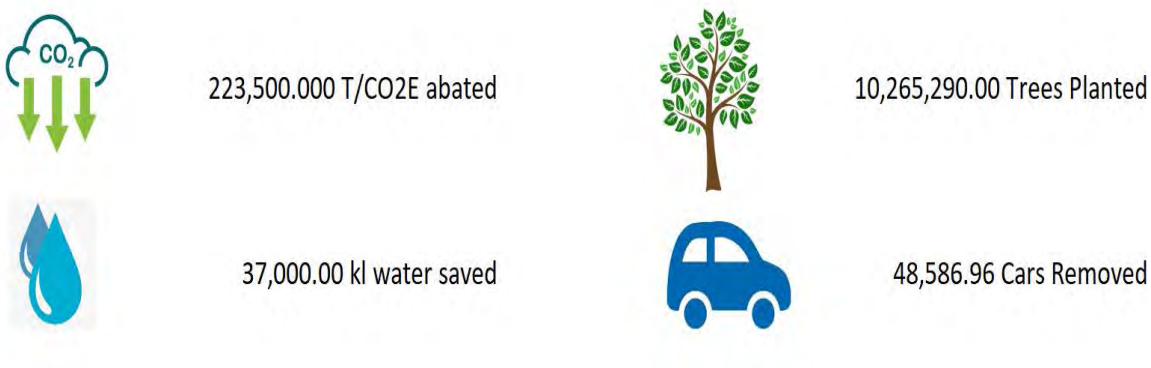
The answer lies in who the municipality chooses to partner with - unlike other waste streams, convenience is not the most significant predictor of household participation in textile diversion. This finding is atypical to any other waste stream (such as WEEE, or PP&P), as households have a "value attachment" associated with their used clothing. As such, households indicate a very strong preference for ensuring that their donations go to a cause they personally identify with (charitable, social, environmental etc.). In studies conducted by York University in both 2016 and 2019, households expressed significant concerns regarding the "outcome" of their donation – are their used textiles going to be used to support a social or environmental cause, or are they being dumped in developing economies in Africa, Central America and Asia? York's study found that the primary impediment to household participation results from uncertainty surrounding the "outcome" of their donation. This uncertainty is largely attributed to the presence of charity masqueraders (for profit textile collectors), who deceptively brand themselves in a way to suggest that they are a charity. Many of these organizations lack transparency with respect to the destination of the material, or what is being done with the proceeds from the donation. This confusion, coupled with several news stories in recent years discussing textile dumping in developing economies is sufficient to deter households from participating in diversion activity. Stated alternatively, households would rather throw their textiles in the garbage, than donate their items to duplicitous textile collectors.

To specifically address this uncertainty, the city of Toronto should designate preferred textile collectors within the community (using municipal branding on bins, or some other form of official recognition). This branding/recognition clearly communicates to residents that "approved collectors" are adhering to best practices in funding transparency, accessibility and service standards. The intent of this

municipal vetting process is to reduce consumer uncertainty regarding both the collector of the material, and the destination of the donation. Municipalities are able to ensure that textiles are diverted from landfill without incurring additional costs, households are assured that their donations are being managed in a responsible way, and charities/not for profits are able to use funds to further advance their social mandates. This approach has been demonstrably effective in more than 100 communities across Canada, with the City of Markham in particular championing the municipally branded approach, Over the past 18 months, the City of Markham has kept more than 5 million kilograms of used textiles out of landfills.

2.312 Environmental Benefits of Textile Diversion

Given the sheer quantity of textiles that are ending up in landfills, increasing diversion rates will have significant environmental benefits. The environmental impact from diverting 10,000T of textiles are shown in figure 2below:



Diverting 10,000 tonnes of textiles (through re-use) abates more than 223 000 metric tonnes of carbon and 37 000 Kilo Litres of water. That carbon reduction is the equivalent of removing 48,586 cars from the road or planting 10,265,290 mature trees.

Keep in mind that there is an estimated 80,000T of used textiles available for collection each year in the city of Toronto – diverting even a fraction of this material will help the city achieve carbon reduction and diversion goals.

2.313 Economic Benefits of Textile Diversion

The economic impacts of designating preferred collectors transfers all end of life management costs onto the service provider. Municipalities and retailers do not bare any direct costs – in fact, for every tonne diverted, municipalities save money through avoided landfilling and processing costs. The value of textiles as a commodity results in a self-sustaining collection infrastructure that negates the need for cost recovery schemes such as extended producer responsibility (EPR). This helps minimize the administrative burden of developing an EPR program and allows for an approach that can be readily replicated in jurisdictions across Canada.

At present, the municipally branded approach described above has been implemented in more than 100 communities in 7 provinces across Canada. The Region of Peel, York Region, City of Ottawa, Municipal Waste Association, Partners in Project Green, Recycling Council of British Columbia and the province of Manitoba are just a select few of the municipalities/organizations that have either adopted (or advocate for) a municipal branded textile diversion program.

2.314 Social Benefits of Textile Diversion

While numerous textile collectors are presently operating in the space – the social impact of used textile collection is unique to an approach that designates charitable/non-profit as a preferred collector. Organizations such as Diabetes Canada, Salvation Army etc. utilize the proceeds of textile collection to develop and deliver programs that promote health and well-being for Ontarians.

As an example, in 2019, Diabetes Canada generated more than 10 million dollars from used textile collection, with 100% of those proceeds going into diabetes research and other support programs. At present, there are more than 90 municipalities across Canada participating in the municipal/charitable textile collection model. Since 2016, this collaborative partnership between municipalities and charitable actors has diverted more than 200,000T of textiles across Canada (diversion that did not take place in the City of Toronto, as city staff were reticent to implement a model that designated a preferred collector, citing competition concerns).

Of note, prior to COVID, the city of Toronto was engaged in conversations with Diabetes Canada, Salvation Army and other charitable textile collectors to develop a municipally supported program. It is

unclear as to what the current status of this partnership is due to the service disruption resulting from the pandemic.

2.32 Furniture Diversion

Much like textiles, there is no prescriptive legislation for how furniture waste should be managed. In most instances, households bear the physical and financial responsibility for transporting furniture waste to landfills, and will often rely on "junk" collectors to provide this service.

While furniture waste generation is highly variable (depending on locality, season etc.), a review of Toronto waste audits suggests that furniture and durable goods makes up approximately 5% of the overall waste stream, representing approximately 45,000 tonnes of material annually for the city.

However, unlike textiles, end of life furniture does not have a value (or at the very least, it is highly dependent on the item, and site/situation specific factors). As such, collectors have to be financially incented, with the generator (in most cases the household) paying to have items removed and sent to landfill.

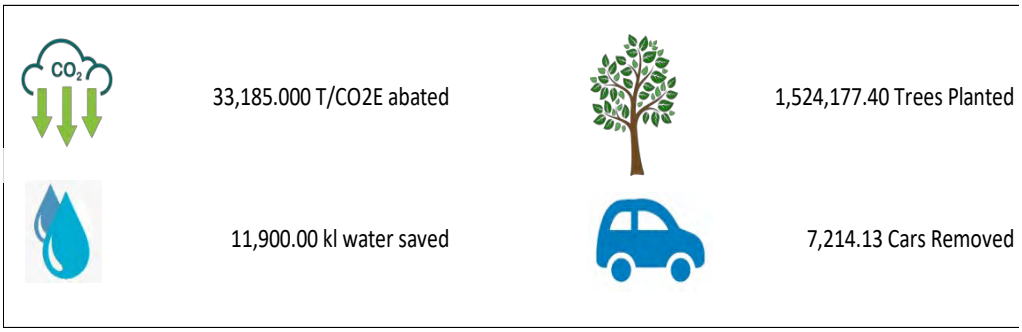
Municipalities have traditionally played a limited role in managing these items, but what role can a municipality play in not only supporting keeping these items out of landfills, but maximizing social and environmental outcomes as well?

2.321 Charitable Initiatives – The Furniture Bank Case Study

Furniture Bank is a Toronto based charity and social enterprise that helps marginalized and at-risk families furnish their homes. Furniture bank accepts gently used furniture and other household items, distributing them to families in need. This initiative helps divert more than 1500 tonnes of material from Toronto landfills annually, but perhaps more importantly, serves more than 10,000 local clients in need on an annual basis.

In strictly economic terms, the City of Toronto benefits through avoided landfill tipping fee costs (as well as collection costs for large, bulky items), while the province benefits through the provision of a social service to marginalized communities (without incurring a direct cost).

Since 2010, furniture bank has diverted almost 10,000T of furniture/household wares from landfills, which has had an enormous environmental impact for Ontario (shown in figure 2), Note: Cars removed from road and mature trees saved are an alternative way to express carbon savings – i.e. Abating 33, 185 metric tonnes of carbon is the equivalent of removing 7214.13 cars from the road.



Given that the vast majority of furniture waste (as noted earlier, in excess of 40,000T for the City of Toronto) is ending up in our landfills, there is an enormous opportunity not only to increase diversion rates, but achieve a truly sustainable outcome. Historically, the obstacle to diverting furniture has been the cost of collection (normally it is the generator who is required to pay for pick up service) and the fees associated with disposal)

Leveraging organizations such as Furniture Bank (to serve as a used furniture collector) provides a rare opportunity to address all three pillars of a sustainable waste management program. We are able to increase diversion from landfills (environment), while transferring costs away from local government (economic) and simultaneously support social impact initiatives (social).

As noted earlier, research suggests that Torontonians express a strong desire to support social initiatives and charities through waste donations (used textiles, furniture etc.). In a two-year study conducted by York University, households were more than twice as likely to donate their used materials to a designated charitable collector.

2.33 Meeting diversion goals, but with a purpose

Waste management (at least in a Canadian context) has historically not been seen through the lens of social sustainability. It is largely seen as a service provided by municipalities, to help keep material

out of landfills and promote circularity. However, as we look to increase diversion rates in the City of Toronto, we have to ask ourselves two questions: 1) Where will the next diverted tonne come from? 2) What do I want to achieve by diverting more material? 3) Why do we generate so much waste in the first place?

As noted earlier, conventional means and mediums of diversion (i.e. Blue Box) have been exhausted – the next diverted tonne is not likely to come from newsprint or cardboard, but from organics, textiles and furniture.

In addition to finding new opportunities to divert material, what is the city trying to achieve by doing so? Is it good enough just to keep material out of landfills, or should we seek to identify ways to maximize economic and social outcomes as well?

The City of Toronto can be a first mover in this space, identifying new and innovative ways not only to drive diversion, but improve the lives of Torontonians. Historically, municipalities across Canada have looked to the City to set the tone and establish a precedent with respect to waste management policy and programming. With this in mind, Toronto has a unique opportunity to show the world what can be accomplished when you choose to divert with a purpose – linking environmental goals with broader sustainability objectives that improve the lives of the City's residents.

Chapter 3: Increasing the effectiveness of Recycling Promotion and Education (P&E)

3.1 What is Recycling Promotion and Education?

An integral component for the proper functioning of a municipal waste management system is ensuring public approval and participation. The efficacy of the system will largely be determined by a households ability to properly recognize divertible material, what to do with recyclables separated from the waste stream, and the importance of diversion activity as a whole (McDonald and Ball, 1988, Evison, 1988, Evison and Read, 2001). A popular tool employed by municipalities in raising levels of household awareness and participation in diversion initiatives is the use of promotion and education (P&E) campaigns.

Promotion and education initiatives are designed to raise levels of consumer awareness regarding municipal waste management programs. While P&E campaigns vary depending on the

intended message and the target audience involved, there is a consensus that communications should clearly specify: (1) why consumers should recycle, including the environmental, economic and community benefits, and (2) how consumers should recycle, including all of the relevant details (what, where, and how) of the program (McKenzie-Mohr, 1995).

Research by Callan and Thomas (2006) and Sidique et al. (2009) have shown that areas which invest directly in P&E programs achieve higher levels of waste diversion than those who fail to make such provisions. Given the assumed effectiveness of P&E in promoting diversion, the province of Ontario has characterized P&E investments as a diversion best practice, with municipalities receiving $1 per household for all P&E related expenses (Stewardship Ontario, 2007). Many municipalities, including the city of Toronto, go over and above this $1 provision, spending in excess of $5 million dollars on waste related promotion and education expenses in the past three years. Both the province and the City of Toronto have identified promotion and education initiatives as being one of the key drivers of helping the city reach its 70% diversion target by the year 2030.

Table 1 below summarizes the types of P&E initiatives that can be used by municipalities.

Type	**Purpose**
Leaflets, pamphlets and flyers	Raise levels of consumer recycling awareness. Could be used in very general terms (i.e. promoting the importance of recycling, or be tailored to the specific characteristics of a given community) !
Radio, web and television advertisements	Raise levels of consumer recycling awareness. Could be used in very general ! terms (i.e. promoting the importance of recycling, or be tailored to the specific characteristics of a given community)
Door to door campaigns	Informs consumers about recycling initiatives at a local level
Product labeling	Indicates the recyclability of a particular product
Bin advertisements	Informs consumers about what materials belong/do not belong in recycling bins. Generally used in public spaces (i.e. parks, malls etc.)

To date, the majority of the research in this area suggests that investments in P&E are effective in encouraging household participation in diversion. Read's study of household recycling in Chelsea, England, found that conventional approaches to P&E (i.e. leaflets, advertisements etc.) were successful

in fostering enduring changes in consumer awareness Read (1998). Further to this finding, Read (1999a) observed that door to door P&E campaigns increased total waste diversion by 23% relative to baseline measurements. Building on Read's work, Jurczak et al. (2006) observed that P&E campaigns adopted in Jaslo, Poland resulted in both an increase in the total tons of material recovered from households, as well as a broader range of materials recycled. With respect to these findings, researchers found that the effectiveness of P&E campaigns is largely rooted in its ability to act as both an internal and external facilitator of diversion behavior. However, as noted by Read (1999a), P&E initiatives are successful in changing "one time public behaviors" (i.e. changing attitudes about recycling (from negative to positive), consumer purchasing habits etc.). As such, P&E initiatives are most effective when levels of recycling awareness are low, generally when a recycling program has been newly implemented. However, are P&E campaigns likely to be as effective in jurisdictions with mature recycling systems, such as Toronto?

To better understand this question, let's consider some of the strategies presently employed by the City.

Promotion and education initiatives can be broken down into the following sub categories to better differentiate project characteristics and types.

These include:

- Program Wide Promotion and Education: Projects that use promotion and education to increase household awareness regarding programmatic changes being proposed/implemented by the City
- Material Specific Promotion and Education: Projects that attempt to promote the recovery of specific materials in the residential Blue Box, Green Bin, MHSW and WEEE programs
- Public Space Promotion and Education: Projects who emphasize promoting recycling in public spaces (parks, arenas, events, trails etc.)
- Multi Residential Promotion and Education: These projects refer to initiatives that specifically focus on promoting recycling in Toronto's multi-residential buildings (also discussed in Chapter 4)

3.2: Qualifier/Caveats to the analysis

Evaluating the efficacy of promotion and education strategies is challenging, as it is often difficult to isolate the causal relationship between the initiative and the observed outcome, i.e. did project X achieve result Y.

Further to that point, P&E initiatives are often delivered in conjunction with the rollout of another initiative or programmatic change, i.e. (promotion and education for the City of Toronto's Curbside Cart Program). This further obscures what relationship may exist between P&E, diversion and costs, as there is a collinearity between initiatives (i.e., did the carts cause the greatest change in diversion, or P&E? How do the presence of carts affect the effectiveness of other non-cart P&E?).

Lastly, there is an inter-temporal dimension to P&E initiatives. Behavioral change can be separated into two time periods short term (transient) change, or long term habitual change. A P&E campaign may result in an initial uptake in recycling behavior, but these results may not sustained over time. Alternatively, the effectiveness of a campaign may not be realized until a future time period, as the observed change in behavior takes time before it takes hold.

With these caveats out of the way, there are certainly a number of general observation based on a review of broader literature and experiences from other jurisdictions that can be made. Caution should always be exercised by the reader when making declarative statements based on this analysis.

3.3 Program Wide P&E Initiatives

Based on data gleaned from the broader literature and municipal experiences to date, a P&E campaign exhibits its greatest impact in areas who are either expanding their program, or are undergoing significant programmatic changes. As an example, promotion and education initiatives that accompany the introduction of new materials, rollout of new bins, new depot sites etc. often result in increased diversion rates. This is particularly true in smaller communities, where promotion and education is seen as an effective complimentary tool during a program's onset – it helps these developing (within the context of diversion) areas reach a new baseline level of performance (around 40-50% diversion rate) relatively rapidly. However, incremental increases in performance beyond a certain level (e.g. to go from 50% diversion to 60% diversion rate) can become challenging, necessitating that multi-pronged, multi medium promotion and education strategies be developed.

Due to the relative maturity of their waste management systems, municipalities in the Greater Toronto Area (i.e. City of Toronto, York Region, Peel Region and Halton) all implement comprehensive P&E campaigns that utilize a number of both traditional and unconventional mediums as a means to drive incremental diversion (i.e. social media, online tools, downloadable apps for consumers, RFID tags, targeted advertisements in newspapers/mailers/billboards, as well as radio and television ads). While a review of historical diversion performance for these communities does suggest that these initiatives have been successful in promoting desired behavior, there is also evidence that it fails to adequately engage

or increase household participation among first generation Canadians and non-native English speakers. Many of the aforementioned strategies are premised on the intended audience having a basic level of technical and language proficiency, as well as having access to the internet and a smartphone. As noted in section 3.7, despite the city's continued efforts to engage minority groups, there is a perception among these households that these efforts are inadequate and do not contain (or does not clearly communicate) the information necessary to make informed waste management decisions (Lakhan, 2016).

Toronto in particular faces unique demographic and infrastructural challenges that makes developing effective promotion and education programs difficult. More than 50% of all households in the city are multi-residential, with a significant percentage of those households being comprised of first generation Canadians. As noted by Lakhan (2015, 2016) many first generation immigrants have never participated in municipal recycling/diversion programs in their country of origin – as a result, P&E materials that are premised on an appeal to environmental altruism ("It's good for the environment", "It promotes sustainability") fail to resonate with these groups as they do not readily identify the connection between recycling/diversion and positive environmental outcomes.

In many ways, Toronto households can be loosely divided into two groups: second and third generation Canadians who live in single family homes, and first generation Canadians who primarily live in multi-residential buildings. Future increases in diversion are not going to come from the first group – Toronto has done a tremendous job of convincing these people about the benefits of diversion and waste reduction, and these same households have been the cornerstone of the city's residential diversion programs for the better part of three decades. However, first generation Canadians and Torontonians who are new to the province need to be engaged in culturally relevant and accessible ways, as there is no "one size fits all" approach to promotion and education. As a result, the City must work closely with cultural, religious and community groups to identify the appropriate triggers/engagement strategies that are most likely to result in the desired behavior among targeted groups.

Based on experiences observed by Ontario's Continuous Improvement Fund and the wider body of academic research in the area, conventional methods of P&E engagement are an effective tool for going from point A to point B with respect to diversion performance (this is sometimes referred to as the equilibrium point – most communities are likely to reach this level of performance with minimal intervention). However, to encourage diversion beyond this point, particularly in the hopes of reaching Toronto's 70% diversion goal, will likely require significantly more time and resources to achieve.

Of note, it is critical that the City clearly communicate what exactly they want residents to do with respect to desired diversion behavior, as general appeals to "divert more" can have unintended

consequences with respect to waste stream contamination. As an example, Essex Windsor's Solid Waste Authority "We Can Recycle More" campaign resulted in residents throwing more of "everything" into the Blue Bin, including numerous items that were not part of the printed paper and packaging stream (waste auditors observed households putting toasters, garden tools, roofing tiles and paint cans in the Blue Bin). This finding highlights the need to specifically tailor the message, as households may have difficulty making a distinction between diversion programs for different streams of material.

3.4 Material Specific P&E

Material specific promotion and education initiatives are intended to increase the capture and diversion of specific materials, i.e. aluminum cans, household hazardous waste etc. Material specific initiatives often accompany more general promotion and education messaging, as it can be used to address environmentally/economically problematic materials (plastic film, polystyrene), high value materials (aluminum cans, clear PET water bottles) or materials with high rates of illegal dumping (mattresses, durable goods etc.).

These initiatives tend to be collaborative projects between the City, packaging producers, waste management operators, and organizations such as the Continuous Improvement Fund, who look to pilot and test strategies to increase the recovery of materials that have been characterized as "problematic". The increased recovery of these materials potentially represents a significant opportunity to increase diversion, as these materials are often recovered at a lower rate relative to other materials found within existing residential waste streams.

Based on a review of available literature and reports published by municipalities and packaging producers, material-specific promotion and education campaigns have historically resulted in a measurable increase in diversion of targeted materials. Unlike generalized P&E campaigns, it is somewhat easier to attribute increases in diversion to a particular initiative due to the specific nature of the campaign. It is atypical for only one material to experience an increase in diversion rates unless that increase was explained by a specific initiative.

There also appears to be some tertiary benefits to material specific P&E campaigns, in that a "spill over" occurs with respect to other recyclable materials. As an example, increasing awareness of plastics is also likely to increase the awareness of recycling in general, indirectly encouraging households to recycle more of everything.

What is less clear is whether the results from material-specific initiatives could be sustained over time, and as a tangent to that, what the "opportunity cost of investment" is. By definition, spending

resources to target a specific material reduces the amount available for other diversion initiatives. Does spending $50000 on increasing the recovery of PET thermoforms make sense, when that material comprises such a small share of the city's recycling program and is costly to manage? Would that money be better utilized elsewhere, i.e. investments in multi-res recycling infrastructure?

It is the recommendation of this study that investments made by the City in material-specific P&E be made when a material is one or more of the following a) generated in sufficient quantities by households b) can be managed economically within the existing waste management system (i.e. aluminum) c) poses a risk to human or environmental health if not managed appropriately through official channels (oil filters, paint cans, aerosols and solvents) and d) suffers from high rates of illegal dumping (mattresses, furniture, white goods, home renovation waste, automobile maintenance waste etc.).

3.5 Public Space P&E (also discussed in Chapter 5)

Promotion and education that encourages diversion/recycling behavior in public spaces is of particular importance to the city of Toronto, both with respect to the maintenance and beautification of public spaces, but also as a means to reduce or eliminate vectors of plastic/paper contamination in natural systems. The province of Ontario has also highlighted "litter" as being a priority environmental issue and has identified a lack of adequate waste collection infrastructure in public spaces as being a key driver of the litter problem.

In a review of studies examining public space recycling in other jurisdictions, evaluating the efficacy of public space recycling initiatives is often an inexact process – seasonality, special events, construction etc. can all adversely impact public space utilization, and subsequently, the quantities of waste being generated and recovered.

During waste audits, it is difficult, if not impossible to control for the multitude of variables that could potentially explain variations in diversion and contamination levels. Public space P&E, particularly through signage, seems to yield improved recycling results. However, these successes are contingent on the types of bin being used and density of bins in a given area. Optimal placement of bins (to ensure they are situated in areas of maximal foot traffic), cleanliness of bins and accessibility are critical pre-requisites to a successful public space P&E campaign.

While chapter 5 will provide a more comprehensive overview of P&E in public spaces, recommendations for promotion and education in public spaces is that it needs to be clear and easy to understand, and that high quality pictures are more effective than text. The City should also strive to ensure that there are comparable levels of service, signage, rules and collection infrastructure across all

public spaces. A significant driver of littering/illegal dumping in public spaces is confusion and lack of awareness regarding what is permissible and what is not. Ensuring a uniform and consistent level of service and engagement across public spaces in the city has been shown to discourage illegal dumping/littering and reinforce expectations for the public regarding permissible and non-permissible disposal behavior.

3.6 Is there a particular form of P&E that works better than others?

In a comprehensive review of both existing P&E initiatives undertaken by the city, as well as overlaying these findings with what can be gleaned from the broader research in this area, is it possible to "rank" P&E strategies? (I.e. are newspaper ads better than online resources etc.?). The short answer to this is that it depends on site and situation specific factors.

Broadly speaking, direct engagement strategies (face to face interactions, community events etc.) yield the greatest immediate change in recycling behavior. However, these types of initiatives can only be implemented on a small scale, and are often resource and time intensive. Conversely, P&E advertisements communicated in local newspapers (a popular strategy employed in Ontario given the compulsory "in kind" contribution by newspaper stewards), is the least effective. However, given that municipalities to dot incur any direct costs, and newspapers extremely low cost and broad outreach, opting for newspaper campaigns is an easy fall back for municipalities who want to do "something". The most important take away from this review of P&E projects (and existing research) is that the City needs to understand their audience, and recognize what works in one area or housing type cannot be readily transposed without adjusting for site and situation specific factors.

3.7 Findings from the Academic Literature

While online web resources have been highlighted as a potentially effective promotion and education strategy for municipalities, Lakhan's study on examining the effectiveness of various P&E mediums on first generation ethnic minorities provides additional insights. Websites are predicated on a basic level of computer literacy and English proficiency. However, a significant percentage of the GTA is comprised of households who are non-native English speakers, or have lower (relative) levels of computer literacy. The following is an excerpt taken from Lakhan's study

> ***"How easy was it for you to find the city's web site on waste management and recycling?"***
>
> This question had to be revised several times during pre-testing, as there was initially some confusion regarding what constitutes "easy" or "difficult" (the original phrasing

of the question asked participants to comment on whether it was difficult to find the waste management web page). Other alternatives that had been tested include "did it take you a long time to find the web page?" – The inherently subjective assessment of difficulty and time made it difficult for pre-test participants to accurately answer the question. Also, pre-test participants expressed concerns over being judged if they answered that it was difficult for them to find the web page (tacitly implying that they were not technologically savvy). For this reason, the term "easy" was used (in lieu of difficult or time consuming), as it was a value positive statement. Though this did not overcome the issue of subjectivity, pre-test participants viewed this statement more favorably relative to alternative phrasing.

48 of 77 focus group participants expressed difficulty in navigating to and within municipal waste websites (commonly coded phrases included "It's hard to find the information I'm looking for"). This result was consistent with the timed observations recorded by facilitators. The mean time for survey participants to navigate from the municipal home page to the waste management resource page was 4.4 minutes. In 26 instances, focus group participants were unable to successfully locate one or more of the waste management resource pages.

The second most frequently coded response for this question was that the municipality's web pages were often translated incorrectly (coded 33 times), making it difficult to locate the appropriate waste related resource. While the Google translate feature was available on each of the municipal web sites, the translation was often inaccurate (mistranslated words and phrases, grammar etc.). 24 study participants indicated that this was actually insulting to them - anecdotes recorded during the sessions include "If you're not going to do it properly, don't bother doing it at all" and "It shows how much they (the municipality) care about us". The notion of "us" and "them" was a recurring theme during the focus group sessions. There was a sentiment that municipalities catered to "white" households and ignored (or placed less emphasis on) the needs of ethnic minorities.

"Does the information presented in this advertisement raise your awareness about your municipalities recycling program?"

Focus group participants indicated that online resources were more informative relative to other mediums of P&E, and as a result, significantly increased recycling awareness (coded 45 times). Participants indicated that the accompanying visual examples on the website (e.g., pictures of various types of packaging, examples of how to properly wash jars and bottles before putting it in the Blue Box etc.) were useful in helping increase recycling awareness (the how and where to recycle). However, 16 respondents indicated that online resources did not increase recycling awareness in any meaningful way. Anecdotes noted during the sessions indicate that a language barrier was the primary impediment to increasing awareness among participants who responded "No" to this question. As noted previously, while the Google translate feature was available on the website, mistranslations resulted in confusion among some focus group participants. Municipalities also have a propensity to use sector specific terms in P&E messaging, i.e. describing juice boxes as Tetrapacks or Aseptic Cartons, or laundry detergent as high density polyethylene etc. These terms often confused study participants, which is perhaps why visual

examples proved so successful in raising awareness. A person may not know what a spiral wound container is, but they recognize the product when shown a picture of it.

"Are you more likely to recycle because of the information contained in the sample advertisement?"

Perhaps the most interesting finding from this part of the focus group sessions is that despite increased recycling awareness, 64 of the 77 study participants said that they would not recycle more as a result of online P&E resources. Once again, the majority of respondents said that they were already recycling, and did not necessarily see the purpose of P&E initiatives. Coded responses from the focus group sessions include "I am already recycling" (coded 59 times), "I'm not going to spend more time than I already am" (coded 43 times) and "It's all just going to end up in the dump anyways" (coded 27 times). The last comment was of particular interest, in that there was a perception among focus group participants that the city was not actually recycling the material that they collected. A number of respondents were under the impression that the municipality charged residents for recyclables collection (as a tax grab), but secretly sent the material to landfills. In 7 instances, respondents thought that recyclables was being shipped overseas to developing countries. Once again, facilitators were instructed not to correct these misconceptions. One respondent indicated that "back home, I would see big shipments of garbage come from other countries and be dumped in open pits". This practice is expressly forbidden in Ontario, as municipal household waste cannot be shipped outside of the province. Why study participants feel this way, and whether these reflect the attitudes and opinions for ethnic minorities as a whole remains a curiosity and a topic worthy of additional investigation.

The above passage illustrates that online P&E have some successes in increasing recycling awareness among ethnic minorities, but are not effective in inducing behavioral change. These findings suggest that large urban municipalities have additional considerations when designing web based resources that extend beyond the "what, when, where and why" of recycling. These municipalities are charged with finding ways to effectively engage a diverse population base, and overcoming numerous misconceptions surrounding municipal recycling practices.

With the aforementioned in mind, depending on locality, online recycling promotion and education can be seen as an "easy win" that is fairly low cost, or a significant challenge that requires careful planning and consideration.

There may even be merit in having municipalities explore alternative means of P&E engagement and delivery, as current research has shown very promising results when municipalities partner with community organizations to delivery joint recycling P&E campaigns. The municipality is tasked with constructing the "ingredients" list with respect to the "what, when, where and why" of recycling, while the community organization creates the customized recipe to reach their membership.

As per Lakhan's study on alternative P&E mediums:

> *Using data collected from 12 religious institutions in 3 provincial communities, a promotion and education program was developed to: 1) Increase awareness about existing waste management programs in the region 2) Describe what materials should be recycled 3) Highlight the importance of recycling (to the individual, to the community and to the environment and 4) Make a direct appeal asking households to participate in their region's recycling programs. Post implementation of the P&E campaign, respondents indicated a statistically significant increase in positive attitudes towards recycling, moral norms, levels of perceived behavioral control and awareness of recycling consequences. Perceived behavioral control, situational factors, attitudes and moral norms were found to be the most significant predictors of recycling intention. Community leaders were demonstrably more successful in affecting positive change in stated recycling behavior among minorities relative to the municipality.*

3.8 Key Findings

Based on our review, the following "general" observations can be made:

- Promotion and education advertising the what, when, where and why of the program is an effective initial strategy for municipalities who have recently implemented their diversion program, or have undergone substantive programmatic changes
- P&E is a central element of virtually every municipal waste management plan, however, different municipalities have different needs and challenges, necessitating that programs be tailored to meet local conditions and characteristics
- Promotion and education should be seen as a complimentary effort that accompanies investments in infrastructure and convenience
- Promotion and education should be delivered using multiple mediums (print, online, billboards) to engage the greatest number of households
- Promotion and education messaging should be clear and prescriptive with regards to what they want/expect households to do
- While there is a significant body of literature (both from city reports and the academic discourse) supporting the efficacy of P&E, surprisingly little is understood about how to promote recycling among "new recyclers" such as immigrants
- Multi-residential promotion and education continues to be a significant challenge for municipalities, particularly those in large urban areas.

Chapter 4: Strategies to Improve Multi Residential Diversion in the City of Toronto

Diversion rates in the City of Toronto have largely stalled in the past five years, and in fact, are trending downwards for the first time since the introduction of the Waste Diversion Act in 2002. What

makes this issue particularly salient is that the city has specified a 70% diversion target by the year 2030, an ambitious goal to accompany broader environmental and sustainability objectives for Toronto. While this declaration has largely been heralded as a "step in the right direction towards a more sustainable Toronto" and applauded by both municipal officials and the general public, the city faces several infrastructural and demographic obstacles to achieving this goal. At this juncture, the City of Toronto is struggling with the concept of "incremental diversion"—how do they go after the material (and households) that are not currently being diverted or participating in residential recycling programs.

This problem has been particularly acute in multi residential buildings, which recycle at approximately 1/6th the rate of single family households. There are currently a total of 1.25 million multi residential households in Ontario, which represents approximately 25% of all households in the province. Multi-residential households tend be situated in higher density urban areas, with 85% of all multi-residential buildings located in the largest four municipalities in the province (Toronto, York Region, Ottawa and Peel Region). While no official mechanism is in place for buildings to report quantities of waste generated and recovered, using waste audit data collected over the past 10 years, Stewardship Ontario estimates that multi residential buildings generate approximately 205,000 t of recyclables per year (Stewardship Ontario, 2009) (where waste audit data is an analysis of what comprises the residential waste stream using samples taken throughout the province). However, there exist numerous barriers to managing waste in multi residential buildings, namely, a lack of access and convenience for residents. Given that most multi residential buildings require households to collect and bring recyclables to the building's basement (where facility recycling carts are located), reports from building managers suggest that a significant percentage of recyclables end up in the waste stream (CIF, 2010). This necessitates that initiatives be undertaken to increase multi-residential recycling participation (through improved access to recycling services, increased promotion and education campaigns etc.).

Specifically targeting multi residential buildings for increased recovery of recyclables is a topic of increasing importance for Toronto. Multi-residential recycling represents a significant opportunity for increased diversion in the city. If the multi-residential sector managed to increase overall recycling rates to 60% (approximately the provincial to average), overall diversion would increase by more than 40,000 Tonnes—most of which would be comprised of readily recyclable material such as corrugated cardboard and boxboard. The next tonne of recycled material is unlikely to come from single family households in the suburbs—participation rates for those areas already exceed 95%. Future increases in Toronto's diversion rate will need to be driven by the multi-residential and industrial, commercial and institutional sectors.

4.1 State of Multi-Residential Diversion in Toronto

As of 2018, the City of Toronto provided waste management services to an estimated 453,000 multi-family units in 25 wards across the region. Overall quantities of printed paper and packaging waste generated for multi residential buildings have been estimated to be in excess of 80,000T, while more than 120,000T of organic waste is generated annually. Of this, it is estimated that less than 20% of all material generated is diverted through the city's Blue Box and Green Bin programs. This falls wells short of the 70% diversion target specified by the city, and is approximately 1/3rd the diversion performance achieved by single family households in the region.

The city provides eligible multi residential buildings with 360 l front and side loading recycling bins that are collected at designated biweekly intervals (through curbside services). Building managers are expected to set out waste and recyclable containers in clear and accessible locations to allow collection vehicles to readily access and load waste from the building (City of Toronto, 2015a, City of Toronto, 2015b). To further encourage recycling, multi residential buildings can request that individual units be provided with "personal" in home recycling bins and bags (6–8 l mini containers for households to temporary store recyclables).

In order to provide guidance on diversion in multi-family buildings, the city has formed a Multi-Family Waste Diversion Working Group to explore ways of implementing multi residential waste diversion initiatives. Given the heterogeneity of multi residential households in Toronto, both with respect to infrastructure (chutes vs. waste rooms), demographics (community housing vs. elder care) and ownership (rental vs. owned) initiatives intended to increase awareness are customized to suit the ????

4.2 Recommendations for improvement:

For the purposes of this report, we define multi residential projects as initiatives that improve the performance of recycling programs in multi residential buildings, either through investments in improved access, awareness, infrastructure or training.

The discussion surrounding multi residential projects (and sub project types) is separated into three broad categories: Initiatives to improve awareness, initiatives to improve convenience, and initiatives to improve capacity. A review of initiatives undertaken by jurisdictions across Ontario and Canada has also been conducted to identify potential best practices than can be implemented by the City of Toronto.

Initiatives to increase awareness: Increasing multi residential recycling awareness can largely be seen as promotion and education efforts undertaken by the municipality to increase multi-res household

awareness regarding the Blue Box program. However, awareness can also refer to training of building staff and service providers to better understand the unique challenges facing multi residential buildings.

Initiatives to increase convenience: Increasing convenience of recycling activities in multi residential buildings is done either through the provision of in home recycling bags/mini bins, floor level recycling chutes, or improved access to recycling drop off points (ensuring that it is clean, safe and clearly labeled).

Initiatives to increase capacity: Increasing capacity of recycling in multi residential buildings includes the purchase of larger drop off bins for buildings, increasing the frequency of recyclable collection by the service operator, and ensuring that what is collected from the building (from households) can be readily collected and managed by the city (reduced contamination etc.)

4.3: Qualifier/Caveats to the analysis

It is important to note that isolating a cause and effect relationship between a particular initiative and an outcome poses numerous methodological challenges. Often times, it is difficult to quantify how exactly a particular program/initiative directly affects diversion, as the causal relationship between action and outcome (increased diversion) isn't always clear. As an example, increasing capacity (through the provision of larger recycling bins) may not have an immediate or direct affect on diversion rates, as household diversion behavior is often the function of a multitude of factors.

Recognizing these limitations is important, as it helps provide some context to the results, and opens the doors for additional inquiry. However, as noted before, sometimes "good enough" is all we need. We caution to the reader with respect to interpreting the results and implying causal relationships.

4.4: Increasing Multi Residential Awareness

Increasing awareness in multi residential households, particularly using conventional promotion and education strategies, have yielded positive results, but there remain significant opportunities for improvement. Historical attempts to increase recycling awareness among mult-residential households in the city have often relied on mediums and materials, such as:

- Distributing print materials directly to residents
- Distributing and displaying posters and multi-residential properties, and
- Applying labels to recycling containers

City staff ensure that these materials are distributed to residents (with a preference given to direct engagement of households), and that signage is clearly displayed. However, as noted in the City of Toronto's Tower Renewal Feasibility study, awareness is only one component of the antecedents to diversion behavior, with the report identifying that language barriers, transience, lack of ownership,

inconvenience, material contamination, lack of financial incentives, lack of support by building management and existing infrastructure all conspire to undermine the success of recycling in multi-residential buildings. In essence, the barriers to participation (as well as the accompanying solutions), go far beyond issues surrounding household attitudes and awareness. In a meta-analysis of the perceived efficacy of promotion and education initiatives conducted by Lakhan (2015), it was found that the strategies to increase awareness in multi-residential buildings were only effective when accompanied by adequate access and capacity. Anecdotes from these studies also seem to suggest that the "bump" in awareness resulting from P&E may not lead to sustained increases in diversion behavior over time. In several instances, increases in diversion were temporary, and often returned to baseline upon the cessation of the P&E campaign. Behavioral habituation was extremely difficult to achieve in multi-residential buildings, although it was not readily apparent as to why this was the case. Some possible reasons posited by study authors suggest that multi-residential buildings, particularly rentals, have much higher turnover rates when compared to single family households (residents constantly changing). There is also a distinct lack of normative pressures, as unlike single family homes serviced by curbside collection, multi-residential tenants do not see (or are seen by) neighbors participating in source separation programs. Habituation, particularly with respect to diversion, is encouraged when you are expected to engage in the behavior at regularly schedueled times, and can be readily identified by others as either "taking part" or choosing not to participate.

This ultimately begs the question as to what changes can be made to promotion and education efforts to increase awareness in multi residential buildings? As noted in the City of Toronto tower study, there is a need to effectively communicate promotion and education materials in multiple languages, and in a way that is culturally relevant to the target audience. There is also an increasing body of literature that suggests different ethnic groups have different behavioural triggers with respect to participation in waste diversion programs. As such, an appeal to environmental conscience may not resonate with a significant percentage of households in multi residential buildings (and minorities in general).

What does seem effective in increasing diversion awareness is direct "door to door" intervention by municipal or building staff that personally communicates the specifics of the program. Retention of the "What, where, when and why" of recycling is significantly higher when using direct engagement strategies, but the drawback is the resource cost (expressed in both time and money) in employing this method. Increasing awareness and training of building staff has also been shown to be critically important in ensuring that recycling programs are actually supported for residents. There were numerous incidences reported from the broader literature of building staff failing to distribute P&E materials, or not providing

clean and accessible waste drop off areas. As noted in the Continuous Improvement Fund Multi Residential Best Practices report, getting building staff to "buy in" to the importance of diversion programs not only promotes diversion efforts among residents, but helps service providers performing pickups (ensuring all bins/carts are accessible, in the right area, not overloaded etc.).

4.5 Multi Residential Accessibility (Convenience)

Convenience (or lack there-of) is often seen as the primary driver of diversion participation in multi-residential buildings. Intuitively, this makes sense – given that residents are often required to bring recyclables/organics down to a building basement (which may be unclean, unsafe or not clearly labeled), there is an incentive to forgo participation and simply dispose of all materials in the waste stream. This assumption has been supported by previous investigations in the literature, however convenience may not be the only determinant of participation. As noted in the previous section, awareness (that the program even exists) was seen as a primary behavioural antecedent, highlighting that promotion and education efforts must be delivered in conjunction with initiatives designed to increase convenience. With that being said, convenience (both with respect to households, building management and service operators) is seen as an almost necessary pre-requisite to the success of any multi-residential diversion program.

Based on a review of the broader literature, increasing convenience for households (through the provision of in home recycling/organics bags/totes/bins, more accessible and organized drop off points and cleanliness of drop off points), contribute materially to observed increases in diversion noted in reports. A degree of caution needs to be taken when assuming this observed increase in diversion will persist – improved accessibility is contingent on continued efforts on both the part of households and building management to ensure that the desired behaviour continues. While households may initially be amenable to using an in home bag during the initial phase of the study, they may grow tired of having to find a separate storage space, or the time expended in doing so. Tangent to this, cleanliness and organization of drop off points requires both households and building managers to work collaboratively to ensure that accessibility is not impeded. The conditionality of this outcome highlights the necessity of prioritizing accessibility as the most critical factor for success of multi residential recycling initiatives. It requires not only ongoing participation of households with respect to source separation behaviour, but a coordinated effort to ensure that the drop off and collection of recyclables is easy to do (something that is not traditionally required of curbside single family households).

Accessibility is also of equal importance to service providers, who often incur significant time costs in the event that access to recycling bins and carts is impeded in some way. Assuming that collection is provided by the municipality (or sub contracted), the additional time in collecting from multi residential households resulting from impeded access can materially contribute to elevated collection costs.

4.6 Increased Capacity

Ensuring that there is sufficient capacity to accommodate recyclables is a fundamental component of a successful multi residential recycling program. Many of the City's existing investments in multi-residential waste management are either specifically designed, or part of a larger initiative, to expand the capacity and outreach of diversion services in multi residential buildings. Increasing capacity (generally speaking) can take two forms: 1) Increasing capacity within the home, through the provision of recycling bags or mini recycling bins or 2) Increasing capacity at the drop off point, to ensure that the bins are large enough to accommodate for the recyclables generated during one pickup period. Unlike investments in improved accessibility and awareness, an increase in capacity results in tangible, enduring and measured increases in (assuming there was a previous constraint on capacity). In a study conducted by Ontario's Continuous Improvement Fund (2016), the purchase of additional recycling carts resulted in a 5% increase in the average quantities of recyclables collected, with an increase in building recycling rates ranging from 4% to 15%. While a comment was made earlier regarding the importance of accessibility in ensuring a successful multi res recycling program, that is predicated on there being sufficient baseline capacity in the building. However, adding capacity over and above what households generate is unlikely to encourage recycling behaviour, but any purchase of bins/carts in buildings where either none or few exist is likely to result in a significant increase in diversion.

The impact of adding in home capacity in multi residential dwellings is slightly less clear. Intuitively (and also based on anecdotes gleaned from the broader literature), adding in home capacity allows a convenient spot for households to put recyclables/waste until they are ready to take the bin/bag to the designated drop off point. However, given that residents are being asked to store recyclables "in home" requires space, and low levels of food contamination (while generally not a huge issue with packaging waste, some food jars and tubs can pose spoilage issues if not properly cleaned). Households where space is already a premium may be unable or unwilling to accommodate for in home storage of both recyclables and garbage. The academic literature shows no real consensus on this issue – there is evidence to suggest that while multi residential households would like the opportunity to recycle, their participation was a function of finding an appropriate storage solution (is there a "sweet spot" for the size of bin/cart put in multi-residential units?)

4.7 Examples from other jurisdictions

A significant investment has been made in multi residential projects across Ontario and Canada, with Ontario's CIF in particular providing in excess of $20 million dollars to support and improve the effectiveness of multi-residential waste management programs. One of the key outcomes of this initiative was the development of a multi-residential best practices guide, which provides specific guidance to municipalities to improve the efficiency and effectiveness of MR programs. The creation of MR Best practices, which assist municipalities in the optimization of their program operations, has resulted in significant improvements to access (in terms of buildings that receive coverage), accessibility, capacity, and engagement. While it is sometimes difficult to provide generalized recommendations given the differences in infrastructure, demography and even types of waste that are produced by the multi-residential sector, some general best practices include:

- Ensuring that there is sufficient capacity to accommodate for the generation of building recyclables is a mandatory first step in implementing a multi-residential recycling program.
- Convenience is a significant predictor of behaviour (measured in terms of accessibility), but it should not be seen as the only determinant of recycling participation
- Promotional and educational materials should be seen as a complimentary tool that accompanies adequate capacity and access
- Promotion and education materials should be translated when possible. Additional research is recommended in terms of how best to engage ethnic minorities living in multi residential buildings.
- Municipalities should work closely with building managers to ensure that recycling programs are promoted. "Buy in" from building management was seen as a significant predictor of MR program success.
- Areas where recyclables are dropped off by households should be kept clean, safe, well lit, and accessible (both to households and collectors)

Monitoring was also seen as a key feature of multi residential best practices – the ability for a municipality to assess and track building performance is integral in ensuring the long term success of MR recycling programs.

4.8 Closing Comments

Of note, there is often an inter-temporal dimension to projects intended to improve diversion in multi-residential buildings. An investment in period one may not result in the desired outcome until years later. Affecting changes in behavior takes time, and even longer before any meaningful changes are noticed. As noted throughout the multi-residential "best practice" reports, municipalities are putting in the pieces to ensure a successful program once (or if) changes come into effect. Investments in capacity and convenience are fundamental to the success of multi residential diversion programs. Investments in these types of projects are almost nonnegotiable, as no amount of promotion and education will ever be able to overcome constraints on capacity or impediments to convenience. The City of Toronto should be encouraged to continue to place focus on these areas, as densification (expressed in the form of increased development of multi-residential properties) is only likely to increase with time. What is obvious is that doing nothing is not a viable option in the multi residential sector. Multi residential households represents a significant opportunity for the City to improve diversion rates (given their performance relative to single family households), but the exact recipe for success has yet to be found. Continuing to invest in these projects, but allowing for an iterative process that allows the City of Toronto to adapt and respond to issues unique to multi-residential buildings is going to be what allows for improved operational efficiency and diversion performance. This further highlights the need to monitor programs such that the City can be adaptive in how they respond to the challenges facing the MR sector. There are a confluence of factors at play that can affect the success of multi residential recycling (many of which are beyond the control of the City of Toronto). As an example, multi residential buildings that are classified as community or public housing have infrastructural and safety issues that go well beyond issues with a buildings' waste management program. Encouraging diversion in these buildings will be an uphill battle in light of exogenous factors surrounding decaying infrastructure and public safety.

Chapter 5: Increasing Diversion in Public Spaces – Waste Away from Home

This chapter is devoted specifically to projects designed to support and develop public space recycling initiatives. It is important to note that public space recycling is also addressed in Chapter 3 on recycling promotion and education, however, those projects specifically focused on increasing awareness of new program initiatives implemented by the City.

Evaluating the efficacy of public space recycling initiatives is often an inexact process – seasonality, special events, construction etc. can all adversely impact public space utilization, and subsequently, the quantities of waste being generated and recovered.

There also appears to be a lack of consensus regarding what constitutes a public space (at least in the academic literature). Broadly speaking, a public space is considered a space that is open and accessible to the public. Road ways, public squares, parks, beaches, town squares etc. are generally considered to be public spaces. To a lesser extent, municipally operated buildings which are open to the public (i.e. libraries, recreational facilities) can also be considered public spaces. As a term and concept, public space is largely fluid (i.e. social gathering places are sometimes construed as public spaces). There remains considerable debate regarding what constitutes public space, the role it plays and how to design cities and spaces to encourage common areas.

Further complicating issues surrounding recycling in public spaces, is that the quantities of waste generated and diverted in these areas is something that remains poorly understood in both Toronto and the province as a whole, as it generally falls outside the regulatory requirements of existing residential waste management programs. While the responsibility for public space recycling largely rests with the municipality (with some exceptions), there is little prescriptive guidance surrounding what types of waste should be collected/diverted. Additionally, there is no official mechanism in place to monitor the number of recycling, composting or waste collection bins in public spaces, which makes ensuring equitable access to services difficult.

While many municipalities undertake initiatives to quantify and estimate public space waste generation through audits (some of which are discussed in this section), it is difficult, if not impossible to control for the multitude of variables that could potentially explain variations in diversion and contamination levels.

Though a degree of caution should be exercised when implying causality, investments in public space recycling projects had more concrete linkages between a particular initiative (i.e. bin twinning) and outcome (increased diversion). As such, this section will be structured in a way that ordinally ranks initiatives based on municipal experiences. This is done to provide insights as to where there are "easy wins" for Toronto looking to improve diversion performance in public space areas.

5.1 The "Easy Wins"

5.11 Increase bin density and placement of public space bins

The initial impediment to public space recycling is simply a lack of opportunity for the public. In the absence of having sufficient bins in a public commons area, people will either have to hold onto

recyclable material until they get home (which rarely happens), or they are going to throw it in the garbage (the most likely outcome)

Ease of access to recycling significantly influences diversion rates – convenience is the primarily motivator for recycling in public spaces based on findings gleaned from these reports.

There has been demonstrable evidence in the broader literature on public space recycling/diverting that has shown the purchase of additional recycling and waste collection bins leads to a direct increase in diversion. Other jurisdictions in Ontario such as the City of London, the City of Markham, the Municipality of Killarney and Essex Windsor all experienced an uptick in total recovered tonnes as a result of bin purchases (sometimes in excess of 50%). It should be noted that this increase in diversion is not solely attributed to the purchase of additional bins – promotion and education efforts, choice of bin, and bin placement all contributed to observed changes in recovered tonnes.

However, there doesn't appear to be an "ideal" figure for the number of bins required in a given area. This is often dependent on site and situation specific factors, so it is difficult to provide exact guidance on how many recycling bins a the City should install. A more critical consideration for the success of a public space diversion initiatives appears to be bin placement. Bins should ideally be placed in areas with the highest foot traffic, or in areas where disposable items (food stuff, newspapers etc.) are likely to be consumed (i.e. concessions stands, transit shelters, densely populated road ways etc.). In both the City of London and the City of Peterborough, the strategic placement of bins along busy, pre-established collection routes (in downtown streets and park trails respectively), were successful in increasing the number of diverted tonnes collected. Placement of bins along existing collection routes (either where the collection contractor is passing by, or municipal staff are already collecting garbage), is seen as a way to realize cost savings. Extraneous trips and special routes that are specifically meant to collect waste/recycling bins should be avoided where possible.

5.12 Increased Capacity

Tangent to bin availability, is the consideration that needs to be given to bin capacity. Many municipalities across Ontario have found that increasing bin capacity for waste/recyclables not only increased diversion, but discouraged littering and illegal dumping in the areas surrounding the bin. Increasing bin capacity achieves multiple purposes:

1) ! The greater the capacity of the bin, the less likely it is to reach capacity and overflow before a scheduled pickup. One of the greatest concerns expressed by both households and city staff is that littering and cleanliness were an impediment to public space recycling. When a recycling bin is "overflowing", residents are more likely to dispose of material in the garbage, or to "pile" on to the overflow by discarding materials around the bin.

2) ! As noted above, increasing capacity reduces the number of scheduled pickups required by the municipality or service provider. This can result in significant cost savings for the City– the City of Kenora, the City of Markham and Essex Windsor have all observed significant decreases in labor and vehicle costs resulting from an expansion of public space recycling/diversion capacity – in the City of Markham's case, the expected reduction in public space collection costs was estimated to be between 50% and 80%. It should be noted that increased capacity is not necessarily achieved by simply providing larger bins – In both the City of Markham and the City of Kenora projects, solar powered compactors were used to compact materials to increase available bin capacity. These cities also implemented monitoring software that would provide feedback to the municipality on when bins were reaching capacity, such that pickups were performed on an "as needed" basis. While this is a 'nice to have' feature, there is not enough evidence to suggest that monitoring software should be a recommended feature for public space bins. Though it does contribute to increased diversion and result in a decrease in collection costs, there is a much higher capital cost incurred at the onset of the project.

5.13 Twinning Bins/Bin Choice

Twinning bins, which refers to placing recycling bins and garbage bins together, was observed to have a significant (positive) effect on diversion rates. Once again, this seems like a fairly obvious solution given that it increases the public's opportunity to recycle, with the barrier to doing so largely being one of cost and available space.

The City of Toronto, the City of Peterborough, Essex Windsor, the Municipality of Killarney etc. have all observed an increase in capture and diversion rates when twinning both recycling and garbage bins together. Twinning bins may also help reduce contamination by making the public aware that there are specifically designated spaces for refuse and recyclables. Municipalities have attempted to differentiate between the two container types using different colors (blue vs. black, multi stream vs. open mouth). While there is a relative paucity of examples examining the effects of twinning on contamination rates, it is hypothesized that contamination in recycling bins will decrease, as the public will have an opportunity to dispose of food stuff and liquids in the garbage bin. Anecdotally, this has been observed by municipal staff, who noted that stand alone recycling bins in public spaces, particularly in high foot traffic areas, contained higher degrees of contamination than those which were placed in combination with waste bin. Of note, restrictions on the sizes of the openings for either recycling or garbage bins

increased the likelihood of waste/recyclables being dumped outside of the bin (people did not want to take the time to open a chute, or navigate beverage containers through a small can sized opening)

5.14 Monitoring and Assessment

As noted above, overall quantities (and composition) of waste being generated in public space areas remains poorly understood. As such, it is highly recommended that the City implement some form of monitoring and assessment requirements for initiatives involving managing waste in public spaces. This may include (or some combination thereof) tracking overall quantities of waste being generated and diverted in public spaces using waste audits, establishing baseline values prior to the launch of a new initiative (or changes to existing initiatives) and examining waste composition and contamination levels over time. It is imperative that the city try and better understand the "scope and scale" of the issue prior to implementing any programmatic or operational changes. A needs assessment is critical for not only developing appropriate solutions for existing problems, but developing preventative strategies for the future.

Monitoring contamination levels is of particular importance to the City, as public spaces in particular suffer from extremely high degrees of organic contamination that often render recyclables worthless. This, in part, is explained by the nature of consumption in public spaces. A half full pop can is normally disposed in the recycling bin, subsequently contaminating the rest of the material. This can (and does) have adverse effects on the quality of material that can be recycled, necessitating that the City implement measures to help combat contamination through better signage, restricted bin openings, increased capacity and regular servicing/emptying.

5.2 The "Maybe" Works:

5.21 Implementing Multi Stream Bins

What type of bin should be implemented in a public space is largely a function of economics, available space, and existing collection infrastructure. Municipalities with single stream systems may not care how recyclables are collected in public spaces, but there appears to be a preference for multi-stream public space bins as a means to reduce contamination. Essex Windsor, the City of Killarney and the Municipality of Meaford all observed significant reduction in contamination post implementation of tri-stream recycling containers. The City of Killarney's report on public spaces indicated that items most commonly consumed by the public walking on city streets naturally fell into two categories (paper products vs. beverage bottles/cans), which contributed to the decision to choose multi stream bins.

However, multi stream bins, on average, tend to be more expensive and physically larger than open mouth containers. The City may want to take this into consideration when selecting bins for public spaces. In areas where the types of material being disposed is relatively homogenous (i.e. primarily newsprint), single stream containers may be a suitable and more cost effective solution.

Several studies have also highlighted the need for recycling bins to have lids to prevent illegal dumping. This is particularly true of bins located in parks, which had higher observed instances of illegal dumping due to their relatively remote locations. Closed lids also help prevent weather related contamination and interference from vermin.

5.3 What needs work:

5.31 Recycling Promotion and Education in Public Spaces

Like with most promotion and education efforts, it is difficult to ascertain the direct relationship between changes in diversion and a campaign initiated by the municipality. While projects in the City of Markham, the City of St. Thomas, Essex Windsor and the City of Sarnia all noted the success of P&E in increasing diversion, it is difficult to determine how much of the observed change in diversion were specifically attributable to P&E efforts (vs. increased bin density, bin placement or bin choice).

The general consensus from experiences in other municipalities is that promotion and education materials should be:

- Clear and consistent
- Closely align with the CIF Public Space Best Practice recommendations
- Attempt to maximize recycling program participation
- Reduce contamination in recycling receptacles, and
- Encourage/reinforce at home recycling behaviour

Visuals (often in the form of Bin stickers or signs) were seen as being more effective than text when it came to communicating information to the public. What text was used, should ideally communicate simple, global messages "Please Recycle", "Remember to Recycle!" "We can Recycle More!" etc. Labeling bins with the recycling Mobius loop was also seen as a way to effectively communicate to the public that these bins were specifically designated for recyclables, not garbage.

When it comes to promoting recycling in public spaces, simplicity seems to be key. In most of the aforementioned reports that specifically commented on the effectiveness of promotion and education initiatives, signs and labels that visually captured what materials were accepted (and where to put them)

complimented the effectiveness of other public space initiatives. Of note, the City of Toronto had conducted a small control study that measured the diversion rate of recycling bins with P&E signage, and without. Bins with signage diverted 37.5% more material than those without signs. However, a somewhat unexpected result is that bins with signs experienced an almost 50% increase in contamination rates. In this particular instance, the signs appeared to "remind" the public to recycle, but did not effectively communicate what constituted recyclable material.

In 2017, the region of Niagara conducted a study that found that direct engagement strategies should be employed by municipalities to encourage participation in public space initiatives. The report identified focus groups, public outreach that involved person to person meetings and follow up surveys with the public as means to promote public space initiatives. While these were seen as being successful strategies (and there is demonstrable evidence in the broader academic literature that supports this position), direct engagement is often seen as being too resource and time intensive.

Public space recycling is likely to continue to pose an issue for Toronto, as there is less personal incentive for the public to recycle. The logical first step to public space recycling P&E appears to be providing the "essentials" of the program (what can be recycled, where does it go etc.). These messages should be communicated as simply and clearly as possible, to support other initiatives such as bin twinning, increased bin density etc. However, as evidenced in these reports, conventional methods of promotion and education are unlikely to result in significant increases in diversion (or reduced contamination etc.).

5.4 Factors Contributing to Littering/Illegal Dumping in Public Spaces

A finding worth highlighting is that willingness to illegally dump waste and/or litter is a function of whether a public space (or common area) is being adequately maintained and whether that space is perceived to be a communal space.

As noted by (Brunton-Smith et al., 2014), the aesthetics or cleanliness of an area is inversely related to rates of illegal dumping – the cleaner or better maintained an area, the less likely people are to illegal dump waste. By contrast, if an area is perceived to be poorly maintained (litter, overflowing waste bins, other illegal dumping), then people will be more inclined to dump waste. The characteristics of a site send signals to people about the collective lack of control and concern about the space and the values and intentions of others that share the space. In simpler terms, people will rationalize and justify the behavior as it is seen as a situation where "If other people don't care, why should I?" This effect is exacerbated in instances where perceived enforcement is low.

This situation manifests itself slightly differently in multi-residential buildings, where tenants are more likely to illegally dump waste when the designated collection point (most often the garbage/recycling room) is poorly maintained and dirty. This is sometimes characterized as the "pile on" effect, wherein the presence of litter/junk encourages other households to improperly/illegally dispose of material. A lack of communal maintenance or care for a shared space ultimately incents people to dump. Multi-residential buildings are also more likely to have higher turnover with respect to tenant occupancy (in rented units). Bulky waste generated during moves (old furniture, mattresses etc.) is often illegally dumped – either in the waste room (if there is sufficient space) or in surrounding public spaces. As noted by Ontario's Continuous Improvement Fund, a significant predictor of illegal dumping in multi-residential buildings is how well the building is maintained (clean waste room, well lit) and commitment by the building operator/owner to enforce rules surrounding waste disposal.

It should be noted that both willingness and observed instances of illegal dumping and littering in public spaces decreases significantly in areas that are perceived to be a communal space/amenity. As an example, public parks are often seen as one of the sites most likely to attract illegal dumping – however, when members from that community utilize that space and feel a collective responsibility for its maintenance, then illegal dumping is discouraged. The concept of "ownership" has been observed to have a significant influence on waste disposal behavior, particularly with respect to adherence to rules and regulations. In multi-residential buildings where residents own their units (versus renting) or belong to a cooperative, observed instances of illegal dumping, participation in source separation initiatives and contamination rates of the organics/recycling stream are significantly lower when compared to rental units. This behavior may also explain, in part, why some people choose to illegally dump material outside of their communities. Not only is there a reduced risk of being recognized, but people are also able to avoid harming areas that they themselves may use and perceive to be as part of their neighborhood.

5.4 Findings from the academic literature and research recommendations

Beyond the concerns surrounding sanitation, there is evidence in the academic literature to suggest that "bin overflow" results in a negative association with recycling among members of the public. When people see a bin that is overflowing or heavily contaminated, there is an assumption that the municipality (or service provider) does not care, and neither should they. There is a principle referred to as "shared responsibility in stewardship" where the public will participate in a given environmental initiative premised on an equal or greater effort on the part of the expectant party (a city, a company

etc.). If there is evidence to suggest that the expectant party (in this case the municipality) does not care about public space recycling, neither will the public.

In the Public Space better practices report published by Ontario's Continuous Improvement Fund, clear and consistent signage was one of the recommendations. While I agree with the former point, new research suggests message "consistency" may not produce the desired results. As noted in Chapter 3, whatever behavioral change that public space P&E results in is likely achieved at the project onset – as soon as the signage becomes part of the built environment, its efficacy diminishes. It simply blends into the landscape for regular patrons, and visitors are unlikely to feel a perceived moral obligation to recycle in a given space as they are not part of the community (not to say that they don't recycle, but they are less likely to do so out of perceived normative pressures).

As such, developing "new" promotion and education signage on a regular basis (monthly, quarterly etc.) or alternatively, implement something that is a-typical to the space (visually jarring, clearly doesn't belong) may produce desired results. While the latter may contravene the expected aesthetic, there is demonstrable evidence in the academic literature to indicate that the public respond to this type of signage.

Findings from the literature on multi stream bins with restricted openings:

Restricted openings on public space bins may reduce the risk of contamination, but more recent research seems to suggest that people make recycling decisions (in public spaces) in split seconds. During an observational study conducted Lakhan in 2015, it was noted that the public generally does not pay attention to the labels on recycling bins. There is a propensity to group "like with like", i.e. "If I see a bin has a lot of newspaper in it, that's where I'm going to put my newspaper". In instances where there are opaque bins (where you cannot see its contents), it runs the risk of becoming a catch all for all recyclable materials and garbage. However, given that public space disposal decisions post consumption are made in fractions of a second, there is a natural inclination to put their garbage/recyclables in the spot that has the biggest opening – which happens to be the waste bin. In most instances in which bin twinning is implemented, multi stream recycling bins have designated openings with different sizes, while the waste container is normally a "wide mouth" bin, encouraging people to put both recyclables and garbage in the larger container opening. This "bad behavior" is reinforced via the cognitive compliance principle, where people will see that the garbage bin is full of recyclables. As such, they will think to themselves "If other people are doing it, it is ok if I do it as well".

5.5 Key Learnings

1) ! Density and placement of bins is the most critical factor in determining the efficacy of a public space recycling initiative. You need to be able to give people as many opportunities to recycle as possible, and ensure that those bins are placed in areas with the highest amounts of foot traffic
2) ! As a tangent to the above point, every garbage should ideally be accompanied by a recycling bin (and vice versa). Providing only one or the other either limits the opportunity to recycle, or results in significant contamination of collected recyclables (in recycling bin only scenarios)
3) ! Public space bins need to be kept clean and tidy. While any receptacle in a public area is going to be at a higher risk for illegal dumping and vermin, a failure to ensure cleanliness (either by allowing the bins to reach capacity before pick up, or other exogenous factors), will discourage the public from recycling (and may even lead to a negative attitude towards the behaviour over time)
4) ! Municipalities that have the requisite collection infrastructure in place may find automated cart collection for recyclables effective. However, these initiatives generally require a significant capital expense during initial implementation, which may restrict such investments to larger municipalities. However, the potential savings in labor/vehicle time, reduced incidences of workplace injury and other collection efficiencies may help rationalize the investment.
5) ! The type of bin you choose matters – there are benefits and drawbacks to various opening designs and multi stream recycling containers. Restricting openings to match the recycling stream can reduce cross contamination discourage illegal dumping, rain and snow egress and vermin. It does, however, result in fewer (but higher quality) tonnes collected. Multi stream bins are significantly more costly which may be an issue for smaller municipalities. They can, however, facilitate twinning of services, aid in matching public space recycling to existing municipal collection services (e.g., two stream collection) and present a neater collection point.
6) ! Contamination is always going to be an issue in public spaces – primarily food and animal waste (poop and scoop). It is difficult to address the former, as items consumed in public spaces (i.e. a pop) may have leftovers that a person cannot reasonably discard of. This further highlights that twinning of bins be a logical "first step" when implementing a public space recycling program. Providing the public the opportunity to dispose of unconsumed organic waste can potentially reduce the risk of contamination in the recycling stream. Signage (or Bin Labels) that clearly communicate what is/is not an acceptable material may also discourage contamination.
7) ! Promotion and education in public spaces needs to be clear and easy to understand. High quality pictures are more effective than text. While no reports were able to establish what type of signs

were most effective, "something is better than nothing". Recycling bins that were not accompanied by signage diverted fewer tonnes than those that did. Given the high rates of contamination in public spaces, it is the recommendation of this report that P&E materials emphasis what "does/doesn't" belong in the bin.

8) ! Monitoring and assessment is fundamental to the success of any public space program. Being able to establish baseline measures of how an area is being used, what types of waste/recyclables is being generated, can all aid municipalities in decided how to roll out their public space recycling programs. Ongoing monitoring of program performance is also necessary to ensure that adjustments can be made when needed, and to identify what specific initiatives are driving the greatest results.

Chapter 6: Improving Diversion in Toronto's IC&I Sector

While the City of Toronto should be applauded for their efforts and successes in promoting residential diversion (through the Blue Box, Green Bin and Orange Drop programs), they will be unable to meet their transform TO goals without significantly increasing diversion from the Industrial, Commercial and Institutional (IC&I). At present, Ontario diverts less than 12% of all material generated from the IC&I sector – exacerbating this problem is that the IC&I sector makes up more than 70% of all non-hazardous waste generated in the province.]. While this seemingly points to deep rooted policy, infrastructural and behavioral impediments to diversion, it also represents a significant opportunity for the city's waste management sector - even incremental improvements in overall diversion levels will have potentially significant impacts on various sustainability metrics (carbon emissions, need to procure virgin materials etc.) Increasing diversion in Ontario's IC&I sector has been highlighted as policy priority for the province, particularly in light of its poor performance relative to the residential sector. However, there remain a number of obstacles to diversion for the IC&I sector, which include:

1) Lack of legislation $
2) Lack of data $
3) Lack of enforcement $
4) Lack of resources $

This chapter briefly outlines the exact nature of these problems as they pertain to Toronto, and what potential solutions may exist to help the City overcome these obstacles. It is important to note that at present, the Province on Ontario is implementing new legislation that specifically addresses producer responsibility and some of the issues facing the IC&I sector (Blue Box Transition Plan). However, the exact nature of what these changes will entail is being contested among affected stakeholders (i.e. producers,

municipalities and the MOECP), and as a result, the potential impact to the City of Toronto remains unclear at this time.

6.1 Legislative advocacy with the province

In 1994, the Ontario Ministry of the Environment enacted the 3Rs Regulations (Regulations 101/94 to 105/94) under the Environmental Protection Act to increase diversion of residential, Industrial, Commercial and Institutional (IC&I) and construction and demolition waste from disposal in Ontario and help Ontario meet its waste diversion targets. The 3Rs Regulations that impact the IC&I sector include:

- Ontario Regulation 102/94: Waste Audits and Waste Reduction Work Plans
- Ontario Regulation 103/94: Industrial, Commercial and Institutional Source Separation Programs
- Ontario Regulation 104/94: Packaging Audits and Packaging Reduction Work Plans

The IC&I 3Rs regulation targets large establishments over a certain size or over designated revenue. These establishments are required to conduct waste audits and develop waste reduction work plans that must be made available for Ministry of the Environment (MOECP) enforcement staff to review at any time. Depending on the sector, the MOECP has designated which materials must be source separated for recycling. Sectors targeted and size of establishments required to meet the Regulations are presented in the following table:

IC&I Category	Requirements to Carry Out Source Separation and Develop Waste Reduction Plans Under Ontario 3Rs Regulations
Hospitals	Applies to any public hospital classified as group A, B or F. Does not apply to nursing homes or homes for the aged.
Hotels and motels	Applies to hotels or motels with more than 75 units and located in a local municipality that has a population of at least 5,000.
Office Buildings	Designated if it has at least 10,000 square metres of floor space for use as offices and located in a municipality that has a population of at least 5,000.
Multi-Residential Buildings	Applies to buildings with six or more units.
Restaurants	Designated if gross sales for all restaurants operated by the owner in Ontario were $3 million or more in any of the two preceding calendar years. Applies to owner's restaurants in municipalities that have a population of at least 5,000. If the restaurant is in a designated retail

IC&I Category	Requirements to Carry Out Source Separation and Develop Waste Reduction Plans Under Ontario 3Rs Regulations
	shopping establishment or complex, office building, hotel or motel, hospital or campus the owner of the designated establishment is responsible for implementing a source separation program.
Retail Shopping Establishments	Designated if it has at least 10,000 square metres of floor space and located in a municipality that has a population of at least 5,000. For example a department store in a mall can ensure compliance by participating in the program operated by the owner of the mall.
Retail Shopping Complexes	Designated if it has at least 10,000 square metres of floor space of establishments (parking not included) and located in a municipality having a population of at least 5,000. The owner may allow tenants to implement their own program but it must meet the regulations.
Educational Institutions	Applies to operator of an educational institution with more than 350 persons enrolled.
Large Manufacturing Establishments	Does not apply if the owner is able to demonstrate that during the two preceding calendar years, there was no calendar month in which the hours worked by the persons employed at the site exceeded 16,000 hours.

At present, existing provincial legislation does not require small and medium sized business establishments to develop a waste diversion plan. While the initial intent of excluding these groups from legislation was to reduce administrative burden, it did not account for the fact that the majority of establishments in the province failed to meet the thresholds outlined in the table above. As a result, how waste is being managed by these establishments is not readily known, as data pertaining to tonnes generated, tonnes diverted, composition of waste, flow of waste etc. is not reported to either the province or the municipality. The lack of centralized information on IC&I waste generation, diversion and disposal by Ontario businesses has been identified as a barrier to developing and monitoring a coordinated IC&I waste diversion strategy, but little progress has been made. Generally speaking, waste is primarily serviced through private collection, or in some instances, may receive limited municipal waste services (i.e. some schools and long term care facilities are serviced as part of a municipality's residential diversion program).

The City of Toronto faces particular challenges as it relates to the IC&I sector, as there are more than 76 thousand businesses presently operating in the city. Much of these businesses are made up of small and medium sized establishments that fall outside the purview of existing waste management legislation. It is imperative that the City work with the province in ensuring that new legislative requirements under the Blue Box Transition is large enough in scope to capture these small and medium sizes establishments.

These changes must provide clear and prescriptive guidance regarding what data is required from these establishments when submitting their waste diversion plans, and give the City sufficient authority to collect this information and enforce penalties for non-compliance. One of the foremost issues with the existing legislation is that it is has historically been seen as a “paper tiger” threat.

Even for establishments that were required to submit their diversion data and plans to the province, there has been poor compliance by the IC&I sectors affected by the regulations. Lack of awareness of the existence of and enforcement of 3Rs regulations by MOECP are believed to be the two primary factors for poor compliance. This issue was raised by the Environmental Commissioner of Ontario. Allocating sufficient resources for enforcement (at either the provincial or city level) is also going to be critical moving forward, as the sheer size of the IC&I sector in Toronto makes it prohibitively difficult to enforce, monitor and track.

However, even in the best of circumstances, it is unlikely that there are going to be sufficient resources to police all IC&I generators, all of the time. As such, it is the recommendation of this report that the City of Toronto identify IC&I sectors that present the greatest opportunity for diversion and b) generate materials that can be readily recovered given existing infrastructure and end markets. Previous studies by The City of Calgary and City of Ottawa have identified four IC&I sectors that offer the greatest opportunity in terms of waste diversion potential.

These are:

- Restaurants and fast food services
- Grocery stores
- Small/medium retail
- Offices

Based on waste audits of these sectors, it was found that that an estimated 70 to 90 per cent of the material disposed by these sectors is made up of material that can be easily diverted if source separated and kept clean. These materials include: paper, cardboard and food waste. As a result, these four sectors should be targeted as the first focus of most IC&I waste diversion strategies, as they offer good opportunities for waste diversion.

6.2 Working with businesses

Another critical component of improving Toronto's IC&I diversion rate is to work with businesses to better understand what is required when developing a waste diversion plan. As noted earlier, existing legislation did not provide any particular guidance to small and medium sized waste generations. Should these businesses become obligated under any new provincial legislation, expectations need to be clearly defined, particularly surrounding data collection, data submission and verification. In many instances, smaller establishments have very limited knowledge about waste management options, and largely leave it to the discretion of private waste haulers to determine where end of life material goes. The City must be able to work with businesses in providing them the necessary support and clarity regarding new requirements, as the learning curve for many of the smaller generators is going to be steep.

Other jurisdictions such as Calgary, Vancouver and York Region provide incentives such as free consultation and technical assistance to help educate IC&I waste generators and industry groups about waste diversion. The role of the municipality is to facilitate the sharing of best practices and help organizations navigate the logistical and legislative requirements of implementing a successful diversion program.

As an example, Green Calgary – a non-profit environmental organization, partially funded by the City of Calgary, provides technical assistance to local businesses to help them divert waste. The organization encourages waste diversion activities in the IC&I sector by offering a wide variety of services including environmental education, waste audit and reduction plans, technical assistance, and a waste exchange.

The Recycling Council of Ontario (RCO) also provides some support to businesses through its 3RCertified program. 3RCertified is a voluntary certification program for the IC&I sector, recognizing organizations taking a leadership position in waste reduction and diversion. The program's criteria covers the various ways an organization manages its solid waste – from policies and waste audits through operations, procurement of products and services, management reviews and many other categories. As part of the 3R Certified program, RCO has developed a Standard Waste Audit Methodology (SWAM) which 3Rs-certified applicants are required to use. RCO also provides Ontario Waste Auditor Training on a fee-for-service basis to train auditors on data analysis and accurate methods of measuring and reporting performance.

Some municipalities (Owen Sound, Durham) have also implemented pre-emptive measures for reducing waste from the IC&I sector, including a requirement that new establishments must have an area designated for recyclables and source separation as part of their floor plans. The City of Owen Sound has

actually taken it a step further, implementing a bylaw that requires all 600 businesses in their community submit information on current waste diversion practices.

While the initiatives outlined above help municipalities better understand the size and scope of the IC&I problem in their communities, improving diversion in Toronto's IC&I sector fundamentally requires adequate provincial support and guidance. The ability to collect, monitor and store data should be managed at the provincial level, as it is inefficient for individual municipalities to develop their own databases related to IC&I diversion. A central data repository for IC&I data (remitted by generators) is conceptually similar to the RPRA municipal data call that is used for residential diversion programs. However, this would only be possible for the IC&I sector if the province provides the legislative framework that enables to collection of this information. In many ways, the City is hamstrung by what direction the province moves in.

6.3 Moving forward

While attempting to increase diversion in the IC&I sector should continue be promoted as a policy priority in the province, the City of Toronto faces an uphill battle. Significant amendments to existing regulation (i.e., expanding the scope of obligated generators, consideration of disposal bans, landfill levies, etc.) will be required if both the province and the City hope to reach their diversion goals. Tangent to that point, the economics of diversion relative to disposal will have to be given careful consideration. For as long as cheap waste disposal options exist for the IC&I sector (sending waste to other jurisdictions for a comparatively nominal cost), increasing diversion in the absence of legislation would be all but impossible.

However, diversion comes at a cost - both with respect to directly managing material and developing/maintaining infrastructure to accommodate for increased tonnes in the system. This cost is potentially quite significant, sufficiently so that it may not even be possible to achieve without producers willing to bear the burden of some (or all) of that cost. The future of diversion in Toronto's IC&I sector remains unclear, but the unrealized value of materials presently going to landfills (as well as the associated environmental and social harms) makes it impossible to ignore much longer. Without improving diversion form the IC&I sector, Toronto will fall far short of their ambitious diversion and carbon abatement targets.

Chapter 7: Methane Mitigation Strategies

While the Transform TO goals are communicated in terms of waste reduction, diversion rates and carbon reduction, methane (CH4) mitigation is a topic that has historically been neglected (relative to carbon

abatement/reduction). While Life Cycle Analysis studies (discussed in chapter 8) are intended to capture global warming potential impacts (of which both carbon and methane are a subset of), identifying opportunities to reduce methane emissions is an important part of helping the City meet their broader sustainability goals. While carbon dioxide is typically seen as the culprit of global warming and anthropogenic climate change, methane is approximately 86 times more potent than carbon dioxide as a GHG.

According to global inventories of anthropogenic CH4 sources, the most important sectors for urban CH4 emissions are energy, waste, agriculture, and transportation. Energy and transportation primarily emit fossil CH4 derived from natural gas, whereas waste treatment and agriculture produce biogenic CH4 from the process of anaerobic decomposition. Fossil sources produce CH4 as a result of combustion or as fugitive emissions of natural gas from natural gas distribution networks or combustion units.

The focus of this section is on waste and waste water related methane mitigation.

7.1 Current Landfill Methane Mitigation Efforts Are Insufficient

The cornerstone of Toronto's methane reduction strategy is the landfill gas capture system installed at the Green Lane Landfill. Since 2004, landfill gas capture at the Green Lane landfill has abated the equivalent of more than 450,000 metric tonnes CO2e, and is part of Toronto's broader strategy that has seen the city successfully reduce greenhouse gas emissions by 24% since 2007.

Engineered systems to physically remove CH4 produced in landfills are currently thought to be the most effective landfill methane mitigation technique. Landfill gas collection systems use extensive networks of wells and pipes to extract gases produced inside the landfill. Captured landfill gas is vented to the atmosphere, flared, or used as a renewable fuel for electricity generation (as is the case in Toronto). However, landfill gas collection systems alone are insufficient. While this is certainly a critical step in managing methane emissions from landfill, another strategy is to use microbial oxidation of CH4 in landfill cover materials to destroy CH4 before it reaches the atmosphere. Biological CH4 oxidation can be promoted by additions of soil, compost, and sludge over landfills.

Landfill gas recovery systems may also may also paradoxically increase emissions by venting recovered CH4 (that isn't converted into energy) directly to the atmosphere, thereby preventing any oxidization by methanotrophic soil microorganisms that would otherwise occur. The extensive plumbing systems used for landfill gas recovery like the one used at the Green Lane landfill create ample opportunities for fugitive

emissions. At sites where landfill gas is recovered for use as biogas (such as Green Lane), landfills may be managed to optimize CH4 collection rather than to reduce CH4 emissions. This suggests that biogas production may undermine greenhouse gas reduction goals of a landfill gas recovery project, if there are significant fugitive emissions in the biogas lifecycle.

To maximize the potential of CH4 mitigation, CH4 emissions reduction should become an explicit goal of landfill management for Toronto. More research is needed to understand the effectiveness of currently practiced and proposed landfill mitigation activities. In particular, a better understanding of fugitive emissions from landfill gas capture systems, e.g., from leaks in gas collection pipes or gaps between liners could be useful to both mitigation efforts and improved quantification of landfill emissions in inventories.

Use of CH4 imaging technology could enable better surveys of landfill areas and rapid determination of the location of leaks. Improving landfill cover technology that enhances biological CH4 oxidation is a promising route for reducing CH4 emissions from landfills and other waste systems. This strategy has been demonstrated in combination with existing landfill gas recovery systems, can be used for former landfills that continue to emit CH4 decades after closure, and is likely the most cost-effective mitigation solution. Moving forward, the City needs to develop and implement alternatives to landfilling organic waste to prevent the production of waste CH4, such as with composting programs and mechanical biological treatment.

7.2 Solving the problem at the source

While landfill gas recovery is a method to deal with the organic materials already in landfills, diverting organic materials such as food and yard waste from landfills (using composting or anaerobic digestion) will reduce the production of methane in the first place. As noted in Chapter 2 with respect to organics diversion, one of the foremost challenges facing the city is minimizing the amount of organic waste that is going to the landfill.

A significant percentage of organics generation (both household and IC&I) is ending up in the waste stream, and subsequently Toronto's landfills. As much as 40% of all organic waste is comprised of avoidable food waste, which can be readily diverted through the cities Green Bin program. However, attempting to achieve a reduction in organic waste is one part behavioral, and one part infrastructural.

7.3 Infrastructural Change

From an infrastructural perspective, many multi-residential households do not have readily available access to the City's Green Bin program. The foremost challenge is one of storage – unlike single family

households which are provided with either a 46.5L or 97L organic waste cart by the city, multi-residential households often do not have space for indoor storage of an organics cart, and as such, are forced to bring organics waste to a designated collection point in the building (waste room). A significant percentage of privately operated multi-residential buildings also do not offer organics collection, and are not serviced by the City's Green/Blue Bin program. It is also worth noting that multi-residential households make up slightly less than 50% of all households in the City. Toronto is fairly unique when compared to neighboring Peel and York Region, in that the proportion of multi-family homes relative to single family dwellings are significantly higher. As a result, it is prohibitively difficult for the City to provide uniform levels of service for all households in the city.

Encouraging multi-residential household participation in an organics programs will require significant investments in building infrastructure, mandating the installation of tri-sort garbage chutes (recycling, organics, waste). The City should also work closely with building managers to ensure that waste rooms/facilities are clean, accessible and regularly serviced, and help in communicating how households can participate in diversion activities (what goes in the bin, promotion and education etc.).

7.4 Behavioral Change

Behavioral change requires targeted messaging that clearly communicates the "What, Why and Where" of organics diversion to both households and local businesses.

While the City already engages in a number of initiatives designed to educate Torontonians about food waste and strategies to avoid it, other jurisdictions across the world have found success using targeted penalties and supporting legislation to discourage food waste.

Seoul, South Korea and Seattle, Washington, U.S.A. are two examples of major urban cities attempting to address food waste through legislative intervention. For example, in Seoul, the city charges a fee for food waste, and it currently diverts 95 percent of its food waste from homes and businesses, compared to less than 2 percent in 1995. A form of "Pay as you throw" is implemented, where residents and businesses pay a weight based fee for food disposal (where discarded waste is then subsequently processed into bio-fuel and fertilizer). The city also provides more than 6,000 automated bins where residents can weigh their food waste and pay fees related to food waste disposal.

Seattle, Washington has taken a more punitive approach, (although it is being challenged in court) by making it illegal to discard of food waste all together. This accompanies other strategies for reducing food

waste such as education campaigns focused on waste reduction, smarter shopping ideas, and smarter composting strategies.

Behavioral intervention is not limited to households, as businesses play an even bigger role in terms of the potential to avoid significant quantities of organics ending up in landfills. The City has a diverse range of IC&I sectors that all generate organic waste (restaurants, coffee shops, grocery stores, and malls), which is both a main source of food waste, and an opportunity to reduce food waste.

As an example, New York City has championed food waste reduction and is a worldwide leader in turning food waste into compost. The city works collaboratively with supermarkets, restaurants and commercial composters, taking food scraps from waste generators to turn into biogas energy and compost. This is part of a multimillion-dollar program to cut down on greenhouse gas emissions and reduce more than 500,000 short tons of food waste going to landfill every year.

Food rescue programs also provide an opportunity to re-purpose and redistribute surplus food before it gets a chance to become food waste. The City of Toronto already works with organizations such as Second Harvest to use surplus food as a means to support economically marginalized Torontonians. While food rescue programs are not necessarily seen as a waste reduction initiative, the ultimate outcome of these types of programs is a reduction in GHG emissions and the amount of material going to landfill. This actually highlights the need to "Think outside the Blue/Green Box" for the City, and not view waste management as being discrete from other initiatives and programs. Ultimately, any strategy that can help ameliorate the quantities of waste being generated by the City should be explored.

7.5: Waste Water Methane Mitigation

Municipal wastewater treatment plants are one of the major contributors to the increase in the global greenhouse gas (GHG) emissions, as methane is emitted during the handling and treatment of municipal wastewater through the anaerobic decomposition of organic material. Most developed countries rely on centralized aerobic wastewater treatment systems to collect and treat municipal wastewater. While these systems produce relatively small amounts of direct methane emissions, they also generate large quantities of biosolids, which can result in high rates of methane being released into the atmosphere. This necessitates that emission mitigation strategies be developed that can leverage methane capture at wastewater treatment facilities.

There are several approaches to wastewater methane mitigation and recovery and also several options for the use of recovered methane, some of which include:

1) $Installing anaerobic sludge digestion
2) Installing biogas capture systems at existing open air anaerobic facilities

By using anaerobic digestion, where microbes decompose without oxygen, a methane-rich biogas byproduct is produced, with an energy content that is approximately 75 per cent that of natural gas. This gas can be used for on-site energy needs, or processed further and used in lieu of natural gas. In addition, the solid remnants of the waste create a nutrient-rich "digestate" that can be added to soil to boost plant growth.

Research by the University of Toronto have found that methane capture at four of Toronto's waste water treatment facilities could generate as much as 113 megawatts of electricity per year - enough to make the plants self-sustaining from an energy point of view.

The ability to generate electricity using biogas in lieu of fossil fuels, while simultaneously preventing methane from escaping into the atmosphere, is a model that is being embraced around the world, including in the United States, Brazil, Argentina, Norway and others. Finding ways to harness energy from waste water methane can play an important role in helping the City meet its long term carbon abatement and climate goals.

7.5 Key Recommendations:

- While landfill gas capture can play a critical role in helping reduce CH4 emissions, it is not sufficient as a stand-alone strategy
- It is more effective to keep organic waste out of the landfill, than trying to capture methane through landfill gas capture.
- The City should prioritize increasing diversion of organics, particularly in multi-residential buildings which may face certain infrastructural challenges.
- Improve access and convenience to encourage participation in the Green Bin program
- Educate both households and businesses regarding ways to minimize avoidable food waste. This includes campaigns designed to increase awareness regarding waste reduction, smarter shopping ideas and smarter composting strategies.

- Other jurisdictions across the world have found success in incentivizing organics waste diversion (by charging a fee for food waste disposal). Some cities such as Seattle have even made food waste illegal (although ability to enforce that may be difficult)
- Food rescue programs are an opportunity to redistribute food surplus to groups in need, and avoiding the need to landfill
- Harnessing methane from waste water treatment facilities is an opportunity to generate energy and reduce GHG emissions.

8.0 Approaches to LCA modeling

A critical component of achieving the city's carbon and waste diversion goals is how do we actually quantify and measure progress?

Life cycle assessment (LCA) has been extensively applied to evaluate environmental burdens associated with Municipal Solid Waste (MSW) management). But in addition to quantifying the environmental impacts and burdens associated with waste management options, LCAs can also be used to explore opportunities for improvements. It also helps to expand the perspective beyond the waste management system. This makes it possible to take the significant environmental benefits that can be obtained through alternative waste management options into account; for example, energy-from-waste (EfW) reduces the consumption of energy from fossil fuels; recycled materials replace part of virgin materials; and the compost from biological treatment substitutes the production of chemical fertilizers.

The City of Toronto has long used life cycle analysis as a tool to help inform policy development and communicate the impacts of their waste management program. However, at present, there is no prescribed methodology for how to actually conduct an LCA, and there have been past instances in which the City have used different approaches to modeling the same issue (yielding inconsistent results). This section outlines what key factors need to be considered by the City when conducting an LCA, including providing guidance on system boundaries and data used.

A common basis for the analysis of LCA studies should include an understanding of: (1) study area and scale (2) goals of the reviewed LCAs (3) functional units (4) system boundaries (5) types of data sources (6) environmental impacts; (7) sensitivity analysis (8) economic costs of MSW treatment and (9) the quantitative results for net energy use (NEU), global warming potential (GWP) and acidification potential (AP).

8.1 Different types of LCAs

A traditional LCA of municipal solid waste, encompassing waste collection, transportation, sorting and treatment until inert or recycled, can be used to evaluate the life cycle impacts of a waste management system, particularly in instances in which a waste prevention activity (WPA) has been implemented. A conventional LCA is designed to capture the impacts of programmatic, infrastructural or systemic change to the system, compared to a "status quo" baseline. However, this approach omits the net upstream impacts from implementing the WPA

Table 1 below (Cleary, 2009), summarizes types of waste prevention activity, including the effect of WPAs on product services.

Type of waste prevention activity (WPA)	**Effect of WPA type on product service(s)**	**Presence of alternate product system(s) that contribute additional MSW for treatment**	**Example(s)**
WPA-1 Reduction in material consumption without product service substitution	Reduction in quantity of product services (no substitute product services provided)	No	-reduced generation of "junk mail"
Dematerialization			
WPA-2 Reuse of a disposable good	Substitution of functionally equivalent product services	No	-reuse of a disposable shopping bag
WPA-3 Substitution of a service, provided by a capital good, for a disposable good	Substitution of functionally equivalent product services	Yes (capital good)	-drying of hands by means of hand dryers instead of hand towels -drinking water supplied from water faucets instead of bottles -newspaper articles available online instead of printed on newsprint
WPA-4 Substitution of a reusable good for a disposable one	Substitution of functionally equivalent product services	Yes (substitute reusable good)	-substitution of refillable glass wine bottles for disposable ones -substitution of reusable shopping bags for disposable ones
WPA-5 Lightweighting of a good	Substitution of functionally equivalent product services	Yes (substitute disposable good)	-substitution of lightweight plastic containers for glass ones (both containers are single use)
WPA-6 Lengthening the useful lifespan of a durable good	Substitution of functionally equivalent product services	Yes (substitute durable good)	-increasing the useful lifespan of a refrigerator through improved design
Waste prevention at collection			
WPA-7 On-property residential waste treatment	No effect	No	-backyard composting -grasscycling
WPA-8 Storage of waste products and materials	No effect	No	-storage of obsolete appliances

Ideally, all investigated product systems for an LCA should begin at the same point – raw material extraction. However, the majority of LCA studies tend to define the system boundary at the point of disposal. This curtailment of the LCA system boundary, also known as the zero burden approach, simplifies the assessment and allows the LCA to focus on waste treatment.

The results of a LCA are critically dependent on the system boundaries, notably the choice of attributional or consequential modelling. Published LCA studies rarely specify and justify their modelling choices. For life cycle inventory analysis (LCI) it is common to distinguish between consequential and attributional modelling.

8.11 Attributional LCAs

An attributional approach is a modeling system in which inputs and outputs are attributed to the functional unit of a product system by linking and/or partitioning the unit processes of the system according to a normative rule. An attributional product system can be used to answer the question: "Under the specified normative allocation rule, what are (the environmental impacts related to) the allocated shares of the activities that have contributed to the production, consumption, and disposal of the product?" Thus, the purpose of attributional modelling is to trace a specific aspect of the product (as determined by the allocation rule) back to its contributing unit processes.

8.12 Consequential LCAs

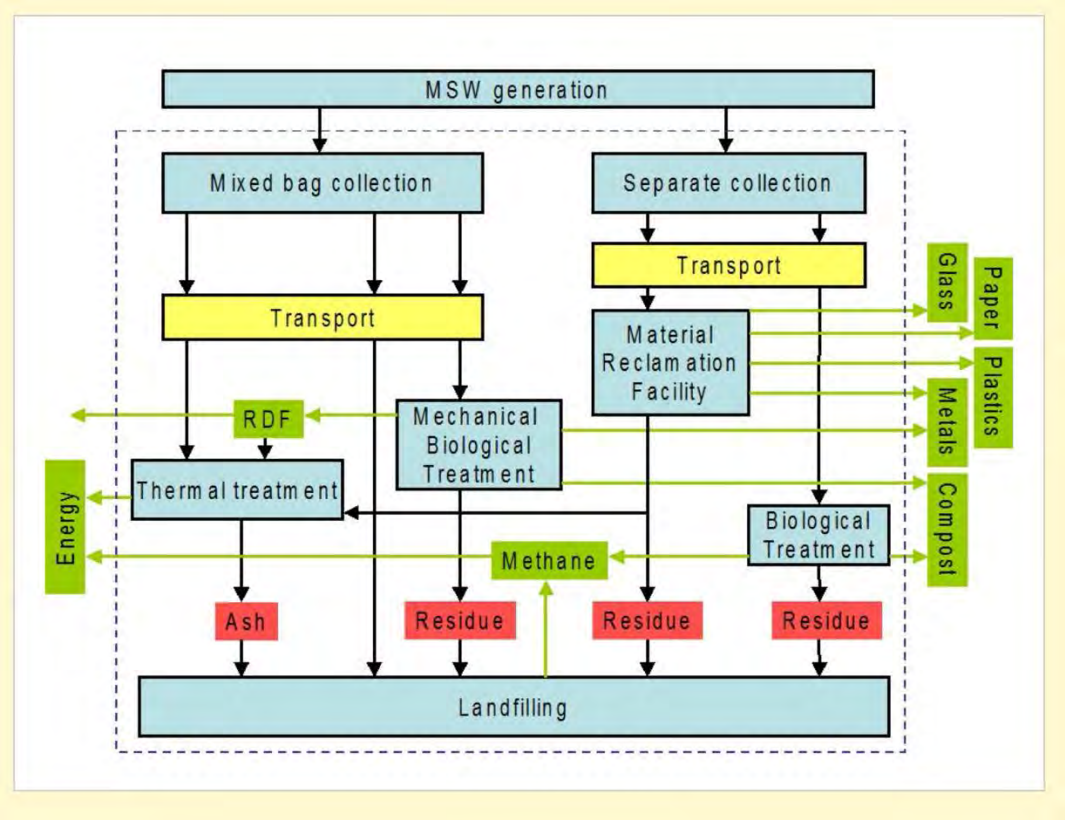
Should the objective of the LCA be the accounting of the system-wide effects of implementing a WPA, a consequential LCA is the most appropriate method of analysis. Although the 2006 International Organization for Standardization (ISO) requirements and guidelines for LCA do not recognize the methodology associated with consequential LCA, this LCA type has been described in numerous publications. A consequential LCA is "a model of causal relationships originating at the decision at hand" addressing the system-wide effects of a change in the functional outputs and inputs on material and energy flows to and from the environment. Thus, it has a much larger system boundary than an attributional LCA because it also addresses significant flows outside of the MSW management life cycle. Unlike the attributional LCA, this method addresses the marginal effect of a change. There is no need to include within the system boundary those unit processes that would not be affected by the WPA. The functional unit of a consequential LCA would be the amount of waste prevention one intends to undertake.

8.2 Defining System Boundaries

The LCA system boundary is the interface between the product or waste management system and the environment or other product systems, determining which unit processes are included within the LCA. The system boundaries must account for time, space and functional unit. The ISO 14044 standard, when addressing the goal and scope definition component of LCA, states that "any decisions to omit life cycle stages, processes, inputs or outputs shall be clearly stated and the reasons and implications for their

omission shall be explained" (ISO 2006). The life cycle stages of MSW management commonly include: (1) collection; (2) transportation to a sorting facility; (3) sorting; (4) transportation to a treatment facility, and (5) treatment - potentially including recycling, biological treatment, thermal treatment and landfilling.

Figure 4 below depicts "conventional" system boundaries of a waste management LCA:



It is important to note that a third LCA waste management model (Waste Management and Prevention LCA) exists, that includes up stream impacts as a means to capture waste reduction and waste prevention.

While there are comparatively few studies that adopt this methodological approach, it is considered a more comprehensive method for calculating life cycle impacts of various products, as it includes up stream environmental impacts as well. As an example, due to the proliferation of light weight packaging, there is a need to better understand how package light weighting affects transportation emissions and source reduction.

Under a conventional LCA approach, the potential benefits of package light weighting would not be reflected in the results, as the system boundaries would only capture impacts from the point of disposal.

Moving forward, this more holistic approach to life cycle analysis will be of greater importance to the City, particularly when attempting to model waste management impacts of printed paper and packaging.

8.3 Functional Units

The functional unit is fundamental to the understanding of the results of an LCA, and provides a common basis for the comparison of results across studies. It exists as a reference unit to which the input and output data are normalized. For LCAs of MSW, it ensures that all of the environmental emissions are based on identical inputs to each waste management system. Functional units are also associated with the usable products generated during MSW management, including electricity, heat and compost.

The functional unit helps you compare the overall environmental performance of different systems in terms of impacts per unit of delivered service.

An appropriately defined functional unit should:

1. Be a quantity of service that is being managed

2. Include a numeric value with a physically measurable unit

8.4 Energy Grid Mix

MSW management systems consume both electricity and fossil fuels, and may generate usable heat and electricity from thermal treatment systems, as well as from the combustion of biogas collected from landfills and anaerobic digestion facilities. The assumptions relating to the method of generating the energy both consumed and displaced by MSW management systems may have a substantial effect on the results of the LCA.

8.5 Treatment of transport distances

Of note, a significant percentage of LCA studies pertaining to waste management omit the environmental emissions attributable to transportation (both collection of waste, transport to MRF and transport to end market). As an example, the adapted USEPA Warm model used by Environmental Canada assumes default transportation distances that specifies all material is processed, recycled/disposed of domestically.

The rationalization made by some of these previous studies is that environmental emissions from transportation would be negligible relative to those from other waste management components. In particular, some studies have claimed that the environmental emissions from the transportation

component of LCAs do not affect the overall results so long as the transportation system is reasonably efficient.

This approach contravenes the findings of other LCA studies (which do attempt to capture transport distances) – depending on where end markets are located (and whether end market reprocessing is included within system boundaries), the energy emissions associated with transportation can be quite significant. As an example, end markets for Ontario polycoat tend to be primarily in South Korea. As a result, municipalities who market polycoat may have to ship their materials in excess of 5000km (a combination of truck and ship freight) in order to reach their end market destination. The emissions associated with transport are actually significant enough to offset a substantial portion of the emissions savings attributable to recycling.

While it is accurate to say that transport has significantly less influence on overall life cycle impacts relative to a process such as paper pulping, it's exclusion from an LCA model cannot be readily rationalized. The environmental impacts attributable to transportation are material, particularly in instances where end markets are located in other jurisdictions.

8.6 Impact categories

In an LCA, at least 16 different impact categories are taken into account, including: climate change; acidification; eutrophication, terrestrial; eutrophication, marine; eutrophication, freshwater; particulate matter; photochemical ozone formation; human toxicity, cancer; human toxicity, non-cancer; ecotoxicity, freshwater; land use; water use; resource use, minerals and metals; and resource use, fossils, ionizing radiation, ozone depletion (EC, 2017).

However, some limitations still exist in the models used for assessing the impacts and some impacts are still not completely captured. The choice of impact category results to display is subjective, although the most common found in the broader literature include global warming potential, acidification potential, eutrophication of surface water and resource consumption. Measures of toxicity are less common impact categories. While the ISO 14042 standard specifies that a life cycle analysis should reflect a comprehensive set of environmental issues, a lack of data for certain impact categories can sometimes limit what impacts a user is able to show. The goal of the life cycle analysis should also help inform what impact categories to measure. In the case of Toronto, it is recommended that the LCA impact categories reflect the TransformTO goal, specifically focusing on global warming potential criteria.

8.7 Types and sources of data:

At present, there are more than 20 life cycle inventory databases that are available either commercially, or as an open access platform. The primary LCA databases include:

- EcoInvent
- UVEK LCI Data
- The Evah Pigments Database
- LCA Commons
- Environmental Footprints
- Idea
- Gabi
- Agri-footprint
- ARVI
- Soca
- NEEDS
- ESU World Food
- ELCD
- ProBas
- WARM

Overwhelmingly, the majority of LCA studies utilize either EcoInvent, Gabi or WARM (with the decision to use a particular database very much a function of locality – North American studies tend to utilize the WARM model, while international studies primarily utilize EcoInvent and Gabi).

What database to use when conducting an LCA is also a function of resource availability – some databases required paid licenses to access, while others are free. With respect to modeling LCA impacts of waste management activity in Canada, an adapted variation of the USEPA WARM calculator tends to be the most popular tool, as it is open access database with a long and well documented history that explains model components and assumptions in great detail. However, WARM has specific limitations with respect to specifying material allocations, designating transport distances and customizing energy grid mixes.

It is worth noting that the results from an LCA can differ significantly depending on which database is being used. Engaging in a comparative analysis wherein two studies are using different databases is extremely difficult – there are sufficient differences between data sources, that even when referring to the same material (i.e. newsprint) and process (recycling), that the results will not match.

It is important to remember that irrespective of the database use, quantifying LCA impacts of waste management activity is an inexact science.

While results may be fairly specific (i.e. recycling one tonne of aluminum ingot reduces carbon by 10.01 metric tonnes), that is a function of how the models report results, and can create an illusory sense of precision that simply is not possible. When comparing LCA studies from various sources, it is perhaps more important to ensure that results are directionally accurate (consistent in overall findings) as opposed to comparing exact values.

8.8 LCA Checklist

It should be noted that there is no "one size fits all" approach to LCA modeling, particularly with respect to waste management. What approach the City of Toronto should take is a function of several factors, including what the goal of the LCA is, and what the City is trying to measure. As a general best practice, the City should address these criteria when undertaking an LCA:

1. $ Goal definition and scoping
    - Define functional unit.
    - Define system boundaries.
2. $ Inventory
    - Define all life cycle steps.
    - Draw all input and output streams (air, water, and soil).
    - Determine key components in each stream.
    - Quantify key components of streams.
3. $ Impact Assessment
    - Determine types of pollution.
    - Determine sizes of pollution.
4. $ Valuation
    - Normative criterion for valuation: The new design should be better in some emission and input types and not worse on any of the other emission and input types.
5. $ Improvement
    - Identify major contributions to pollutions.
    - Reduce pollution by re-design relevant step.

Chapter 9: Obstacles and Barriers to meeting Toronto's diversion targets – not all diversion activities are made equal

While the purpose of this report is to assist the City in developing programs and policies to promote waste diversion, it is prudent to situate Toronto's goals within the larger lens of what Ontario and Canada are trying to achieve with respect to waste and identify the obstacles and barriers to meeting these goals.

The following is a list of both Toronto specific, provincial and national goals with respect to waste management

1) Canada will move to divert at least 75% of plastic waste from federal operations by 2030
2) Canada will move to ban single use plastics by the year 2021
3) Toronto will divert 95% of all waste by the year 2050
4) The Province of Ontario will divert 30% of all wastes by 2020, 50% by 2030 and 80% by 2050
5) The Ellen Macarthur Foundation's goal is to ensure that 100% of all plastic packaging is designed to be fully reusable, recyclable and compostable (waste to energy DOES NOT count)

All of the above goals represent a tremendous amount of work and highlight a commitment at all levels of government to addressing Canada's waste problems. For the first time in recent memory, there is a coordinated and concerted effort to reduce the amount of waste going to landfill, and these efforts are being driven by a groundswell of consumer awareness and activism.

With that in mind, are these goals aspirational or realistic? Given both the ambitious nature of the targets and corresponding timelines, is this something that can be readily achieved? The answer to that is: Nobody knows.

9.1 Where is the Data?

The biggest challenge facing our waste management sector is a complete lack of data, most of which is necessary information before we can even begin designing policies and systems that are more sustainable in the long term.

As an example, if Toronto would like to divert 95% of all waste by the year 2050, it would seem prudent that we know just how much waste we are talking about. What is often lost on policy planners and decision makers is that the figures we see reported regarding waste generation, waste recovery, percentage of material recycled/diverted etc. are largely based on best guess estimates. A lack of credible data remains the foremost challenge to achieving our diversion targets, as there is significant confusion and uncertainty regarding just how much waste exists and how much is being diverted.

In Winter of 2019, Deloitte Canada published a report on behalf of the Canadian Council Ministers of the Environment that "Canada is only recycling 9% of its plastics". This headline captured the attention of people across the world, as it was difficult to imagine how a country that prides itself on being environmentally progressive could be doing so abysmally when it came to plastic waste. However, a closer inspection of what actually went into that estimate reveals that projections surrounding plastic generation, recovery etc. were all modeled, using a set of heavily caveated assumptions. Data for the

Industrial, Commercial and Institutional sector in particular remains poorly understood, as there is no legislative mandate (provincially or nationally) that IC&I generators track and maintain that information. In short, we don't know whether we are recycling 9% or 90% of plastics – nobody does.

Why this matters for the City of Toronto is that it is critical that decision makers understand what information is available and what can be done with it. Often times there is a disconnect between what people think is possible/feasible relative to the information and resources that the City has access to.

As a thought exercise, which of the following information does the city have access to?

1) Total quantities of plastics (or any material) generated and sold into Toronto in the last calendar year (both residential and IC&I)?
2) How many tonnes of potentially recoverable materials is ending up in landfills?
3) The costs of attempting to recycle material at end life? (if recyclable)
4) What quantities of waste are being self-managed on site for commercial generators
5) Estimates to determine long term landfilling capacity for both residential and IC&I sources
6) Detailed and methodologically defensible waste auditing strategies to approximate for the waste generation profiles of individual wards and housing types (single vs. multi-family)
7) A detailed overview of waste management infrastructure currently available. This includes the number of material recycling/AD facilities, transfer stations, depots, as well as information regarding the operational capabilities of each of these sties (capacity, throughput etc.)
8) A mass balance of where materials recycled ultimately end up (what end market? In what application? Etc.)
10) A common data repository that is responsible for collecting, maintaining and analyzing data pertinent to the waste management sector that can be used to assist in policy formulation and decision making.

While developing and working towards ambitious goals should ultimately be applauded, it is of equal importance that our goals reflect the reality of the situation, and identify means and methods to help overcome issues surrounding data access and collection. The lack of "good data" poses numerous challenges, namely, evaluating progress is ultimately contingent on being able to track, measure and monitor data related to waste diversion. What is of critical importance is that any discussions surrounding waste management policy and programming that Toronto undertakes *must* be rooted in sound data. This is particularly true of any potential legislation or policies that involves the IC&I sector – we cannot develop a potential solution for encouraging diversion in these sectors, without having a sense of the size and scale of the problem.

Vowing to keep waste out of landfills is a commendable objective, but only if we could tell you ! how much there is to actually keep out.

9.2 The importance of goal setting

The discussion surrounding data's role in helping develop goals is a useful segue into the second part of this paper – the importance of goal setting.

As noted above, goal setting is critical for the success of a waste management program, however, goal setting should ideally address the following characteristics:

1) What is the goal, and what am I measuring?
2) Is my goal realistic given access to existing information, resources and infrastructure?
3) Is there consensus about what the goal should be among stakeholders?
4) If different stakeholders have competing goals/objectives, how do we encourage collaborative dialogue to avoid antagonism?
5) Is there quantifiable metrics to track and measure progress towards my goal?
6) Am I able to change my goal in response in new situations or information?
7) How will I know if I have achieved my goal?
8) How can I monitor the results of my goal over time to ensure continued success?
9) How do set new goals once our initial goal has been reached?

What makes goal setting in waste management particularly problematic (beyond the lack of data), is the lack of consensus regarding what it is we are trying to achieve.

As noted earlier, there was a significant amount of momentum across the sector to work towards a circular economy and achieve zero waste – however, despite this seeming consensus, there are multiple paths to achieving a particular outcome, with very different sets of winners and losers depending on what we choose to prioritize.

To use a practical example, let's revisit the City 's 95% diversion target by the year 2050. In this case, our goal is diversion, and we are measuring % of total waste diverted relative to overall quantities of waste generated. As noted prior, we have acknowledged that there are data concerns regarding credibly quantifying total generation, but let's set that aside for a moment.

While the 95% diversion target is certainly an ambitious and aspirational goal that the city should strive for, it is not something that is readily achievable, for two reasons: 1) Weight based key performance indicators, and 2) The definition of diversion.

1) The foremost issue is that diversion is a weight based KPI, in a world where our packaging and products are becoming increasingly lighter and lighter. This phenomenon, which has been characterized as "the evolving tonne" shows that the proliferation of light weight, composite materials results in materials that are volumous, but not heavy. Compared to the average mix of materials found in the Blue Box a decade ago, current materials are anywhere from 15-25% lighter.

Why this matters is that a diversion target (measured against total waste generation), is inherently going to be handicapped by the fact that the total tonnes being managed in our system is decreasing over time (for printed paper and packaging). It is also worth noting that the types of materials that will need to be collected to achieve incremental diversion will be difficult to recycle material. These materials are often incompatible with existing collection and processing infrastructure, with limited end market applications. In short, there is very little economic incentive to recover these materials – the economics of diversion, and more specifically, recycling, is often untenable.

2) While other jurisdictions (i.e. Belgium) have significantly higher diversion rates for their residential recycling programs, the way we choose to define diversion in Toronto (and Ontario as a whole) differs. In certain jurisdictions, waste to energy (the 4th R), is considered a viable method of keeping materials out of landfills. However, in Ontario, waste to energy is not considered a viable form of diversion. While this report is not intended to debate the merits or viability of waste to energy, it is worth noting that the goals that we set should be consistent with the infrastructure and rules we have in place.

In short, it is highly unlikely that Toronto will be able to reach their goal of 95% diversion without considering some form of energy to waste facility. Even if we assume an idealized scenario where all households put their waste in the appropriate Blue and Green bins, residue losses at sortation facilities often range from 8 – 12% (both as a result of contamination, and yield losses from sorting equipment). Note: Yield loss refers to recyclables that are damaged or contaminated as a result of the sortation process.

9.3 Prioritizing Recovery: Balancing goals with our budgets

Returning to the topic of economics, it is impossible to develop sustainable waste management goals without carefully considering the economic impacts of attempting to realize those goals. As noted in an earlier section of this paper, some of the goals we have defined for the waste management sector include the recyclability of products/packaging. The Ellen MacArthur foundation has even gone so far as to say that ALL products must be made up of materials that can either be recycled, reused or composted.

While this goal is certainly commendable and something that should be worked towards, an emphasis on recycling is not practical or efficient giving the configuration of existing waste management

systems. When developing, operating and maintaining a waste management system, it is critical that we do not lose sight of the guiding principles of the waste management hierarchy. Reduce, Re-use, Recycle isn't just a catchy phrase, it's the order in which we are supposed to do things. Even prior to the COVID pandemic, the recycling industry for printed paper and packaging was already severely depressed as a result of China and South East Asia barring the import of recyclables. These effects were only exacerbated by the impact of COVID, which has adversely affected commodity pricing for recycled materials and radically altered the flow of markets. In some instances, virgin resin is now cheaper to source and use than recycled resin, and is threatening to undo years of progress with respect to increasing recycled content in consumer goods.

What industry will do in response to this crisis remains uncertain – there is no guarantee that recycled markets will recover in the immediate future. Policy planners are now facing the very real choice of continuing to pursue a goal of recyclability/compostability/reusability, despite a rapidly changing landscape that is extraordinarily difficult to predict and plan for. In turn, manufacturers must make design decisions today that will have an impact on their operations for months, if not years to come.

As the city of Toronto works towards its diversion targets, it's important to remember that not all diversion activity is equal – there are going to be instances in which recycling/diverting certain materials cannot be rationalized either economically or environmentally (i.e. recycling plastic film), which begs the question as to whether it is feasible to recycle everything, everywhere. This is point that deserves particular emphasis, as historically, Toronto's policy objectives suggest that "more is better" with respect to waste diversion. While much of the current dialog surrounding waste management revolves around increasing recycling rates and diversion levels, the City must take a step back and ask whether this should continue to be the focal point of waste management policy. Are there metrics beyond recycling and diversion rates that need to be considered when evaluating the long term sustainability and climate benefits of Toronto's waste management systems?

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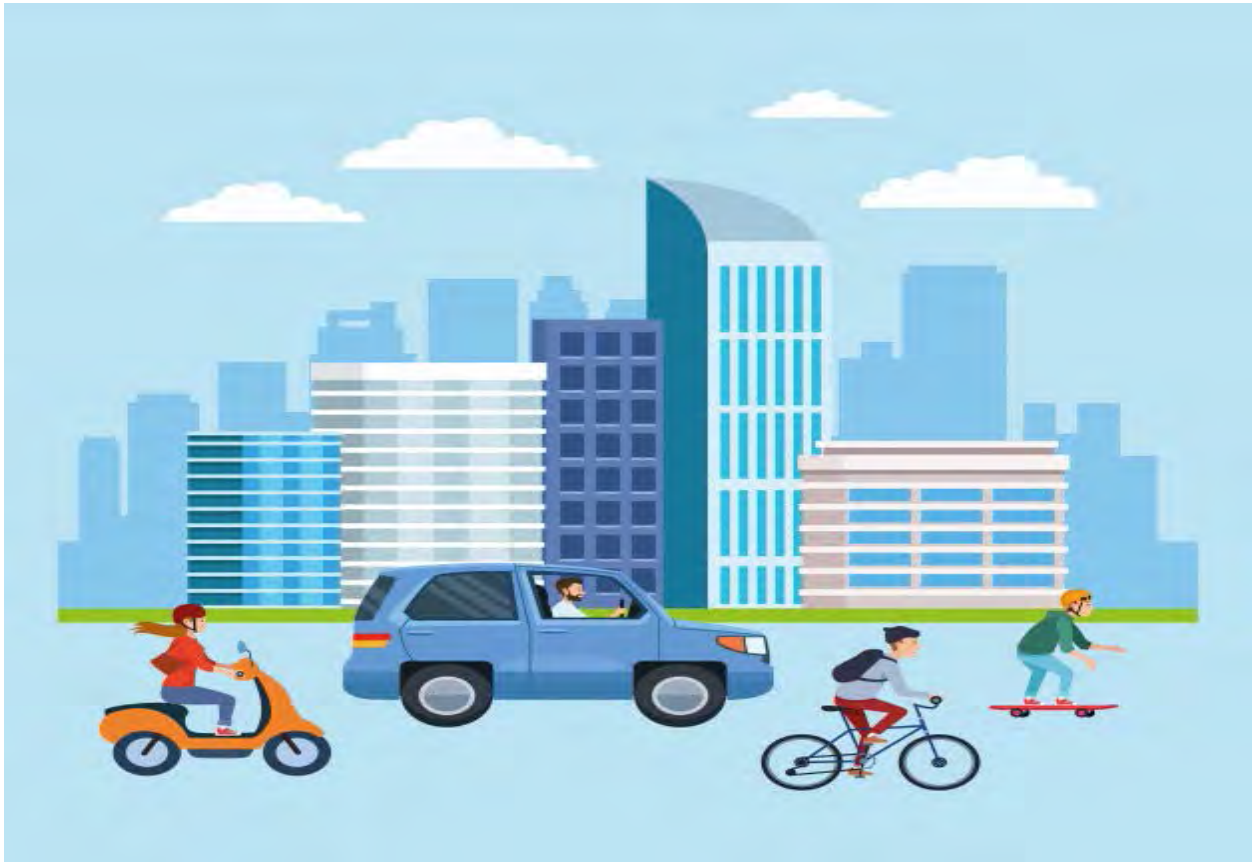

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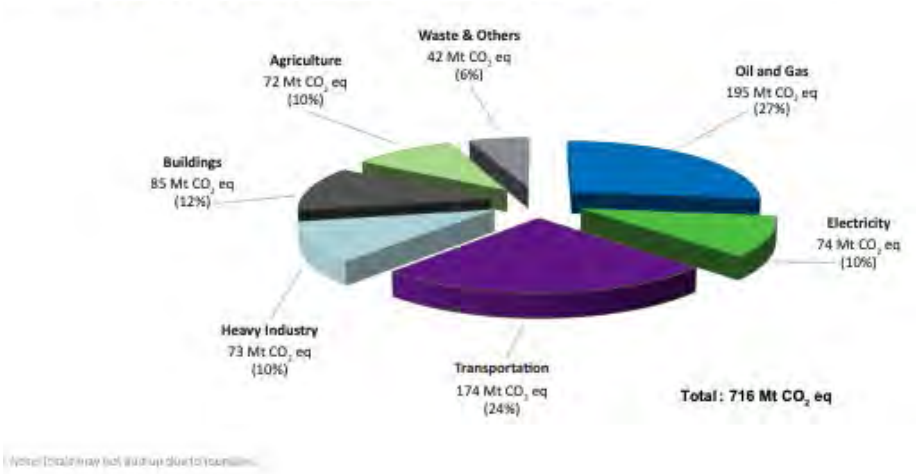
1. Introduction

1.1. Current Emission Landscape

In 2019, Environment and Climate Change Canada reported that Canada's GHG emissions are equivalent to 716 MT CO2 eq. This number is 2 percent lower than 2005 emission rates and e greenhouse gas emissions are more than 40 percent below 1990 levels.[1] The Canadian economy has grown faster than its emission levels due to continuous offsets of emission increases in the Transportation, Oil and Gas sectors by decreases in Electricity Heavy industries.[2] Transportation emissions account for 24.3% of total emissions, and includes personal vehicles - light duty vehicles and trucks, in addition to commercial heavy-duty vehicles.

Figure 1: Breakdown of Canada's Emissions by Economic Sector, 2017/ Source: Environment and Climate Change Canada



"2019 National Inventory Report 1990-2017: Greenhouse Gas Sources and Sinks in Canada"

In Toronto, greenhouse gas emissions by sector are broken down by transportation, building and waste. In 2017, GHG emissions from Toronto's Transportation sector were 5.7 MT (metric tonnes), and accounted for 38 percent of community-wide emissions. As Figure 2 shows, the major contributor to the emissions is Passenger Vehicles accounting for 79% of total emissions from the transportation sector.[3]

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[1] City of Toronto. "TransformTO: Climate Action for a Healthy, Equitable & Prosperous Toronto." City of Toronto, 2018. https://www.toronto.ca/wp-content/uploads/2020/02/92f8-TransformTO-Climate-Action-for-a-Healthy-Equitable-Prosperous-Toronto-Implementation-Update-2017-and-2018.pdf

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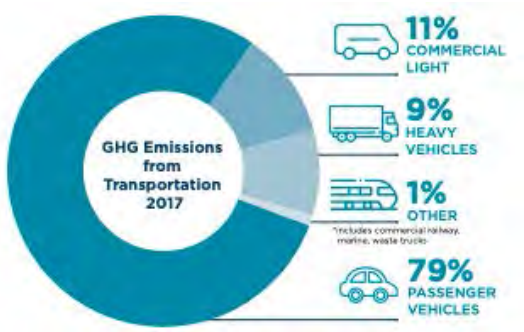
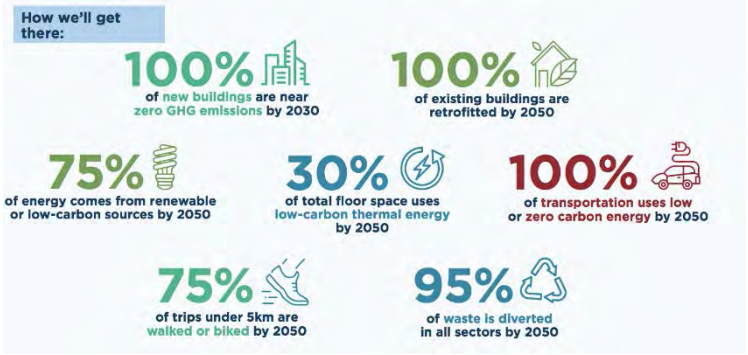


Figure 2: GHG Emissions from Transportation in Toronto, 2017/ Source: City of Toronto, "TransformTO: Climate Action for a Healthy, Equitable & Prosperous Toronto, Implementation Update 2017 and 2018"

1.2. TransformTO

TransformTO is Toronto's climate action strategy that outlines long-term goals to switch to a low-carbon economy. The goal is to achieve an 80 percent emission reduction by 2050 to achieve and encourage prosperous, equitable and healthy communities. In 2017, the committee set emission reduction targets of 30 percent by 2020, 65 percent by 2030, and net zero by 2050, against 1990 levels.[4] To meet these targets, a detailed pathway was listed to achieve specific emission reductions within each of the main four focus areas - Homes and Buildings, Transportation, Energy and Waste. Figure 3 outlines these long-term goals with respect to the main components of TransformTO.[5]

Figure 3: Long-term goals under TransformTO's greenhouse gas emission targets.



1.3. Transportation as a part of TransformTO

Since 2008, the total amount of vehicle kilometers travelled (VKT) has increased by 3.7 billion kilometers travelled in 2016.[6] However, overall emissions from vehicles has decreased by 0.64 million tonnes of eCO2,

[4] City of Toronto. "TransformTO Overview." City of Toronto, 2018. https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/transformto-climate-action-strategy/.

[5] City of Toronto. "TransformTO: Climate Action for a Healthy, Equitable & Prosperous Toronto." City of Toronto, 2018. https://www.toronto.ca/wp-content/uploads/2020/02/92f8-TransformTO-Climate-Action-for-a-Healthy-Equitable-Prosperous-Toronto-Implementation-Update-2017-and-2018.pdf

[6] City of Toronto. "TransformTO: Climate Action for a Healthy, Equitable & Prosperous Toronto." City of Toronto, 2018. https://www.toronto.ca/wp-content/uploads/2020/02/92f8-TransformTO-Climate-Action-for-a-Healthy-Equitable-Prosperous-Toronto-Implementation-Update-2017-and-2018.pdf

reflecting an increase in fuel efficiency combined with uptake in electric vehicles in Toronto.[7] In general, as shown in Figure 2, 79 percent of all GHG emissions in the transportation sector emerge from passenger vehicles, which includes, cars, SUVs, vans, and light trucks. Commercial vehicles account for approximately 20 percent of all transportation related GHG emissions, even though they account for only 12 percent of total vehicle kilometers travelled in the city.[8]

The city aims at achieving the following goals by 2050:

1. 100 percent of vehicles in Toronto will use low-carbon energy
2. 75 percent of trips under 5km will be walked or cycled

2. Barriers and Challenges

In 2016, the City Council approved a set of short-term strategies to be achieved by 2020 that would pave the way to future implementation plans. Many of these strategies did not achieve their targets. The struggle to achieve these targets in a timely manner can in part be attributed with the following barriers and challenges as identified by the authors through literature review and interviews with City staff and TTC staff:

2.1. Governance Barriers

A. Approval Mechanism

For every project added to the street, council approval is required. This process at times is lengthy and may take months to get implemented on the ground. While this process is necessary for large scale infrastructure or corridor improvement projects, it however becomes a challenge for implementing relatively minor improvement projects, such as increasing bike lanes by one km. While some of the approval requirements were eased during the Covid-19 pandemic as part of the recovery response, these approvals can create significant delays in implementing green mobility plans to achieve net zero by 2050.[9]

B. Decentralized Planning Mechanism

TransformTO currently relies on several internal working groups and other external agencies like the TTC [10]. This heavy reliance on multiple stakeholder groups increases approval and execution timelines, and requires extensive coordination but also increases the difficulty of aligning a comprehensive strategy for achieving the larger goals and targets.

2.2. Operational Barriers

A. Risks to Affordability and Access

Expansion of transit is strongly tied to regional transportation plans and prioritization of specific travel modes. With the onset of pandemic restrictions pedestrian access was prioritized; this is a change from

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[7] City of Toronto. "TransformTO: Climate Action for a Healthy, Equitable & Prosperous Toronto." City of Toronto, 2018. https://www.toronto.ca/wp-content/uploads/2020/02/92f8-TransformTO-Climate-Action-for-a-Healthy-Equitable-Prosperous-Toronto-Implementation-Update-2017-and-2018.pdf

[8] City of Toronto. "TransformTO: Climate Action for a Healthy, Equitable & Prosperous Toronto." City of Toronto, 2018. https://www.toronto.ca/wp-content/uploads/2020/02/92f8-TransformTO-Climate-Action-for-a-Healthy-Equitable-Prosperous-Toronto-Implementation-Update-2017-and-2018.pdf

[9] Interview with staff from Cycling and Pedestrian Projects, Transportation Services, City of Toronto, 17 August 2020.

[10] Interview with staff from Policy & Research, Environment and Energy Division, City of Toronto, 3 September 2020

the emphasis on transit pre-pandemic. During Summer 2020, higher-income areas were prioritized for ActiveTO. The risk of excluding suburban neighbourhoods and/or lower-income neighbourhoods from the benefits of Toronto's recovery planning is the disproportionate delivery of benefits (i.e. reduced air pollution, improved public transit delivery, reduced noise, safer streets). The equitable spatial distribution of pilot projects should therefore be considered in order to ensure the benefits of these projects reach already underserved communities. Similarly, the implementation of electric fleets for public transportation need to be follow a similar protocol rather than solely choosing routes based on the return on recovering costs.
While this implementation may in the long-term provide a more efficient system with reduced operating costs, with positive health benefits, in the initial case these factors impact the accessibility, affordability and experience of users, and so must be carefully considered.

B. Multi-Modal Connectivity

Surface bus and streetcar route timing while scheduled to connect where possible, are on slightly different frequency schedules than subway networks, and even more so than the less frequent high-speed mass transit of GO Train & Bus arrivals and departures, especially in non-peak times. This increase of connecting wait times for passengers increases total commute time, particularly in suburban areas. This is a deterrent to people to use public transport and increases the preference for private vehicle use leading to increased congestion and emissions problems. An efficient multi-modal scheduling system requires technical and route support to mitigate traffic blockages and congestion, and establish connection priorities. It must also be noted that many of these private vehicle trips are mostly single occupancy which increase per-capita GHG emissions for residents.

According to Census 2011 survey by Statistics Canada, 69.9% of work commutes within Toronto were made by cars with 5.4% of those trips were made as passengers. The same report states that 23.3% of trips were made by public transit, 4.6% by walking and 1.2% by cycling[11]. An older report from the City of Toronto states that 67% of trips entering Toronto in 2006 were made in single occupant vehicles. Only one in every five trips into Toronto during the morning peak travel period is made using GO train, GO bus, TTC and buses from other municipalities[12].

2.3. Socio-Economic Equity Challenges

A. Disconnected services

Limited access to public transit services, both in outlying suburban areas where multi-modal connections are a challenge, or access to metro stations where accessibility is difficult, or lack of safe first and last mile connectivity to the station, and inadequate quality non-motorised transport (NMT) infrastructures i.e. for walking and cycling, discourage citizens from using public transport services, and encourage a reliance on personal vehicle use.

This issue is further heightened by the lack of integrated land use patterns and the need for increased mixed-use developments that provide broadband community needs. This lack of integration increases the need for residents to travel longer distances to reach their job centers, groceries, recreation etc., and polarizes socio-economic inequities within communities. Absence of these commercial and

[11] Statistics Canada, (Table 1.a Proportion of workers commuting to work by car, truck or van, by public transit, on foot, or by bicycle, census metropolitan areas, 2011)
[12] Toronto Public Health. Air Pollution Burden of Illness from Traffic in Toronto – Problems and Solutions. November 2007. Toronto, Canada. (https://www.toronto.ca/legdocs/mmis/2007/hl/bgrd/backgroundfile-8046.pdf)

recreational facilities within walking or cycling distances, as per the 15-minute city ideal, heightens the need for effective public transit, and where not available forces residents to rely on their personal vehicles.

Gentrification further complicates the ideals of the 15-minute city as it forces lower and middle income families to seek housing further out, perpetuating the cycle of personal vehicle use and transit expansion. Strict urban growth boundaries combined with Community Investment Trusts, and the elimination of exclusionary zoning, such as R1 residential zones/ single family housing zones may assist in mitigating the impacts of gentrification and outward migration.
Oregon has demonstrated the benefits of effectively eliminating single-family zoning in passing of Bill 2001, and the work of Mercy Corps' Community Investment Trust provides several case studies in effective strategies for mitigating loss of community due to gentrification.

B. Affordability

Higher costs to access and use of public transit including limited multi-modal connectivity and longer wait times deters users from using it. Whether actual or assumed, based on user perception, individuals tend to take the fastest and least expensive route (these decisions are based on both status and perceptions of what costs more based on the time and effort attributed to transit mode). [13] Additionally, housing rent around transit corridors is very high, and pushes low-income groups to affordable areas which are predominantly outside the service areas - forcing them to rely on personal vehicles if they have access to one. While electric vehicles (EV's) may be less expensive to operate annually, EVs are still more expensive than internal combustion engine vehicles and price parity is not expected until 2025.[14] This price premium limits widespread ownership across all demographics, especially affecting lower-income groups.

C. Equity as 'checklist' [Too many people left out]

Ensuring equity should be a point of discussion in all stakeholder and community engagements. It is important that a continuity of unbiased consultation be facilitated to avoid gaps of representation from initial project planning, through design development and implementation processes. However, there are significant gaps during initial project planning, design development and implementation processes. Toronto is a diverse city, with lots of immigrant populations, whose first language is not English (or French). The material produced for consultation or for feedback surveys is not available in different languages. While it is unnecessary to produce the material in all languages for the entire city, but for specific Wards or neighborhoods, extra surveys and consulting material may be produced in the major languages spoken there apart from English and French.

3. Research Methodology

The research team at OCAD University was keen to answer the following question:

> ***How to achieve 2050 TransformTO targets by incorporating both environmental and social equity lenses to achieve better health and equitable access for the residents of Toronto?***

To successfully answer this question, the team undertook a mixed-methods research approach. They incorporated the use of Literature Review to develop an understanding of green mobility practices, and how social equity goals are accounted for in the transformation to green mobility development. Following the Literature Review,

[13] Toronto Public Health. Air Pollution Burden of Illness from Traffic in Toronto – Problems and Solutions. November 2007. Toronto, Canada. (https://www.toronto.ca/legdocs/mmis/2007/hl/bgrd/backgroundfile-8046.pdf)

the team conducted a deep-dive case study analysis on six major cities across North America and Europe. These cities were selected due to the degree of their operational similarities to Toronto. In parallel to conducting these analyses, the team also interviewed key City of Toronto staff from the Environment and Energy Division, the Cycling and Pedestrian Unit and staff from the TTC.

4. Case Study Analysis

The following data and best practices were derived from the case study research. The data was collected in # alignment of key criteria focussed on governance structure, inclusionary policies with regards to access, and affordability and lastly, mixed-use land development. #

City	Barrier Addressed	Toronto Applicability
London	Governance and Financing	Implementing congestion charging, and reinvesting proceeds
Vienna	Operational: Pedestrian Traffic	Street Design, Increased space for pedestrian use and biking infrastructure
Paris	Financing: Personal EV Adoption	EV incentivization, and financing
New York City	Governance and Socio-Economic: Equity and coordination in decision-making	Develop long-term visions with goals that are applicable for various departments.
Chicago	Operational and Socio-Economic Equity: EV bus fleet, subsidies and bike share expansion	Evaluate options for providing subsidies to disadvantaged demographic groups.
Portland	Governance and Socio-Economic Equity: Integrated State and local policies, innovative engagement	Assimilate different programs and departments towards a common goal, and develop innovative engagement and education strategies.

4.1. London

London's transportation system is unique for several reasons, one of them being its governance structure. The Transport for London (TfL) is a model for both transport investment and management across the world with approximately 44 percent of people in London using public transport to commute.[14] This agency is part of the Greater London Authority that is managed by the Mayor of London who has executive chair authority. Having a single chair allows for increased public accountability while contributing to higher levels of customer satisfaction due to increased knowledge of who to address concerns to. Furthermore, this agency overlooks and manages

[14] Office of National Statistics. (2013), 2011 Census Analysis – Method of Travel to Work in England and Wales, London: Office of National Statistics

most of the transport modes in London, allowing for effective multi-modal integration that helps with both long-term planning investments and timely implementation strategies.[15]

A second notable and successful practice for London has been its ability to reinvest local funds in transport. In the last 14 years, London has raised $2.7 billion in revenues from its congestion charging and all these funds have been used to upgrade transport infrastructure.[16]

Toronto Context:

Toronto currently faces both governance and operational barriers. To provide more collaborative integration in the system would alleviate some of the governance barriers that hinder the achievement of the TransformTO goals. Further, creating an additional revenue stream in the form of congestion charging on crowded corridors like the DVP or Gardiner, and increasing the cost of parking and fuel can help to create a sustainable financial model for public transit, and increasing ridership.

4.2. Vienna

Recently, Vienna was declared the world's greenest city on the basis of air-quality, green spaces and access to public transport.[17] In 2017, Vienna had 81 miles of walkways, not including any trails. The city has undertaken extensive research to understand how they can increase pedestrian spaces thereby providing a safe option to both cyclists and walkers, and how they can construct even and wide pathways. For example, narrow and brick paths raise concerns of inaccessibility to families with strollers, individuals on wheelchairs and others with disabilities. Recognising these barriers, Vienna has developed a single Pedestrian Master Plan strategy in 2017 that addresses all barriers, challenges and implementation pathways.[18] The highlight of this plan is that it takes into perspective new housing construction plans that will increase user traffic and views them as opportunities to enhance the sidewalk network.

Toronto Context:

The pandemic has decreased TTC ridership and increased preferences for walkability and biking.[19] Increased accommodation and enhancement of pedestrian infrastructure in TransformTO goals can assist with addressing some of the socio-economic challenges.

4.3. Paris

Paris aims to phase out combustion engine vehicles by 2030.[20] In France, the local authorities have been strongly aligned in the development of charging stations, leading to increased efforts to encourage public adoption of Electric Vehicles (EV).[21] The federal level involvement has led to successful implementation of a taxation

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[15] The full range of transport that comes under the responsibility of TfL includes: Underground; Overground rail, including some national rail services into Liverpool Street; trams; buses; river services; 580km of streets and all traffic lights; cycling; traffic management on red routes; taxi licensing and regulation; Dial-a-ride; Congestion Charging; the Docklands Light Railway and Air Lines

[16] Transport for London. Freedom of Information: Transparency, 2017. https://tfl.gov.uk/corporate/transparency/freedom-of-information/foi-request-detail?referenceId=FOI-2271-1617#:~:text=All%20revenue%20generated%20by%20the,in%20the%20Capital's%20transport%20infrastructure

[17] EuroNews."Vienna crowned world's greenest city for its parks and public transit." May, 2020. https://www.euronews.com/2020/05/12/vienna-crowned-world-s-greenest-city-for-its-parks-and-public-transit

[18] Town of Vienna. "Pedestrian Master Plan." https://www.viennava.gov/DocumentCenter/View/2636

[19] Interview with TTC.

[20] Electrek. "Paris to only allow electric cars as soon as 2030 ahead of France's 2040 goal." October, 2017 https://electrek.co/2017/10/12/paris-electric-cars-2030-ahead-of-france/

[21] Watson Farley & Williams. "The Future of E-charging Infrastructure: France." May, 2020. https://www.wfw.com/articles/the-future-of-e-charging-infrastructure-france/

system, the burden of which falls on consumers buying CO2-emitting cars. While buyers of CO2 emitting cars are taxed, those switching to EV cars receive a monetary bonus in addition to a 50 percent discount on license plates. These monetary incentives vary across different income households, with the low-income households receiving the most, working towards establishing more equitable options for purchase. Further, these incentives apply to both, purchase of first and second-hand vehicles.[22]

Toronto Context:

To achieve the TransformTO goal, significant EV uptake is required; presently 6300 vehicles are currently registered as EV's in Toronto.[23] To increase uptake, the City can explore financing avenues to reduce upfront costs, for both used and new vehicles. Additionally, increasing the number of e-bikes through Bike Share can also help mitigate financing barriers in the short-term.

4.4. New York City

PlanNYC is a long-range strategic plan that New York City released to 'ensure a high quality of life for its residents and contribute to a 30% reduction in global warming emissions'. The transportation plan included, promotes creation of new safe cycling infrastructure including bicycle parking. Since then many innovative methods have been used to increase the ridership within the city including adopting 'Vision Zero' for road safety. About 60 public plazas and squares have been designated as pedestrian only and the plan has created 600km of bicycle infrastructure. New York city has also been innovating through shared bikes facilities and car-sharing schemes.[24] Due to the vastness of the city and its different characters; context and roads, different complete street templates have been created for the network to better accommodate different combinations of transport modes. The City has also partnered with different citizen groups for decision making, as well as different departments of the City such as public health, housing, parks etc. [25] The 'Brooklyn Active Transportation Community Planning Initiative' which was a street redesign and community enhancement project involved New York City Department of Transportation, Department of Health and Mental Hygiene, Brooklyn District Public Health Office, and Brownsville Partnership (an initiative of Community Solutions) and demonstrates the level of city collaborative management necessary for successful implementation.[26]

Toronto Context:

It is essential for the City to have a long-term vision with a set of goals that are common for its various departments and programs. This allows for better integration and coordination between various departments. It is also critical to include departments for Public Health , Mental Health, and Community Housing to ensure social equity and serve the larger socio-economic and quality of goals along with TransformTO goals through transportation innovations. Toronto Hydro with Public Works may act as a critical and valuable asset especially when implementing electric mobility at a large scale.

4.5. Chicago

The Chicago Transit Authority or CTA manages the transportation services in the city, and offers discounted ticket prices for children, students, seniors and people with disabilities. However, no such discounts are available for low-income individuals. The City is working towards increasing equity and inclusion amongst its residents. Studies conducted indicate that a 50% fare subsidy for low-income adults who comprise 10-15% of the ridership

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[22] Fleetcarma. " What can we learn from France about EV adoption?" https://www.fleetcarma.com/can-learn-france-ev-adoption/

[23] City of Toronto, "Electric Vehicle Strategy: Supporting the City in Achieving its TransformTO Transportation Goals"

[24] Knupfer, Stefan M., Pokotilo, Vadim and Woetzel, Jonathan: "Elements of success: Urban transportation systems of 24 global cities (June 2018)" Pages 64, 65

[25] City of Toronto Public Health: "Road to Heath: Improving Walking and Cycling in Toronto, (April 2012)" Pages 54, 55, 71-74

[26] Center for Active Design. "Brooklyn Active Transportation Community Planning Initiative" (https://centerforactivedesign.org/brooklynactivetransportation)

would cost $25-50 million annually, however it is estimated that this will provide them easy access to employment and other social services, thereby having a positive impact on the regional economy.[27] In addition the goals of the Chicago Metropolitan Agency for Planning (CMAP) includes creating and supporting linkages to disadvantaged communities to jobs and services and provide improved transportation choices to low-income individuals to avoid placing any kinds of disproportionate burdens on them.[28] Chicago's public bicycle share program, Divvy Bikes, launched a program in 2015 'Divvy for Everyone' which focused on establishing stations in low income neighborhoods, low priced annual membership, and waiver of credit card requirements.[29] As part of the City's electric mobility plans, CTA along with the CMAP is working towards converting its transit fleet into electric vehicles. They see this as a measure for setting an example as well as a market for electric vehicles. The expansion aims at converting 25% of the bus fleet into electric and installing infrastructure including charging stations for them. [30]

As part of public engagement and changing the perspective towards riding cycles, a successful program; the Mayor's Ambassadors program has been termed successful and has sought volunteers to participate in the program to encourage residents to ride more bikes on the streets and eventually make a switch from personal cars to cycles. The educational campaigns target bicycle riders of all ages and competencies, non-bicyclists, and motorists. These Ambassadors deliver bicycle safety and road-sharing information at public engagements, neighbourhood festivals and community events.[31] The City has also overlapped its bicycle ridership goals with increased road safety goals, to minimize the safety concerns and unwillingness by people to ride a cycle with fast moving vehicles on the streets.[32]

Toronto Context:

The city should look at its long-term vision in a comprehensive manner, coordinating different agencies to achieve common goals through shared priorities and specific strategies around transport and bicycle / e-scooter ridership. It should also carry out cost benefit analysis for income, age and need-based subsidies for its residents, to develop measures that are more equitable and do not impact specific minority immigrant groups disproportionately.

4.6. Portland

With stronger policies at local and State levels, investments, and proper education the City of Portland has the one of the highest bicycling mode-share networks [33] amongst North American cities and has a high percentage of work trips by bicycles. Its *Complete Streets Policy* has increased the number of cycling infrastructure as well the number of cyclists. Any new development, construction or rebuild requires the inclusion of cycling facilities. This is further supported by the State of Oregon's *Bike Bill* program which allows for 1% of state-wide transportation revenue to be utilized for bicycling and pedestrian infrastructure improvements. The City's unique urban form with smaller block sizes, inclusive land use, and transit integration have further enhanced the ridership. Cyclists are allowed to bring their cycles onboard the city buses, streetcars and transit trains, and the transit agency also has a "Bike & Ride" facility that provides secure bike parking facilities at the stations. Apart from implementing innovative and different bike facilities such as shared lane markings, bicycle boulevards, coloured bike lanes and bicycle traffic lights, the City also deploys innovative education and engagement strategies. Some of them include active adult and youth bicycle education courses, Bike-to-Work Days and

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[27] Marysue Barett (2019). Chicago Business. "Can Transportation Equity happen in Chicago?" (https://www.chicagobusiness.com/lightfoot-100/can-transportation-equity-happen-chicago)

[28] Manaugh, K., Badami, M., & El-Geneidy, A. (2015). "Integrating Social Equity into Urban Transportation Planning: A Review of Metropolitan Transportation Plans in North America." Page 15

[29] Mohith, Mohammad. "(In)Equity in Active Transportation Planning: Toronto's Overlooked Inner Suburbs (July 2019)". Page 15

[30] Katie Pyzk (2018). Smart Cities Dive." A look into Chicago's electric vehicle future "

[31] Pedestrian and Bicycle Information Center: "Case Study Compendium, (July 2010)". Page 57

[32] Miovision Technologies: "Building a bike friendly Chicago: How video data is moving Chicago forward"

[33] City of Toronto Public Health: "Road to Heath: Improving Walking and Cycling in Toronto, (April 2012)" Page 23 https://www.toronto.ca/legdocs/mmis/2012/hl/bgrd/backgroundfile-46520.pdf

Ciclovia (car-free) events, and City-sponsored events. The city further aims at installing 1090km of bike infrastructure by the year 2030. [34 +]

As mentioned previously, In Portland Oregon, Mercy Corps Northwest piloted the first Community Investment ever as an innovative model to mitigate gentrification caused by urban revitalization and the demand for walkable communities.[37] Coupled with the elimination of exclusionary zoning, Portland paves the way for urban innovation in not only making the ideals of the 15 minute city attainable for a broad transect of the population, Portland also paves a path toward mitigating gentrification induced vulnerability and lifting up the assets of lower income communities.

Toronto Context:

The example above shows how a comprehensive and coordinated effort to finance, educate, and incentivise a bicycling network can be utilized to change transportation habits. To achieve the TransformTO goal, the City needs to expand its cycling services to underserved areas and combine it with the City's Neighborhood Improvement Areas (NIA) program to have a holistic impact. This needs to be supported by improving the existing cycling infrastructure and ensuring the routes are safe and protected from fast moving traffic. This can be ensured and supported through the Vision Zero program that looks over safety for all road users. Apart from this, there is a requirement for stronger policies from City and provincial levels to enable the City to execute projects at a faster pace and that provides the necessary funding mechanisms for implementation.

5. Recommendations

5.1. # Encourage Active Transportation Infrastructure

- The least expensive and most environment friendly mode of transport is walking followed by cycling. Therefore, adequate efforts need to be undertaken to highlight their importance and encourage residents to use them, through education and campaigns

- This needs to be supported by providing proper infrastructure for walking and biking, for example, sidewalks that are properly maintained throughout the year, and wide enough to accommodate the users, and bike facilities that are marked, prioritized and designed with an adequate buffer to ensure safety from fast moving vehicles.

- Adopt innovative practices such as shared streets, physical traffic calming measures, speed zoning etc. to create safe space for pedestrians and cyclists that would encourage them to use the facilities.

5.2. # Reduce Transport Demand and discourage the use of personal vehicles and to encourage public transport.

- Encourage the development of livable communities; for example, a localized mixed-used development, where various services and facilities such as healthcare, education, employment, commercial, entertainment, and recreation are within short distances through walking and cycling, and not require the use of a personal vehicle.

- Create policies that would encourage the creation of Transit-oriented Developments (TOD) that are mixed-use developments centered around a mass transit node or bus station. This would encourage

[34] Clean Air Partnership: "Building Better Cycling Arteries in Cities Lessons for Toronto (2010)"

reliance on public transport for longer commutes and ensure more shorter trips locally through walking and cycling.

- Enable policies to ensure housing affordability, by creating financial models that couple diverse demographic rental and ownership group models, with options for families and extended families.

- Adopt innovative policies that would make ownership and use of a personal vehicle more expensive, making it less expensive to use public transport and active transport modes.

    - Congestion pricing is an innovative tool that is being used in many cities, where drivers are charged a tariff to drive in designated zones of the city during weekdays. London and Singapore have adopted this practice in their downtown and other job centers. This additional price discourages residents from driving to their work, making public transport a better option.

    - Increasing parking rates, fuel costs, and vehicle ownership costs has over the time proven to change behaviour from private vehicle driving to public transit for employment or commercial center commutes.

5.3. Create a sustainable financing model

- To actualize transportation goals, long term investment is needed. The current approval mechanism depends heavily on the City's budget cycle and provincial support, creating gaps in implementation timelines.

- The City can create a new fund that can leverage private capital to ensure continuity of all transportation related goals and in addition, they can adopt innovative policies as mentioned and reinvest the revenues in achieving target goals. London has been a prime example of reinvesting all funds raised through congestion charging into enhancing its transportation networks.

5.4. Move towards cleaner fuel sources

- Switch to cleaner fuels for transportation. Since new technology and vehicles are expensive it is more economical for cities to gradually convert their public transport fleet into electric vehicles. Although higher upfront costs, a program of cost recovery through operation, ticketing, increased ridership is needed.

- Smaller electric vehicles can be used as part of para-transit services or feeder bus networks that help in addressing first and last-mile connectivity challenges, and make access to train and bus stations easier and more reliable.

- Electric vehicles may also be part of an e-bike share fleet, of e-scooters and car-share. While the e-bike share may be part of the city's existing bike share programs, the other two would require additional policies to guide city street usage and prevent other mode disruptions.

- Electric vehicles as public transport fleets or private vehicles require charging stations which need supportive infrastructure. Care must be taken to ensure that these infrastructures are distributed equitably through the city neighborhoods.

6. Next Steps

- Develop City-wide long-term visions, goals, and holistic measures to achieve them through engagement with different agencies and departments simultaneously.

- Create a special group to oversee TransformTO goals for 2050, to coordinate specifically with the various stakeholders to ensure a dedicated and more responsive process. It must also engage with other municipalities in the GTA to ensure an exchange of resources and benefits for the entire region. This is specifically critical to understand transportation needs for people commuting from different municipalities daily for their jobs.

- Implementation strategies should undertake socio-economic and equity impact assessment at each stage to ensure that all groups and communities benefit equitably.

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Books and Articles

White Lanes are Bike Lanes: Bicycle Advocacy and Urban Planning by Dr. Melody Hoffman

Bicycle/Race: Transportation, Culture, & Resistance by Adonia E. Lugo, PhD

Bikequity: Money, Class & Bicycling, a book of essays edited by Elly Blue

This list of anti-racist resources, especially for parents with children

The Unlikely Thru-Hiker: An Appalachian Trail Journey by Derick Lugo

People for Bikes Equity Report

"For People of Color, Barriers to Biking Go Far Beyond Infrastructure, Study Shows" by Michael Andersen

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