TORONTO LANDSCAPE ANALYSIS

TORONTO

CIRCLE ECONOMY

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LANDSCAPE ANALYSIS | **COLOPHON**

This report represents the first output of a research project between Circle Economy, David Suzuki Foundation, Dillon Consulting and the City of Toronto. It seeks to build on existing Toronto strategies that support circular economy goals (i.e. Long-Term Waste Management Strategy, TransformTO, Toronto's Food Strategy, and Toronto's Resilience Strategy etc.). Following the project kick-off workshop with stakeholders in February 2020, the data and documents recommended by the participants have been reviewed and processed to produce this Landscape Analysis.

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CONTENTS

READERS GUIDE

This document presents a high-level overview of key economic, environmental, social, and policy information that will help establish a shared understanding of the current state of Toronto's economy and where opportunities or barriers might lie in accelerating a circular economy. This information and analysis aim to support greater alignment between different departments within the City of Toronto in identifying priority areas for the city's transition towards a circular economy. This report is based on the most recent and relevant quantitative data and statistics that the researchers were able to access between January and April 2020. Where Toronto-level data was not available, the closest geographical level of data available (e.g. Toronto Census Metropolitan Area (CMA) or the Greater Toronto Area) was used instead. Additional information from City policy documents, reports from working groups, and notes from the kick-off workshop in February 2020 were referenced to support the findings of the researchers.

TABLE OF CONTENTS

INTRODUCTION 4

1 SOCIO-ECONOMIC ANALYSIS 6

2 HOUSEHOLD ANALYSIS 16

3 POLICY LANDSCAPE 20

4 CONCLUSIONS 24

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BACKGROUND

Toronto is the Provincial capital of Ontario and sits on the northwest shore of Lake Ontario, the traditional territory of many nations including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee and the Wendat peoples and now home to many diverse First Nations, Inuit and Métis peoples. People have been living on the shores of Lake Ontario since time immemorial. Due to its strategic location on the Great Lakes and St. Lawrence River, the city now called Toronto initially joined the global economy as a prominent commercial lake port, railway and industrial hub.(1)

Today, Toronto is an important urban centre in North America. It is the most populous city in Canada, and fifth largest in North America.(2) The city is a national and international hub for communications and cultural life, and the second-largest financial centre in North America.(3,4) About 80% of the jobs in Toronto are in the service sector, such as professional, administration, or Information and Communications Technology (ICT) services, generating over 83% of the city's GDP.(5) Toronto is often characterised by its great diversity. Over half of its residents are of non-Canadian birth, a far greater share than at the national level (about 22%),(6) and over 70,000 residents make up the largest Indigenous population in Ontario, the fourth largest in Canada.(7) Over 180 languages and major dialects are spoken in the Toronto region, and over half of residents are non-Canadian born.(8) The city is also well known for having more than 1,600 parks and over 200 km of trails, although most of the parkland is concentrated in just a few areas of the city.(9,10)

Looking ahead, the Greater Toronto Area (GTA) is projected to be the fastest growing region of the province, with its population increasing by 3.4 million, or 49.6%, from 6.8 million in 2018 to over 10.2 million by 2046.(11) The Toronto CMA is estimated to be the fastest-growing metropolitan region in Canada and the United States. The region's population increase is mostly concentrated in the City of Toronto,(12) which registered a population change of 4.5% between 2011 and 2016. The age category with the highest population growth during this period was people aged 65 and above, increasing from 14.4% to 15.6%.(13,14) This expected growth in population, combined with increasing standards of living will be a key factor in driving resource consumption and environmental impacts in the years to come.(15) This is a consequence of our "linear economy" that extracts raw materials to make products, which are ultimately disposed of after use. To ensure that Toronto can support its residents with food, shelter, mobility, and other key needs into the future, our linear economy must transition to a "circular economy" where materials are cycled over multiple uses, thus minimizing natural resource extraction and waste, and reducing the impacts to the environment.(16)

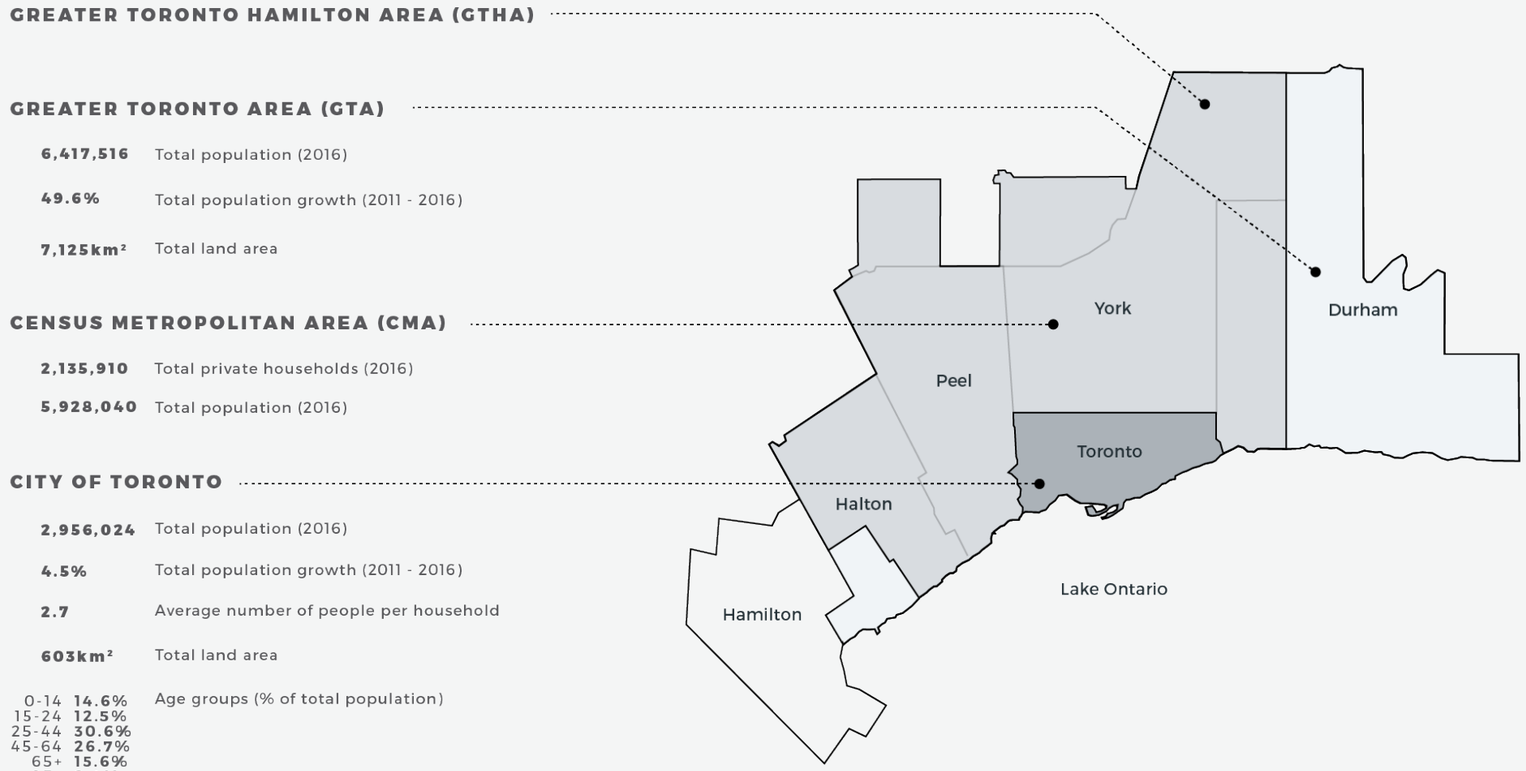

Figure 1: Key demographics of the Greater Toronto Hamilton Area (GTHA) at a glance (17)

FROM A LINEAR TO CIRCULAR ECONOMY

The City of Toronto has taken on a leading role among Canadian cities in recent years by actively pursuing the topic of circular economy, and exploring how to take practical steps away from the linear "take-make-dispose" system. As part of the Long-Term Waste Management Strategy, the City of Toronto is working towards an aspirational goal of zero waste and making Toronto the first municipality in the Province of Ontario with a circular economy. In order to do so, the City is developing strategies and programs (i.e. establishing a Circular Economy Working Group), engaging in multiple networks (i.e. the National Zero Waste Council (NZWC) and the global Circular Economy 100 (CE100) network created by the Ellen MacArthur Foundation) and establishing various circular economy initiatives (i.e. formalization of a city-focused extended producer responsibility policy, investment in infrastructure to turn organic waste into renewable natural gas, development of a 'Circular Procurement Implementation Plan and Framework', etc.). The city's efforts are being recognized internationally.(18)

This research project will seek to build on existing Toronto strategies that support circular economy goals (i.e. Long-Term Waste Management Strategy, TransformTO, Toronto's Food Strategy, and Toronto's Resilience Strategy etc.). In addition, this research project will help inform the development of City policies and actions, and will also help identify circularity goals that cannot be met by the City alone. The research project will provide a credible quantitative and qualitative measure of circularity for the City. This will link to existing City strategies in order to guide future actions and provide a robust ability to monitor progress. The project has been divided into four main tasks, which are described to the right:

TASK 1: START-UP AND CONSULTATION

The start-up and consultation phase (conducted in Quarter 1 of 2020) was used to gather information from key staff at the City of Toronto and the Toronto Region and Conservation Authority, and help establish necessary support for the process to follow. The objective of this task is to ensure the direction of this baseline circularity analysis is aligned with parallel initiatives of the Circular Economy and Innovation Unit and other City-led initiatives.

TASK 2: LANDSCAPE ANALYSIS

A landscape analysis is used to understand the existing state of Toronto's socio-economic and policy context as it relates to the topic of the circular economy. The main results of the Landscape Analysis will help inform the decision on which three sectors should be analyzed further to optimise the beneficial impacts of circular economy solutions, in alignment with the City's other strategic priorities. To this end, sectors have been compared based on their contribution to factors like employment, GDP, and environmental impact, as well as their strategic importance. At the end of this document, three sectors for the more detailed material flow and 'business as usual' analyses in Task 3 are recommended.

TASK 3 (A & B): MATERIAL FLOW ANALYSIS (MFA) & BUSINESS AS USUAL (BAU) ASSESSMENT

To understand where the circular economy can have the most beneficial impact in each of the three selected sectors, a MFA is conducted for each sector to identify opportunities to close material cycles. The MFA will result in visual maps of how water, energy, biomass, metals, and minerals are consumed by the three sectors, and how these subsequently flow out of the sectors in the form of waste and residual flows. Looking ahead, the BAU analysis anticipates what the material consumption patterns for the three selected industries might be in 10 years' time if left unchanged (subject only to economic growth and population growth). This provides a useful baseline to compare the impact of various alternative circular economy scenarios relative to one another.

TASK 4: IDENTIFICATION OF KEY CONSIDERATIONS

In order to chart a path forward toward a circular economy, the researchers will reflect on the insights and outcomes of the previous Tasks, and draw on their expertise and experience from other cities to identify key considerations in transitioning Toronto towards a circular economy.

Socio-economic analysis

Evaluating Toronto's options for a more circular economy requires starting with a basic understanding of its socio-economic situation. This section of the Landscape Analysis aims to identify the sectors of greatest strategic and economic importance, and to understand where existing interest or momentum might be leveraged to achieve the greatest impact. To this end, the city has been analysed from the following angles:

- **Profiles of productive sectors (grouped by North American Industry Classification System (NAICS)**
- **A scan of local business and citizen initiatives in the Toronto area, and what kinds of activities and approaches are most visible and widespread.**

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1.1 ECONOMIC SECTORS

Economic sectors represent what a city produces, or its contribution to the economy. The researchers have conducted a high-level analysis of Toronto's sectors and industries to illustrate which sectors may be of strategic and economic importance in the development of a circular economy strategy. The relative importance of each sector is evaluated based on four indicators:

- Gross Domestic Product ($CAD) provides an indication of a sector's economic importance
- Total employment (number of jobs) provides an indication of a sector's societal importance
- Total Greenhouse Gas (GHG) emissions (tonnes CO2e) provides an indication of a sector's contribution to climate change
- Total waste generated (tonnes) provides an indication of how much material the sector currently wastes that could potentially be put to better use

With each indicator analysis, the relative contribution of each sector to the indicator total is used as a means of prioritising the sectors. Understanding which sectors contribute the most to each indicator helps to direct efforts toward sectors that are most likely to have a positive impact. Twelve sectors are compared, based on clusters of North American Industry Classification System (NAICS) codes (see table below):

CLUSTER	SECTOR	NAICS CLASSIFICATION CODES (AND NUMBER)
COMMERCIAL SERVICES	Information & financial services	Information & Cultural Industries (51) + Finance & Insurance (52)
	Professional, scientific & administrative services	Professional, scientific and technical services (54) + Other services (except public administration) (81)
	Trade	Wholesale trade (41) + Retail trade (44-45)
	Transport & warehousing	Transportation and warehousing (48-49)
	Tourism	Arts, entertainment and recreation (71) + Accommodation and food services (72)
PUBLIC SERVICES	Public administration	Public administration (91)
	Education	Educational services (61)
	Human health & social services	Health care and social assistance (62)
INDUSTRY	Construction & real estate	Construction (23) + Real estate and rental and leasing (53)
	Agriculture & material extraction	Agriculture, forestry, fishing and hunting (11) + Mining, quarrying, and oil and gas extraction (21)
	Energy & water management	Utilities (22)
	Manufacturing	Manufacturing (31-33)

Table 1: North American Industry Classification System (NAICS)

INDICATORS:

LEGEND

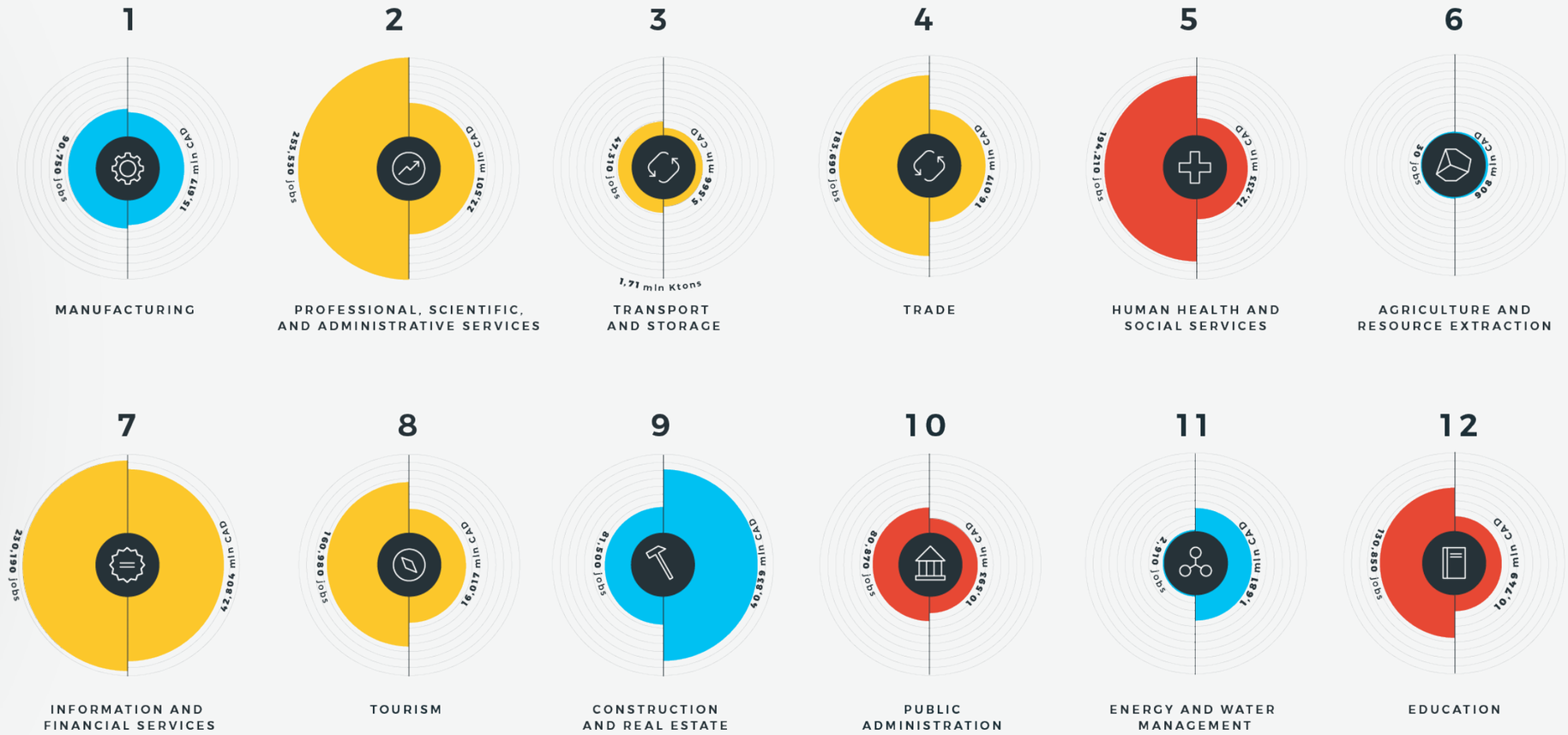

Figure 2: An overview of 12 sectors showing real annual GDP estimates for Toronto (right side) and number of full-time equivalents for Toronto (left side)

HIGHEST ECONOMIC VALUE SECTORS

Key Observations:

- "Information and Financial Services" contribute most (22.3%) to Toronto's GDP at $42.8 billion in 2018. Of this, roughly 75% is constituted by the "Finance and Insurance" sector, and 25% by the "Information and Cultural" sector.
- "Construction and Real Estate" follows closely behind at $40.8 billion (21.3%) in Toronto. Of this, just over 75% is constituted by the "Real Estate, Rental and Leasing" sector, and about 25% by the "Construction" sector.
- The "Finance and Insurance" and "Real Estate, Rental & Leasing" sectors are thus the most significant contributors to Toronto's economy, but "Professional, scientific and administrative services", "Trade" and "Manufacturing are also important.

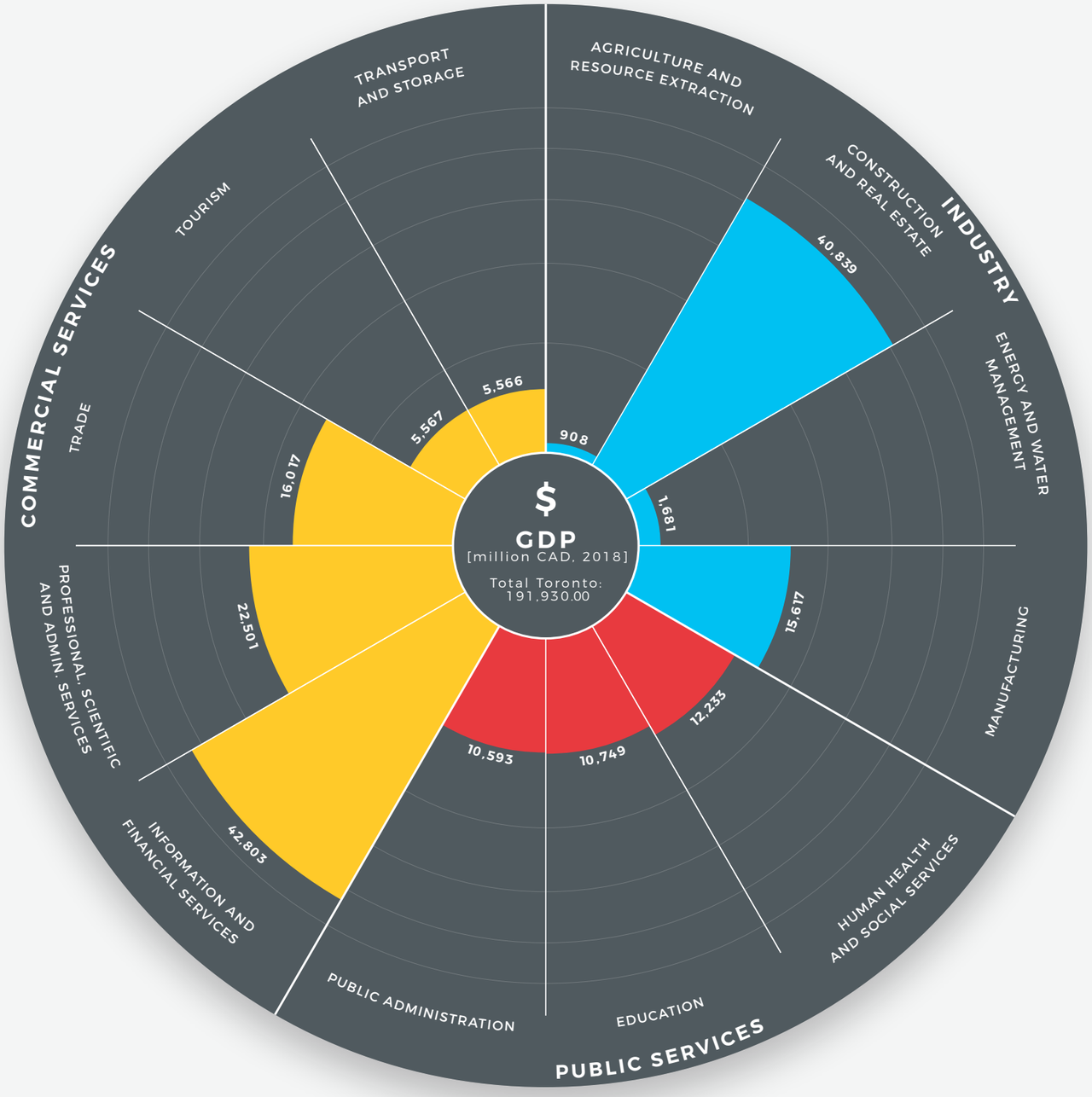

Figure 3: Real Annual GDP Estimates for Toronto (2018)
(at Basic Prices, millions $ in chained 2012 dollars(19)) [Source: City of Toronto]

HIGHEST EMPLOYMENT SECTORS

Key Observations:

- "Professional, scientific and administrative services" provide employment to approximately 253,530 people in Toronto, constituting 16.2% of Toronto's total employment. Of this, the most significant employer is "Technical services" (which includes the IT sector, amongst others), providing 174,040 of these jobs.
- "Information and financial services" provide employment to approximately 230,190 people in Toronto, constituting 14.7% of Toronto's total employment. Of this, the most significant employer is "Finance and Insurance", providing 177,870 of these jobs.
- "Human health and social services" employ approximately 194,210 people (12.4%) and "Trade" employs around 183,690 (11.7%). It is likely that this is primarily retail rather than wholesale trade, as is the case for the Greater Toronto Area.
- Employment in Toronto is dominated by Service-Based industries (78.4%). (20) Since 2014, employment losses in Goods Production (-6.9%) have been balanced by increases in Government and Institutional (+18.0%) and Service-Based jobs (+15.2%).(21)
- In Toronto, the sectors with this highest job growth in 2019 were Finance and Insurance (9.3% growth, and the highest contributor to net jobs), Professional, Scientific and Technical Services (8.6% growth), Health Care and Social Assistance (5.6% growth), and Educational Services (7.5% growth).(22)
- Other sectors that have experienced above-average annual employment growth rates since 2014 in Toronto are "Real Estate, Rental and Leasing" (included in "Construction and real estate" above), "Transportation and Warehousing", and "Accommodation and Food Services" (included in "Tourism" above) (23)
- The growth of the technology sector through specialisation and diversification was an important feature of Toronto's economy in 2019. The sector grew by 84.6% between 2014 and 2019, and it is anticipated to continue growing, with a shift toward soft technology, online platforms and e-commerce.(24)
- In 2019, jobs in manufacturing shrunk by 0.7% (although there was strong growth in the warehousing subcategory). In the South Employment Monitoring Area (EMA) (the areas of the former municipalities of the City of Toronto, York, and East York), the rate of decline in manufacturing jobs was more significant, with 8.3% of jobs lost.(25)
- Toronto's green sector provides over 29,000 jobs, mainly in sustainable transportation (46%), resource management (21.3%), green buildings (17.9%), clean energy (8.7%) and bioproducts (6.1%).(26) An Ontario study found that for every $1 million invested in energy efficiency programmes, approximately 17-21 job years(27) and $2.4-3 million in net GDP growth can be expected.(28)

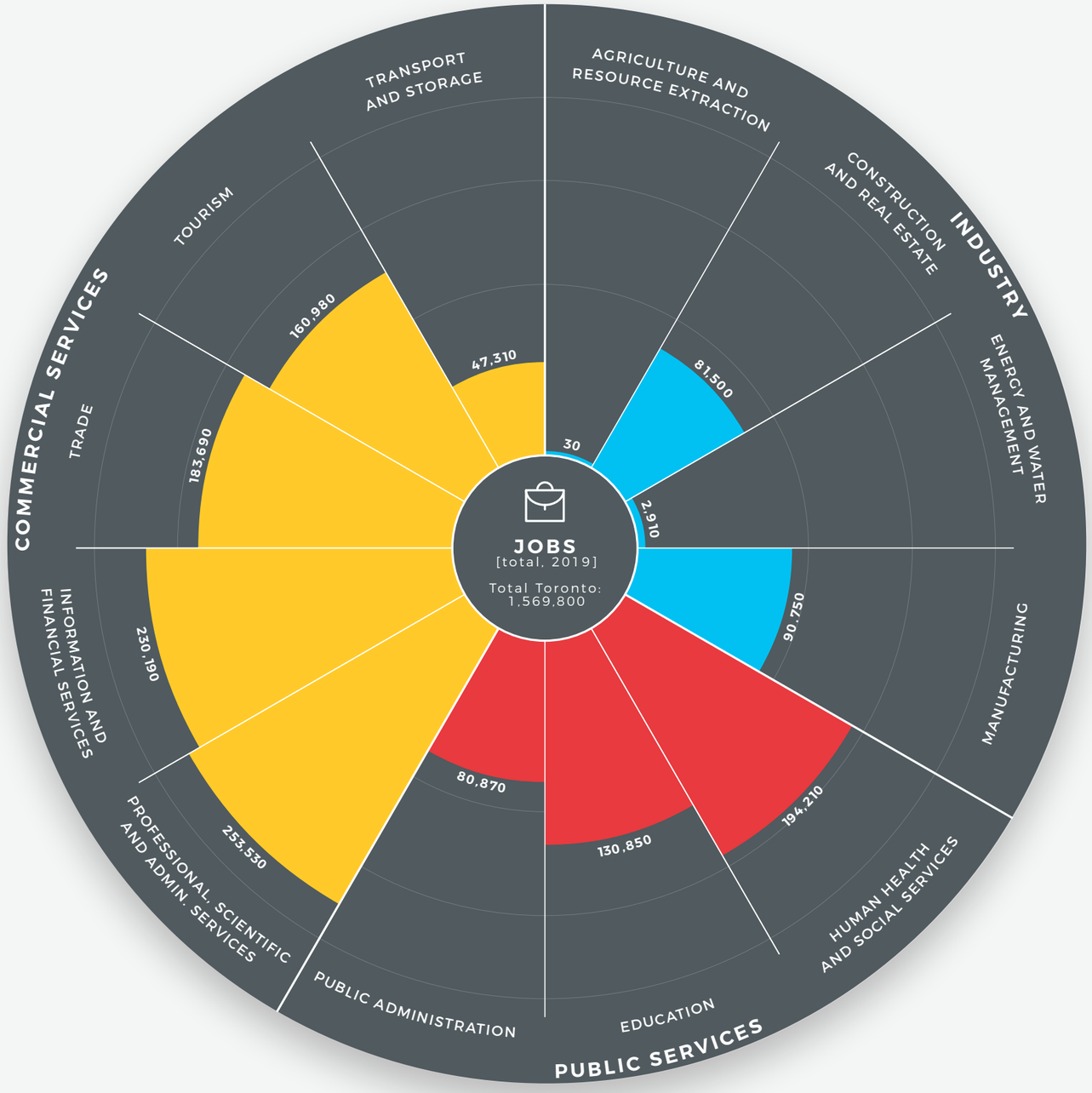

Figure 4: Labour force profile for Toronto (2019) (Number of Full Time Equivalent jobs)
[Source: Statistics Canada's Labour Force Survey 2019, p. 37]

HIGHEST EMITTING SECTORS*

Key Observations:

- "In 2016, on-road transportation was the largest emitter of greenhouse gases in Toronto. According to the 2017-2018 TransformTO update, emissions from the transport sector come mainly from passenger vehicles (79%), followed by commercial vehicles (20%) and other modes (1%).(29)
- The operation of residential, commercial and institutional buildings emitted roughly the same amount of greenhouse gases. According to the 2017-2018 TransformTO update, over half of building emissions came from residential buildings (51%), with the remainder attributed to commercial & institutional buildings (36%) and industrial buildings (13%). It is encouraging to note that Toronto has made significant progress in reducing emissions from building operations in recent years (dropping from 14.5 mtCO2e in 2004 to 7.9 mtCO2e in 2017). In Toronto's buildings, emissions from natural gas are more than 16 times the emissions associated with electricity use.(30)
- Despite Toronto's achievements in reducing the emissions associated with the operations of buildings, the emissions embodied in construction methods and materials are largely unknown. According to United Nations Environment figures, buildings and the construction sector accounted for 39% of energy and process-related CO2 emissions in 2018, and 11% of this was attributable to the manufacturing of building materials and products such as cement, steel and glass.(31) TransformTO's GHG emissions targets are based on local emissions from operations.(32) TransformTO recognizes the importance of lifecycle/embodied emissions and is beginning to study them as part of the longer-term program implementation. The Toronto Green Standard update will consider embodied emissions, as will the Existing Buildings Emissions Strategy which is under development. With significant construction underway in Toronto, and the demolition of existing structures to make way for new ones, the lack of data on the emissions embodied in Toronto's building materials currently inhibits the sector from becoming more circular and less carbon intensive.
- Solid waste generated in the city was also a significant contributor to greenhouse gases in 2016. According to the 2017-2018 TransformTO update, over 97% of this is attributable to emissions of methane and other gases from decomposing landfill waste, with the remainder coming from wastewater treatment.(33)
- In terms of energy use, it is worth noting that Toronto's emissions are mainly due to natural gas (7,466 ktCO2e), followed by gasoline (4,856 ktCO2e), methane (1,492 ktCO2e), diesel (789 ktCO2e) and then electricity (462 ktCO2e).(34)

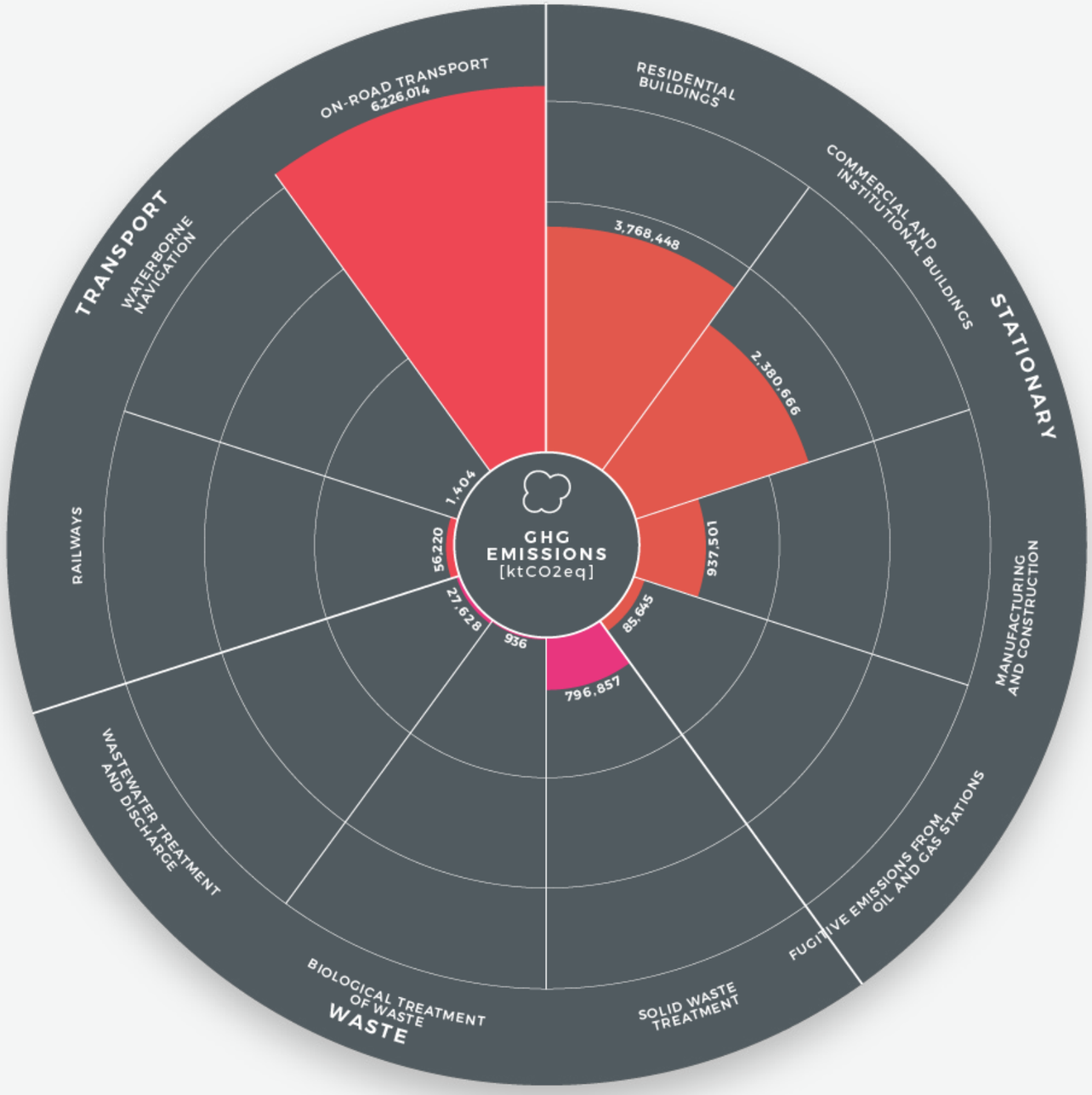

Figure 5: Breakdown of CO2 Equivalent Emissions per sector for Toronto in tCO2e (2016) [Source: C40 Cities]

* Note: The sector classifications for this analysis are slightly different to those used above, as Toronto-level emissions data was not available per NAICS sector.

RESIDENTIAL SOLID WASTE*

Key Observations:

- Ontario-level data indicate that the bulk of Toronto's solid waste is likely to be generated by Industrial, Commercial and Institutional (IC&I) activities. This waste is typically collected by private sector contractors, and information on the volume and composition of this waste is not well documented, and it has not been aggregated for Toronto. In Ontario, IC&I waste (including construction and demolition waste) equates to roughly 1.5 times the waste generated by the Residential sector. Of the IC&I amount, around 83% ends up in landfill due to low diversion rates.(35) The low diversion rates and lack of data on private sector waste collection in Toronto represent significant barriers to achieving a circular economy in the city.
- Toronto's residential waste is well managed and great strides are being made to divert as much as possible from landfill. Approximately 756,749 tons of residential waste was collected in 2019, of which around 53% was diverted.(36) The breakdown of Residential wastes is shown above.
- In residential areas, waste separation and diversion from landfill is influenced by the type of dwelling, with single family homes achieving 64% diversion, and multi-residential achieving just 28% diversion in 2019.(37) Approximately 60% of multi-residential dwellings have their waste collected by the City of Toronto, leaving approximately 40% of multi-residential buildings in Toronto having their waste collected by private waste haulers.(38) It is worth noting that the diversion rates for Toronto as a whole may differ from the diversion rate achieved by City of Toronto's integrated waste management system, as some residential buildings use private waste collection services, and their figures are not included in these calculations

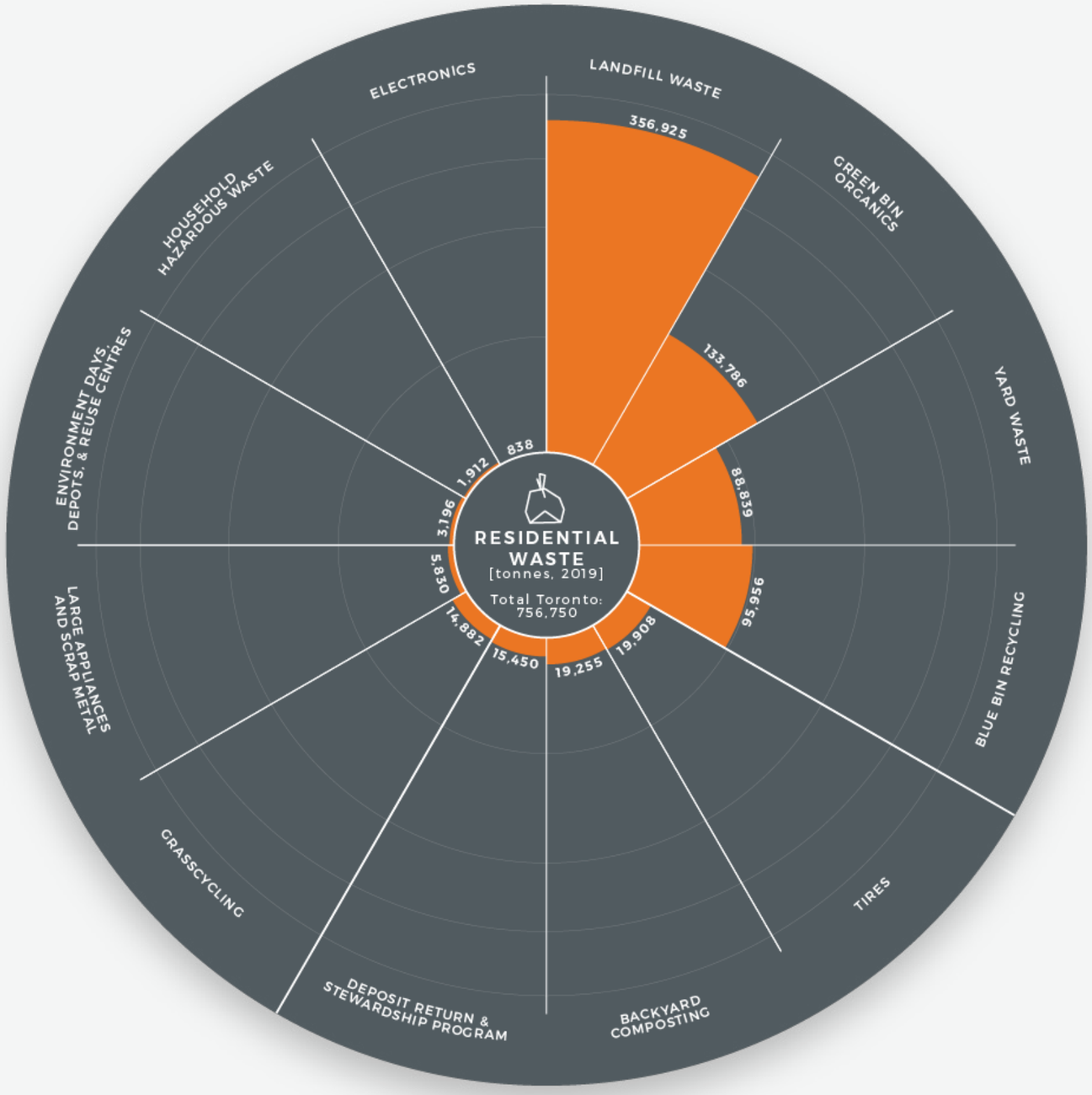

Figure 6: Characterisation of Residential Wastes collected by the public sector in Toronto (2019) [Source: City of Toronto]

* Note: It was not possible to show waste generated by each sector as Toronto-level waste data was not available per NAICS sector.

THE ROLE OF SECTORS IN ACCELERATING A CIRCULAR ECONOMY

Based on an analysis of the sectors that contribute the most to GDP, employment, greenhouse gas emissions, and solid waste generation in Toronto, the following have been identified as potential focus areas for more in-depth investigation in terms of building a circular economy:

Construction

Construction and demolition of buildings has a significant impact on emissions, and presents numerous opportunities for a more circular management of construction material. Little is known about the carbon embodied in the city's building stock, and new projects tend to favor brand new carbon-intensive cement and steel towers.(39) In the process, the inherent value of building components is diminished or lost, and demand for new materials (and the energy, water, minerals and other resources required to manufacture and transport them) increases. Construction is a noteworthy contributor to the city's GDP, and there is significant potential to build on the momentum of the Toronto Green Standard, Green Building Certifications and other measures to encourage more circular resource management.

Solid waste (from IC&I sectors)

Solid waste from the IC&I sectors contributes significantly to Toronto's greenhouse gas emissions, and is more likely to end up in a landfill than is the case with residential waste. The collection of this waste typically falls outside the city's control, but is a symptom of Toronto's linear economy that warrants further investigation and intervention if the city is to transition to a circular economy. Approaches like industrial symbiosis can help to connect waste producers with other industries or companies who might use it as a feedstock, thus helping to reduce overall waste volumes sent to landfill and associated greenhouse gas emissions.

Transportation

Transportation is the single largest contributor to greenhouse gas emissions in Toronto. While there is limited scope to use waste as a resource in this sector, the transition to non-motorised transport, shared transport and clean propulsion methods present opportunities for new business models and innovations that, along with planning and zoning reforms, could significantly reduce the (predominantly airborne) wastes associated with transportation. This sector typically falls outside circular economy strategies due to limited scope for circular actions, the time required to make shifts in the mobility system, and the specialist knowledge of spatial planning, zoning etc. that is required to shift incentives and change patterns of urban development. The shift toward lower carbon mobility is part of Toronto's Official Plan, and work is already underway to transition the city toward lower carbon mobility systems (as evidenced in TransformTO and the Resilience Strategy). In Toronto's case, transport may be a lesser priority for its circular economy efforts at this point in time.

1.2 LOCAL BUSINESS AND COMMUNITY INITIATIVES

Assessing the landscape of local business and citizen initiatives in the city provides important insights on the degree to which circular economy activities are already underway. Looking at which sectors these initiatives are most active in, what kind of approaches are most used, and what plans for future growth are mentioned, indicates where momentum and innovation might exist. It also provides insight into the tangible impacts the initiatives have already achieved, and where there could be potential for further scaling.

The table below summarises the results of a desktop review of business and citizen initiatives within the Greater Toronto Area. The researchers expanded the scope to the GTA level as the intention of the analysis was to capture a broad set of initiatives across different sectors, such as manufacturing, that may not have a large presence in the City itself. Individual sectors have been aggregated into six main groups in an effort to better visually communicate the results in a table. It should be noted however that this list is non-exhaustive, but illustrates initiatives that have an online presence or have been previously documented in other studies.(40)

The table indicates the total number of initiatives that were identified in the review. The initiatives are organised by the sector (rows) that they belong to, and the main approach (columns) that is used. The approaches taken by the initiatives are categorised using Circle Economy's DISRUPT framework.(41) The DISRUPT framework is a set of seven key principles, which is the result of mapping the various terms and definitions used by over 20 organisations working on the topic, in an effort to achieve a shared language around what constitutes the concept of the circular economy. Each initiative that has been identified in this review is represented by one of the seven key elements that most appropriately describes its core concept. Nudnik, for example, is a kidswear brand that makes clothing from entirely off-cut fabrics. The most appropriate element from the DISRUPT framework would therefore be "use waste as a resource", whereby Frogbox (reusable moving boxes) would correspond to the element "preserve and extend what is already made". The two rightmost columns indicate the total number of initiatives per sector, and the degree to which those initiatives have published plans for growth or expansion, such as a new location. It should be noted that this last column is only indicative of the information that was retrievable from the internet, and expresses the percentage of initiatives that have clearly indicated growth or expansion plans.

SECTOR	1. DESIGN FOR THE FUTURE	2. INCORPORATE DIGITAL TECHNOLOGY	3. STRETCH THE LIFETIME	4. RETHINK THE BUSINESS MODEL	5. USE WASTE AS A RESOURCE	6. PRIORITISE REGENERATIVE RESOURCES	7. TEAM UP TO CREATE JOINT VALUE	NUMBER OF ACTIVE PROJECTS RECORDED	PLANS FOR GROWTH/ EXPANSION
Professional and technical services	1						3	4	25%
Trade and tourism	1	1	2	15	5		1	25	44%
Construction and real estate	6				1			7	28%
Agriculture and material extraction				1				1	100%
Utilities and waste management	1		4	2	6	1	2	15	53%
Manufacturing			3		5			8	50%
Community		1	3	3	2		13	27	63%
TOTAL	**9**	**2**	**12**	**21**	**19**	**1**	**19**		

Table 2: Scan of business and community initiatives in the Toronto CMA, categorised by the seven key elements of the DISRUPT framework.

RESULTS OF BUSINESS AND COMMUNITY INITIATIVE SCAN

Based on the search results a total of 88 initiatives have been recorded that contribute to circular economy goals across different parts of the economy. Although this is not an exhaustive list, at a high level it does show a large number of efforts, organised in different ways at different scales, all attempting to support the circular economy through resource efficiency, waste reduction, and sustainable production and consumption. Some key highlights of the results include:

- Of the 88 initiatives, 60 are business initiatives. Breaking down the type of organisations leading the different initiatives, about half are for-profit businesses, with the remainder being divided about equally between social enterprises and not-for-profits.
- The Trade and Tourism category holds the majority of initiatives aside from those that are community-led. These mostly include retailers of consumer goods and services, as well as food vendors and grocers. Thirteen of these businesses have incorporated new business models such as delivery and take-back, leasing, and repair services. Five businesses have used waste products as a resource including packaging, plastics, and spent grain and other forms of food.
- There are 15 initiatives within the utilities and waste management category, mostly focusing on using biomass waste as a resource, either through processing for agriculture applications or biogas generation. There are a handful of waste avoidance and recycling initiatives that specifically aim to divert usable materials and products from landfill, such as electronics, furniture, and other household goods.
- The manufacturing category contains a number of initiatives that focus on the reuse of recyclable content in products, or extending the functional lifespan of waste materials such as electronics, packaging, apparel, and home furnishings through repair and refurbish activities. The construction category has a similar number of initiatives, but focuses much more on designing for the future, by incorporating modularity and design-for-disassembly principles in buildings, or by using high energy efficiency and passive building methods that ensure long lifetimes with minimal operational costs.
- There are a total of 28 community-led projects, with about half having set up collaboration models with local businesses and other organisations that redistribute food or unused items, share knowledge and skills within the community, and promote zero-waste and sustainable consumption practices to the public at large. A handful of community initiatives have combined repair activities with a variety of lending, sharing, and pay-what-you-can models to promote greater accessibility to products and services within the community.
- About half of all the initiatives that have been recorded here have explicitly mentioned plans for growth or expansion. Community initiatives show the strongest growth, which could be explained by the fact that these are mostly volunteer-based networks that have few barriers for expansion. However, the categories of Trade, Manufacturing, and Energy and waste management report that about half of all initiatives will expand in the future. This demonstrates that circular economy principles can make economic sense for businesses, and that there is a receptive market for circular economy value propositions like end-of-life take-back schemes.
- In terms of the distribution across the seven categories of the DISRUPT framework, about three quarters of all initiatives focused on circular business models, extending the lifespan of things already made, and collaborating to create joint value. Take-back schemes or other forms of lifetime extension like repair and refurbishment are most prominent. Using waste as a resource and incorporating digital technology like apps have been particularly useful tools for connecting waste producers, collectors, and potential remanufacturers and driving secondary material marketplaces. Several initiatives, particularly in the construction sector, also incorporated the principle of designing for the future, such as modular building products, climate adaptive structures, or plans for advanced waste collection and separation.

ROLE OF LOCAL BUSINESS AND COMMUNITY INITIATIVES IN ACCELERATING A CIRCULAR ECONOMY

While it is difficult to accurately compare between cities, the number of initiatives found in Toronto is comparable to Amsterdam, which recorded a total of 77 projects in 2018, that involved over 100 local businesses.(42) While there are many differences between these two cities, the initiatives recorded in Toronto are present across a wide range of sectors and community activities, showing that residents and businesses alike are engaged in topics like waste avoidance, resource efficiency, sustainable consumption across sectors and use a wide variety of approaches.

Community initiatives

Community-led initiatives make up a significant portion of all initiatives and indicate that there is a good level of awareness among residents around key topics like waste and sustainable consumption across areas like consumer goods, packaging, and food. Community initiatives focus heavily on collaboration with other groups, with a common aim to improve access to resources within communities, and extending product life times through activities like repair. This also signifies a collaborative relationship between communities and businesses, that could be a key asset in further scaling circular economy efforts in Toronto.

Trade and tourism

Trade and tourism are by far the most active sector in adopting circular economy principles. This is understandable as retail trade in particular is a highly consumer-facing sector. The number of circular economy initiatives in this sector indicates that there is a receptive local market for circular economy offerings, whether that be products with recycled content, packaging-free concepts, or leasing and rental services. It also shows that some residents are willing to adapt their consumption behaviours to accommodate new business models like take-back schemes and repair services, as an example. The trade sector is in a strategically important position to communicate the circular economy narrative, further develop circular business models and offerings, expand the local customer base, and work with both government and other businesses to understand key barriers for scaling.

Construction and real estate

“Construction and real estate”, “Manufacturing”, and “Utilities and waste management” are three sector groupings that each have a high number of circular economy initiatives, and form complementary or symbiotic roles with one another. Each sector manages high volumes of materials, but influences how these materials are managed in different ways. Construction initiatives focus mostly on designing for resilience, modularity, and adaptiveness, while Energy and Waste management initiatives focus on waste collection, diversion, and material and energy recovery. Manufacturing initiatives mainly focus on repair and reuse. Each sector has in some instances successfully incorporated digital tools (i.e. apps and online platforms for second-hand goods) to aid in recovering materials. Given the volume of materials and the complementary focus of each of the three sectors, there could be a key opportunity to integrate these initiatives across the Greater Toronto Area to create a single secondary materials marketplace with an ecosystem of remanufacturing, circular design, and industrial symbiosis activities. Digital tools could enable this ecosystem by matching supply and demand of waste materials, and coordinate between warehousing and material processing activities that lie outside of the city.

4 Household analysis

To understand how the general public can play a role in accelerating the transition toward a circular economy in Toronto, it is important to look at household consumption as part of the broader landscape analysis. A high-level analysis of data from households in Toronto (Census Metropolitan Area) was conducted, looking at consumption patterns and their environmental impact.

We examine the average expenditure (in $CAD) by Toronto households on common goods and services, as well as the ecological footprint (in Global Hectares)(43) of those goods and services. The data for this analysis was collected at the Toronto Census Metropolitan Area (CMA), which is the closest geographical scope to the City of Toronto itself. When contrasted with average household expenditure data at Provincial and National levels, the researchers can determine the overall consumption patterns of the city, and begin to glean insights on how urban lifestyle choices may differ from suburban or rural ones. (44)

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The Toronto Census Metropolitan Area contains just over two million households according to the 2016 national census, and an average of 2.71 residents per household.(45) The average (median) household income in Toronto in 2017 was $98,174, which is $4,507 lower than the national average,(47,48) however the average household expenditure was just over $71,000 CAD per year, which is about 6% higher than the provincial average and 11% higher than the national average household expenditure. (46) Toronto is also noted to have the highest income inequality in the country. Between 1999 and 2016 the net worth increased by $2,100 for the bottom 20% of the population versus more than $600,000 for the top 20%.(49) 46% of all housing in the City of Toronto are rentals, and approximately 43% of renter households pay more than 30% of pre-tax income on rent.(50)

LARGEST CONSUMPTION CATEGORIES

- The average household in the Toronto CMA spends the largest share of money on housing every year, just over $24,000. That is equivalent to 34% of total annual expenses.(51)
- Following closely behind housing, about $12,000 per year is spent on transportation. This equates to about 17% of total annual expenditure, of which 83% is spent on private vehicle operations, and only 17% is spent on public transportation services. (52)
- Just over $9,000 is spent on food every year, which represents about 13% of total expenditure. Following closely behind food expenses are operational costs associated with housing ($4,500), clothing ($4,300), and recreation ($3,700).

Differences in expenditure compared to provincial and national averages

- When household expenditure data at the Toronto CMA level is compared across provincial and national averages, a few key differences stand out. The category with the single largest difference is 'Education'. Torontonians pay 50% and 86% more for education than the provincial and national averages, respectively. This is a substantial difference, but could be explained by the higher density of private schools from kindergarten to high school, as well as a larger concentration of higher education institutions throughout the metropolitan area.(53)
- While transportation is the second highest expenditure category overall, Torontonians only spend about 87% of what Ontarians and Canadians pay on average. A key difference can be noted in expenditure on public transport; Torontonians spend 36% and 56% more on public transport than the average Ontarian or Canadian, respectively. This is certainly due to the higher density and variety of public transport options, relative to the rest of the province.
- Expenditure on housing in Toronto is about 17% higher than the provincial average, and 30% higher than the national average. A key difference can be seen in rental housing however, with Torontonians paying 31% and 42% more than the provincial and national averages.

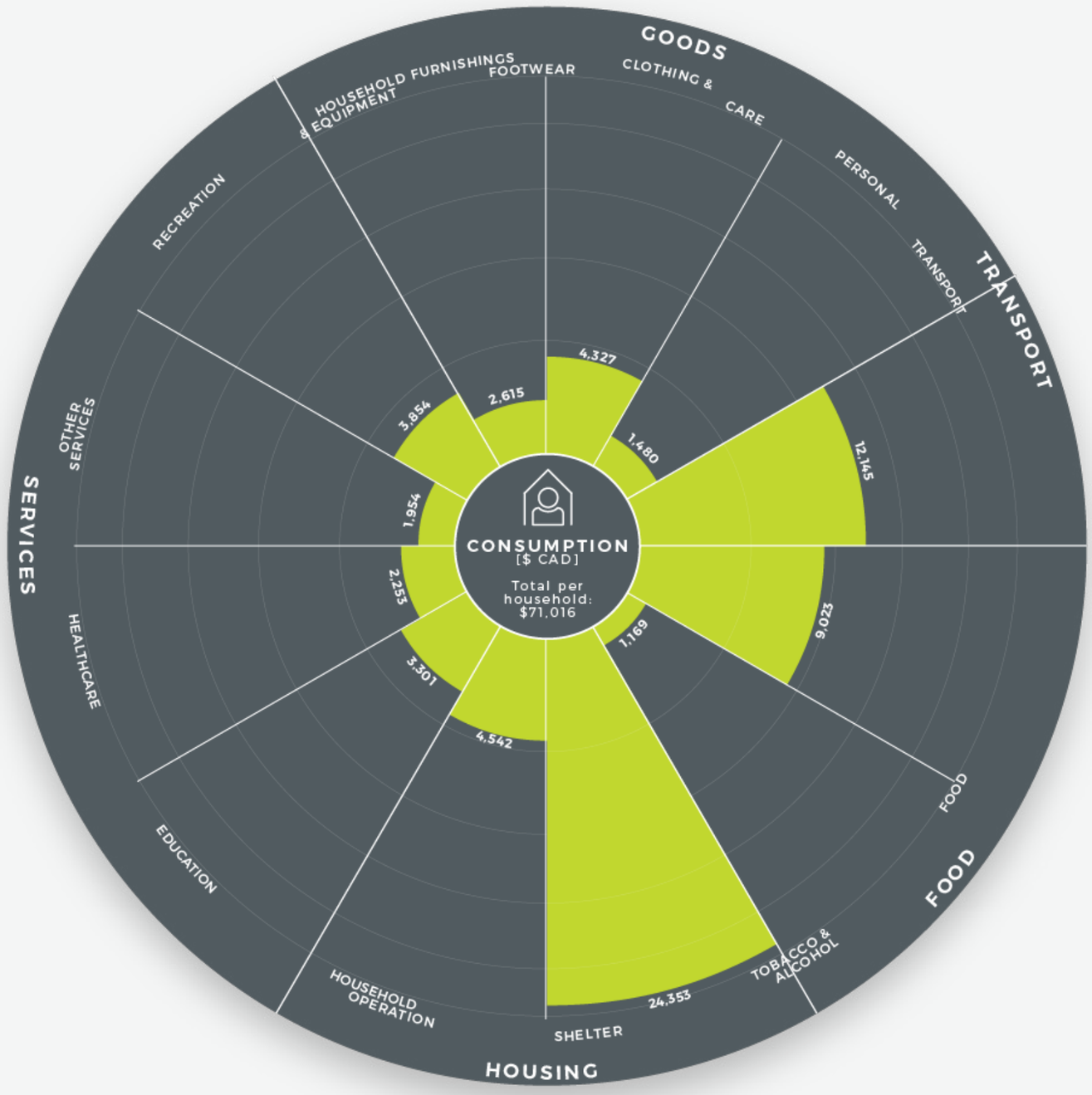

Figure 7: Average expenditure of Toronto (CMA) households across functional consumption categories (2017) [Source: Statistics Canada]

HIGHEST CARBON FOOTPRINT CATEGORIES

A second part of this analysis is an environmental impact assessment of household consumption. The researchers have assessed environmental impact using a carbon footprint calculation.(54) This approach was selected due to a lack of reporting data using the unit of 'tonnes CO2-eq', but also for greater communicability and comparability. A carbon footprint is a widely accepted standard set by the Ecological Footprint Network. It translates tonnes of carbon dioxide into the demand placed on biological capacity, measured in terms of the total area (global hectares), required to sequester these carbon emissions. A carbon footprint calculation puts the magnitude of emissions into a meaningful context; simply put, the total area of land required to absorb the carbon generated through the consumption activity. Carbon footprint calculations have recently been completed at both the national and provincial levels.(55) Figure 6 illustrates the carbon footprint for Toronto CMA households, however some of the consumption categories have been aggregated relative to Figure 5.(56) The key findings have been summarised below:

- The total per capita carbon footprint of a Torontonian is approximately 2.8 gha per capita, which is on-par with the global average per capita footprint and comparable with other Canadian cities like Winnipeg, Montreal, and Vancouver. This is slightly higher than the average Ontario per capita footprint (2.3 gha)(57,58) but significantly lower than many other Canadian cities such as Calgary (7.5), Edmonton (6.4), and Halifax (5.8). The Canadian average per capita carbon footprint is approximately 3.6 gha.(59) The key variable in determining these figures is the composition of the local energy grid mix. Because Toronto has a large share of hydro and nuclear power, this plays the largest role in driving down the carbon footprint score.(60)
- The consumption category with the single highest carbon footprint is transportation, at about 3.8 gha per household. Despite high household expenditure on public transport, transportation stands out as the most carbon-intensive consumption category for Toronto, due to the high consumption of fossil fuels. Toronto's transportation footprint is on-par with that of Ontario, but is below most cities and the Canadian average.
- Household operations, such as the provision of electricity and heat make up 80% of the total Housing (1.1 gha) category. While this appears as a relatively large category overall, Toronto's footprint from housing is about 400% smaller than other cities such as Calgary, Edmonton, and Halifax. (61) This score is highly dependent on the local energy mix, where Ontario uses a significant portion of non-fossil based energy sources relative to other cities.
- Services make up about 0.97 gha per household, with the highest scoring sub-categories being Education and financial services. This high score reflects Toronto's higher household expenditure on education. Food and goods both score about 0.78 gha per household, with the highest scoring sub-categories being meat and animal products for food, and clothing, personal care products, and recreational products for goods.

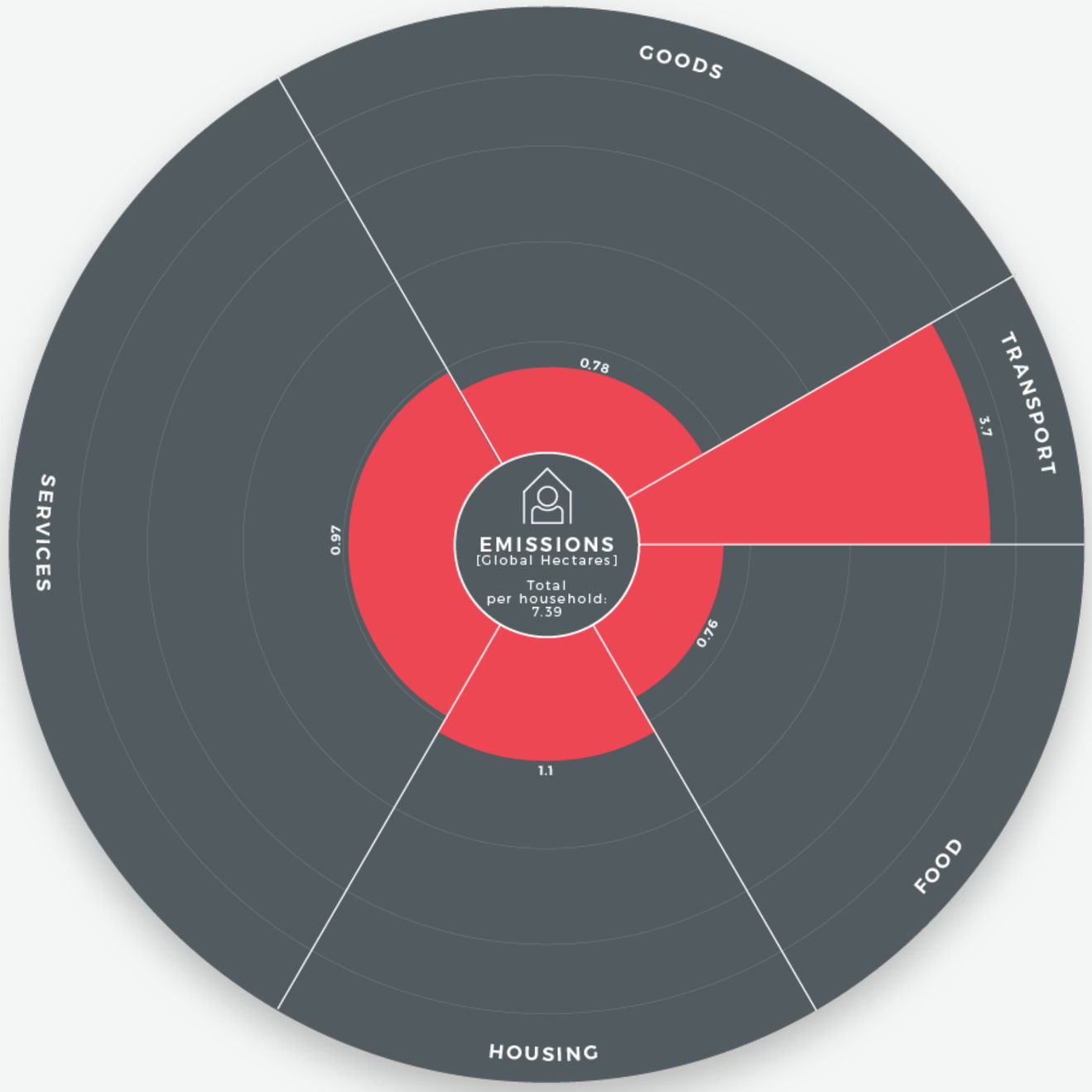

Figure 8: Carbon footprint of Toronto CMA households across functional consumption categories (avg 2010 - 2015) Source: Isman et al.

ROLE OF HOUSEHOLDS IN ACCELERATING A CIRCULAR ECONOMY

This section reflects on the role that households play in Toronto's transition to a circular economy. Some of the expenditure and carbon footprint data that was gathered for this analysis can be compared with national or provincial averages, or directly with other Canadian cities. Based on the relative performance of Toronto households, the researchers aim to glean insights to better understand the ways that households and household activities could help or hinder the acceleration of the circular economy in Toronto.

Transportation

Transportation has the highest carbon footprint (3.8 gha) and the second highest (17%) total expenditure for Toronto households. Despite having substantial public transport infrastructure, use of personal transportation contributes about 70% of the total carbon footprint and 83% of total expenditure in the transportation category. This is clearly an area with a high potential to reduce both environmental impacts and costs to households. This shows that residents in Toronto (and commuters in the greater Toronto area) have a very strong reliance on personal vehicles, which is a clear hindrance to achieving a circular and low carbon economy. Approaches that boost vehicle occupancy and electrification will incrementally reduce the carbon footprint score, however to achieve a truly sustainable mobility system requires deeper systemic interventions. Addressing systemic factors like accessibility to public transport services, urban planning and urban morphology, car and ride sharing, expanding cycling and walking infrastructure, and minimising long-distance commuting would all need to be explored as part of a transition to a circular economy.

Household operations

Household operations, which is a sub-category referring mainly to energy utilities, make up a relatively small portion ($4,500) of total household expenditure, but hold the second highest carbon footprint (about 0.87 gha) next to transportation. This is due to the use of fossil fuels, namely natural gas, for heating and electricity.(62) It is worth noting that Toronto's carbon footprint for household operations is significantly lower than many other Canadian cities due to the high proportion of non-fossil based energy sources in its energy mix.(63) Non-renewable sources still make up about 30% of total energy consumed, indicating a key barrier for achieving a circular low-carbon economy. Initiatives like the Zero Emissions Building Standard and the Toronto Green Standard go a long way in addressing building energy efficiency, however broadening the scope of that work to include circular economy principles could generate opportunities for the city in future construction activities. For example, maximising the installed capacity of decentralised renewable energy technologies and alongside renewable or recycled materials for building retrofits and renovation projects could improve specific building footprint scores. Utilising waste heat for district heating, integrating energy storage, and microgrids(64) could generate positive outcomes at the neighbourhood or district level. At a city level, promoting stricter criteria and standards for building, deconstruction and urban development could present an opportunity to integrate circular economy principles throughout the culture and practices of the local construction sector at large.

Food and beverages

Food and beverages represent a sizable portion (13%) of overall household expenditure, while also representing a relatively large carbon footprint (0.76 gha). Toronto scores on-par with other Canadian metropolitan areas in terms of footprint and expenditure. However considering the environmental and social impacts associated with food that extend beyond the carbon footprint, the high rate of food waste across Canada,(65,66) and the role that individual behaviour can play in addressing many of these impacts, focusing on the sustainable transformation of the local food system would be an important part of a circular economy strategy in Toronto. Currently there are about 20 community and business initiatives that already address the topic of food, while at the same time the socio-economic analysis highlights both the significance of the organic waste waste stream and the lack of waste data in the ICI sector, such as restaurants, cafes, and hotels for example. Building on the successes of current initiatives and tackling key "blind spots" like the ICI sector could go a long way in accelerating a local circular food system and generate substantial environmental and cost benefits.(67)

Consumer goods

Consumer goods If clothing, household furnishings, personal care products, and recreational products are aggregated under the umbrella of "goods", the total carbon footprint adds up to 0.78 gha, which is about 11% of the total household carbon footprint. A number of these consumer goods, namely electronic devices, clothing, and appliances and equipment are responsible for key environmental impacts beyond carbon emissions(68,69) and contain high residual value (components or materials) when disposed of. The researchers have shown that retail trade is a key sector in the local economy, employing about 12% of the City's workforce, and currently engaged in about 25 circular economy initiatives, with an additional 18 community-led initiatives on the topic of waste reduction and sustainable consumption. Focusing on consumer goods shows a high degree of potential to reduce environmental impacts, and promote a narrative of sustainable consumption and production by building on the wide range of local initiatives that have already succeeded in implementing circular economy solutions.

3 Policy analysis

This section is intended to produce a high-level insight into Toronto's current priorities related to circular economy themes. Due to the large number of policies contributing toward individual circular economy goals, the researchers identified common themes reflected in multiple documents, and connected these to the most affected or influential sectors in the economy. This helps to generate a quick overview of where policy "blind spots" may exist, and where sectors are strategically important in driving the transition towards a circular economy.

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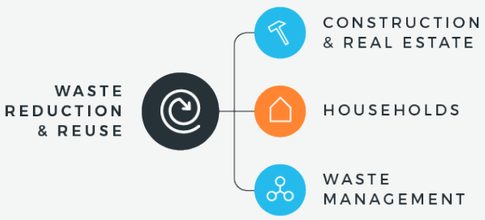
3.1 MUNICIPAL POLICY LANDSCAPE

Policies and goals provide an insight into the future of a city. During the February workshop, participants suggested Toronto policy and strategy documents that capture the city's overall priorities or relate in some way to circular economy. These documents were reviewed, and a subset was chosen from which to identify themes common to multiple documents.(70) The thematic keywords presented in the table below indicate topics that are deemed important by Toronto. They provide a qualitative indicator of where political will and momentum may be found, and can help to guide circular economy approaches in the city. In summary, the city's priorities include:

Waste reduction and reuse

The Long-Term Waste Management Strategy (2016) refers to promoting waste reduction, providing sharing and reuse opportunities and focusing on the multi-residential sector where opportunities for greater diversion exist. It also commits to finding new markets and uses for waste and looking at other leading practices and social research to reduce waste. The Circular Economy Procurement Implementation Plan and Framework (n.d.) aims to develop an evidence-based and measurable circular procurement policy for the city. The Toronto Food Strategy (2018) identifies "Food Systems Waste and the Circular Economy" as a short-term priority. A strategy for reducing single-use and takeaway items is currently under development.

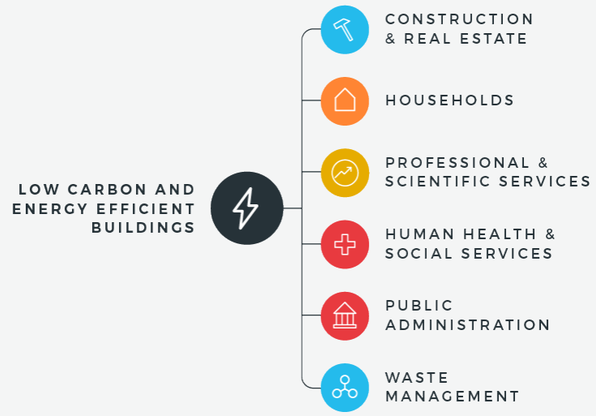


Neighbourhood level sustainability

Transform TO (2017) and Toronto's Resilience Strategy (2019) both refer to actions to reduce emissions and improve resilience at the level of neighbourhoods, as subsystems of the city. The Resilience Strategy states community action to improve the resilience of neighbourhoods as one of its ten goals.

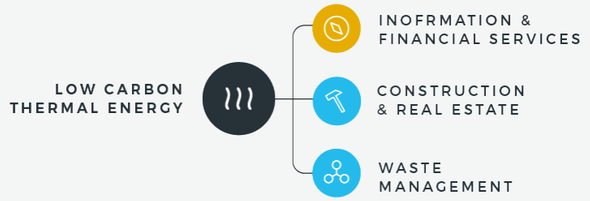
Low carbon and energy efficient buildings

Transform TO (2017) and Toronto's Resilience Strategy (2019) both refer to building-level actions to mitigate and adapt to climate change. Toronto's Official Plan (2019) policies support and encourage innovative energy producing options, including advanced energy conservation and efficiency technologies and processes that contribute towards an energy neutral built environment. The Toronto Green Standard (2018) implements the environmental policies of Toronto's Official Plan. All new development must address a set of sustainable performance measures, including reducing energy use and greenhouse gas emissions for new low rise, mid-high rise and city-owed buildings.



Low carbon thermal energy

The Zero Emissions Buildings Framework (2017), a background study completed for the Toronto Green Standard 2018 update, mentions that Toronto is accelerating the implementation of low carbon thermal energy systems to reduce building emissions, and that 30 potential networks have been identified. The connection of new buildings to district heating or cooling is incentivised through the performance-based Toronto Green Standard, Tier 2 (2018) as a core requirement.

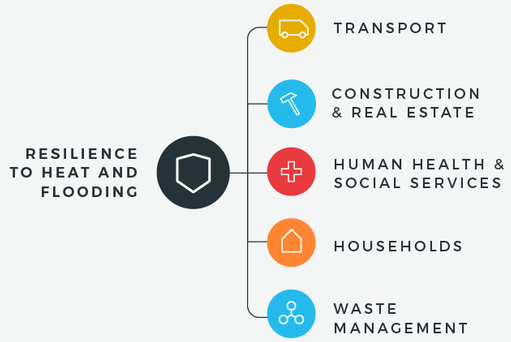


Increased mobility options

Transform TO (2017), the Official Plan (2019) and Toronto's Resilience Strategy (2019) all refer to expanding the range of mobility options to make citizens less dependent on private motor vehicles. There is a particular focus on affordability, reduced transit time and safety of mobility options. The city aims for active transportation to constitute 75% of trips under 5km, and for 100% of transportation options (including public transport and private vehicles) to use low or zero-carbon energy sources by 2050.

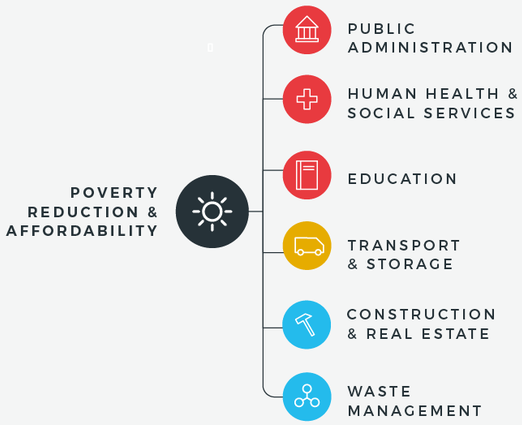
Resilience to heat and flooding

The Official Plan (2019) and Toronto's Resilience Strategy (2019) refer to the need to build resilience to extreme heat and flooding events linked to climate change. The Resilience Strategy specifies that buildings and infrastructure need to be designed to be low carbon and resilient to a changing climate.



Poverty reduction and affordability

Transform TO (2017) and Toronto's Resilience Strategy (2019) both include in their goals the protection of the interests of the poor and most vulnerable, and to eliminate poverty. The Long-Term Waste Management Strategy (2016), Official Plan (2019) and Resilience Strategy (2019) speak of the importance of ensuring that homes and services like waste collection and mobility are affordable to facilitate broader access.



ROLE OF MUNICIPAL POLICY IN ACCELERATING A CIRCULAR ECONOMY

Together, these documents show that the city has high sustainability ambitions, and is translating these into suitable policies and strategies that lead to action on the ground. Many of the common themes (e.g. waste reduction and re-use) are aligned with those of a circular economy, but the process also highlighted some areas of opportunity relating to circular resource use. These were as follows:

Waste diversion in IC&I sectors

The Long-Term Waste Management Strategy (2016) aims to achieve "70% diversion of materials collected (Green Bin, Blue Bin, garbage) from Industrial, Commercial & Institutional customers that receive City collection services by Year 10". The Strategy focuses on those who receive City collection services, and as a result does not capture significant volumes of waste produced by non-City customers that are likely to continue to go to landfill. Another aim is to divert "an additional 50,000 tonnes from sources currently not serviced by the City", but this seems to focus mainly on multi-unit residential buildings and small IC&I players, rather than large IC&I waste generators. Goal 7 of TransformTO (2017) is to divert 95% of waste from all sectors by 2050, but the proposed indicators only look at residential diversion rates. Improving measurement of IC&I waste and increasing diversion rates by large IC&I players seems to be an area that would benefit from additional attention. Addressing waste generated by actors that do not use the City's services presents a challenge for the City of Toronto, as this may be considered beyond its scope of duties or outside its authority, and may require alternative sources of financing to the utility rate model that currently funds its waste management planning and policy activities. However, there is potential to influence change by connecting large industry players to share data, educating them on options and technologies available for resource re-use, establishing zones and infrastructures that facilitate industrial symbiosis, creating demand for re-used content from local suppliers through procurement guidelines etc.

Non-residential food waste

In terms of food waste, the Long-Term Waste Management Strategy (2016) aims to reduce the amount of food going to green bins, and to process that which is collected via state-of-the-art anaerobic digestion facilities, generating both green energy and high-quality compost. The food waste reduction strategy focuses on households, but does not seem to consider other sources of food waste. The Toronto Food Strategy (2018) mentions that Solid Waste Management Services is developing a food waste reduction strategy which includes promotion and education efforts. A new work stream has been created called "Food System Waste" to encompass not only food waste from consumers, but also at other levels like production, supply and distribution. Food Systems Waste and the Circular Economy were identified as themes for 2019, but it appears that this is still under development and has potential to form a significant part of the city's circular economy efforts.

Digital industries

In reviewing the policy and strategy documents, there was very little mention of digital products and solutions as a means of supporting more circular resource use in the city. With a strong IT sector, Toronto has the potential to become a world leader in collaborations with local businesses to address resource and waste challenges in new ways, for example gathering local data or developing new business models that facilitate resource sharing (e.g. online marketplaces for second hand goods).

4 Conclusions

4.1 TORONTO'S CURRENT LANDSCAPE

The landscape analysis was conducted to achieve a shared understanding of Toronto's current situation, including the character of its local economy, policy context, consumption behaviours and existing circular economy initiatives. When brought together, this information helps guide an informed discussion on where there may be opportunities or barriers for driving the transition toward a circular economy. This section summarises the key take-aways from the previous sections on the document and offers commentary on where the key opportunities and barriers lie.

The Information and Financial Services sector may not seem particularly relevant to realising a circular economy, but is in fact a crucial asset for the City in enabling and accelerating the transition.(71) Information, Financial, and Professional Services are all top contributors to the City of Toronto's economic value and employment. While this is common to most urban centres in developed countries,(72) in Toronto, growth in these industries is likely to continue in the future, as these sectors showed the highest job growth rate in 2019. Toronto's Information Technology (IT) sector in particular is already being leveraged to facilitate resource sharing and waste minimization through a variety of initiatives in other sectors (e.g. online resource trading platforms and apps). Furthermore, Financial Services are also key enablers in developing and scaling circular business, financing, and contracting models across multiple sectors. Given the critical enabling role of this sector in a circular economy, its high degree of specialisation in the city, and its expected growth rate in the future, its role should be considered wherever possible in steps to formulate circular economy strategies and plans.

The fact that Toronto's Solid Waste Management Services has embraced circular economy thinking in much of their work, including a number of ambitious waste management policies found in the Long-Term Waste Management Strategy and TransformTO, stands as a strong signal of ambition to both residents and businesses alike. This alone creates a strong enabling environment in the city, however achieving the goals of waste avoidance and diversion requires accurate monitoring of the flow of resources in Toronto. The researchers have found that very little data is available about waste flows within the IC&I sector, yet it is estimated that IC&I waste (including construction and demolition waste) is approximately 1.5 times the volume of residential waste.(73) Further, about 83% of the IC&I waste ends up in landfills. This lack of transparency is a key barrier in achieving a circular economy, and additional efforts should be made to encourage the sharing of data and transparent oversight.

The topic of mobility stands out multiple times in this analysis, mainly through its contribution to GHG emissions. Transportation represents a major expense and the largest carbon footprint category for Toronto's households, and on-road transportation contributes to nearly half of all of Toronto's emissions. The current mobility system in Toronto is a significant barrier to achieving both a low-carbon and circular economy. While the City of Toronto is currently developing a strategy towards a more sustainable transportation system through its different policies, circular economy principles could be incorporated to support a broader mobility strategy that focuses on optimising systemic resource efficiency through optimised urban design and behavioural incentives to boost 'access-over-ownership' models, for example.

The topic of construction and the built environment shows a high potential for adopting circular economy practices at scale. The massive resource-intensity of the sector, its importance to the local economy, and its expected continued growth rates as the city expands and renews its built environment in the decades to come, make a compelling argument to develop an ambitious roadmap for circular construction. Focusing on this sector could generate significant impact reductions, considering the embodied emissions associated with extracting and manufacturing construction materials, and the fact that these materials are typically landfilled rather than reprocessed and reused.(74) There are also clear practical starting points. Seven circular economy initiatives within the sector are underway in the GTA, and there are numerous opportunities for small scale pilot projects throughout the city, including a $1.3-billion investment over the next 10 years to repair 58,000 social housing in Toronto. (75)

The potential for remanufacturing seems to be high, considering the relatively large amount of manufacturing industries active in the Greater Toronto Area (GTA). Ontario reports the highest concentration of manufacturing activity in Canada, especially concentrated in the production of consumer goods (i.e. clothing, household furnishings and equipment, food and beverages, etc.), plastic packaging, paper, and metal for the automotive industry. (76,77, 78) Residents of the City of Toronto are key consumers of these products, which contribute a substantial part of their environmental footprint. The largest number of circular economy initiatives that the researchers have recorded focus on consumer goods, showing that there is good momentum and engagement between business and communities to expand and scale much further. Exploring circular models for manufacturing and consumption within the GTA could offer a significant opportunity to boost innovation and competitiveness, while also reducing numerous impacts to the environment.

4.2. SELECTING PRIORITY AREAS

As a next step in the project, three priority areas will be selected for deeper research in the form of material flow analyses. These will allow the researchers to uncover greater detail and insight on the resource flows in each priority area, and the associated impacts, like value loss or embodied carbon emissions. This level of analysis is necessary to generate evidence-based recommendations for circular economy approaches that address those impacts.

In the researcher's previous work with cities, priority areas have often been decided based on the following:

- Where can visibility and awareness be built? What projects could the City quickly develop that build awareness, engage the local business community, and test practical circular economy approaches. Relevant priority areas might include food waste and circular agriculture, or household consumption and expanding reuse and repair of consumer goods.
- Where are some 'quick wins' to address the biggest impacts? What are some of the biggest impacts that can be addressed, like embodied carbon, pollution, value loss, or waste directed toward sub-optimal destinations? Relevant priority areas might include construction, durable consumer goods, waste management, manufacturing.
- How could strategic priorities be further reinforced? What new perspectives could a circular economy bring to Toronto's current policy goals and ambitions? Relevant priority areas might include household consumption patterns, industrial waste reuse and construction material recycling.

The researchers have offered their own recommendations on which three sectors should be selected for the purpose of developing a material flow analysis. The final recommendations described below should be seen as an input to a broader conversation with the City of Toronto, and the project team is encouraged to use the insights from the landscape analysis to draw their own perspectives on what Toronto should prioritise.

Construction:

As previously discussed in Section 3, the construction sector is important in achieving a circular economy due to its prominence throughout the city, its expected future growth, the massive throughput of materials, and its impact on emissions and waste. Some businesses in the sector are involved in a number of initiatives that explore circular economy approaches like design for modularity and disassembly, showing a good potential for innovation. The researchers believe that gaining a clearer and more granular understanding of the material flows within this sector will help the City of Toronto better assess how and where the biggest steps can be taken to accelerate the circular economy.

Waste management from sources not serviced by the City:

Waste management is at the centre of many of Toronto's circular economy efforts, and there are a number of ambitions to achieve the goal of 'zero waste'. Data on waste however, particularly non-residential and construction waste is not well known or recorded. As this sector has such a pivotal role in achieving a circular economy, the researchers recommend that a material flow analysis is conducted to better understand the 'metabolism' of waste from non-City serviced sources and what data gaps persist.

Consumer goods

Consumer goods such as personal care products, household furnishings and equipment, and textiles together represent about one quarter of average household expenditure, have relatively high environmental footprints, are associated with a significant amount of packaging, and have good potential for high value applications and lifetime extension. A broad range of initiatives exist in Toronto that aim to divert waste and shape more sustainable consumption behaviour. Further exploring the flow of consumer goods, in and out of households could help build a quantitative understanding of the size of opportunities to accelerate circular business models and boost resource recovery.

4.3. NEXT STEPS AND TASKS FOR TASK 3

In the following research task (Task 3a: Material Flow Analysis) the three priority sectors selected by the City of Toronto will be analysed in more detail. Material flow analyses will be conducted for these sectors to provide deeper answers and insights into the following areas:

- Origins and destinations of materials, specifically what fractions of material resources are either produced and disposed of locally or imported/exported abroad. Greater insight into other relevant cross-border activities provided the geographical position of Toronto (e.g. exports of solid waste to the USA) will also be provided where relevant.
- Material sub-fractions that are flowing through each area, how material resources are transformed, and where value loss occurs.
- Waste production and management, and opportunities for greater value recovery through the application of circular economy principles.
- An assessment of environmental and social impacts associated with material flows (to the extent that data is available), including greater detail on the GHG emissions associated with materials, building on the analysis presented in this document.
- A more detailed exploration of where circular economy strategies could be pursued, reflecting on what existing initiatives in the city are already underway or established.

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Glossary of terms

Carbon Dioxide Equivalent

A carbon dioxide equivalent or CO2 equivalent (CO2-eq) is a metric measure used to compare the emissions from various greenhouse gases (GHG) on the basis of their global-warming potential (GWP), by converting amounts of other GHGs (e.g., methane, nitrous oxide) to the equivalent amount of carbon dioxide with the same GWP.

Census Metropolitan Area (CMA)

A CMA is an area consisting of one or more adjacent municipalities situated around a major urban core. As defined by the Canadian national statistical agency, CMAs must have a total population of at least 100,000, of which 50,000 or more live in the core.

In Toronto, the CMA is often called 'Toronto Region'. It includes the City of Toronto, as well as other 14 neighbouring municipalities (i.e. Mississauga, Brampton, Markham, Vaughan, Richmond Hill, Oakville, Ajax, Pickering, Milton, Newmarket, Caledon, Halton Hills, Aurora, Georgina, Whitchurch-Stouffville, New Tecumseth, Bradford West Gwillimbury, Orangeville, East Gwillimbury, Uxbridge, King, Mono, Chippewas of Georgina Island First Nation).

Circle Economy's DISRUPT Framework

To define a common language for the circular economy, Circle Economy has mapped the various terms and definitions used by over 20 organisations working on elements of the circular economy concept. After interpreting and grouping these various terms, seven key elements (coined the DISRUPT framework) emerged to define seven main aspects that are part of the concept and definition of circular economy. The seven elements are:

1. Design for the future
2. Incorporate digital technology
3. Stretch the lifetime
4. Rethink the business model
5. Use waste as a resource
6. Prioritise regenerative resources
7. Team up to create joint value

Circular Economy

A circular economy is an economic system that aims at reducing the need for resource extraction by enabling the use of existing resources, re-using materials, retaining value of products in use for longer, and minimizing the creation of waste, pollution, and carbon emissions. The term encompasses 7 concepts (coined the DISRUPT framework), and its use widely varies depending on the problems being addressed, the audience, or the lens through which the author views the world.

City of Toronto

The City of Toronto is the provincial capital of Ontario, Canada. It is the most populous municipality in Canada, with a total population of 2,956,024 people.

Greater Toronto Area (GTA)

The Greater Toronto Area (GTA) is a Canadian metropolitan area consisting of 25 adjacent suburbs and exurbs, grouped into 5 municipalities: The City of Toronto, Durham, Halton, Peel, and York.

Consumption-based emissions

A Consumption-based approach to measuring emissions allocates the emissions to consumption (for example: either by an individual, household, or nation) Emissions therefore calculate the emissions from material extraction, processing, manufacturing, trade, etc. of goods and services. (This is also commonly referred to as a carbon footprint). This is different than Production-based emissions, which instead allocate emissions to domestic production activities, regardless of whether it is to serve domestic or overseas markets.

IC&I waste

The acronym IC&I refers to Industrial, Commercial and Institutional sectors. Waste management services for IC&I sectors are not managed by the city, and are instead managed by private companies. Data around the volumes, diversion rates, and final destinations of IC&I waste are difficult to find and validate, due to the lack of reporting requirements from waste management companies.

Industrial Symbiosis

The Ellen McArthur Foundation defines industrial symbiosis as local partnerships that can make circularity more accessible via the share and reuse of resources to create a shared value (i.e. exchanges of energy, water, and materials in closed loops across industries). The purpose of industrial symbiosis is to create loops of technical or biological materials while minimising the leakage and waste in the loops.

Material and energy metabolism

A resource (including material, energy, water resources) metabolism refers to the study of how physical resources flow and transform within a given geogrpahical scope; often a city in the case of an "urban metabolism". The metabolism concept draws its analogy from biology, with the aim of better understanding and optimising how resources are produced, processed, consumed, cycled or ultimately wasted and destroyed within a system.

Service-producing Industries

The North American Industry Classification System (NAICS) defines the Service-Providing Industry as the super sector group that consists of:

- Trade, Transportation, and Utilities (NAICS 42, 44-45, 48-49, 22)
- Information (NAICS 51)
- Financial Activities (NAICS 52,53)
- Professional and Business Services (NAICS 54-56)
- Education and Health Services (NAICS 61, 62)
- Leisure and Hospitality (NAICS 71,72)
- Other Services (except Public Administration) (NAICS 81)
- Government

Technical Services

This sector comprises establishments that specialize in performing technical activities for others, such as specialized design, computer, and technical consulting services, among other activities that require a high degree of expertise and training.

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