Circular Solutions for CRD Waste in Toronto

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Keywords:
circular economy, construction renovation and demolition waste, waste management, systems thinking, systems change, sustainable growth

***CONSTRUCTION, RENOVATION, AND DEMOLITION WASTE** (CRD) in the city of Toronto goes largely unmonitored and unregulated. As the city rapidly continues growing and changing more as the COVID-19 Pandemic has impacted the way people use and need space, there will certainly be no slowing of the amount of CRD waste produced. With a changing market, population, and changing individual needs, many opt to renovate or demolish and start new, all the while creating waste. This waste is often overlooked in conversations of green building and sustainable growth. In an effort to understand the problem, this project examines the current policy framework that Toronto's CRD waste system sits within, from federal to municipal. Throughout the project, visuals such as graphs, charts, infographics, maps, and diagrams are used to clearly communicate and quickly show complex concepts to bring an understanding of the system, problems, and solutions to a broader audience. This project emphasizes mapping and other visualization techniques to clearly identify, illuminate and explore existing barriers in the current system, possible future solutions, and identify leverage points for creating change and moving towards a circular economy for construction, renovation, and demolition waste in Toronto. Graphic analysis and information design curates and communicates a large body of research from across the world.

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CIRCULAR SOLUTIONS FOR CONSTRUCTION, RENOVATION, AND DEMOLITION WASTE IN TORONTO

By

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in

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CIRCULAR ECONOMY SOLUTIONS FOR CONSTRUCTION, RENOVATION, AND DEMOLITION WASTE IN TORONTO

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ABSTRACT

The city of Toronto is growing and changing rapidly, ever more now with the impacts of COVID-19 on the way people use and need space. With changing markets and needs, many opt to renovate or demolish and start new, all the while creating waste. This waste is often overlooked in conversations of green buildings and sustainable growth. This project uses systems mapping and visualization techniques to illuminate and explore existing barriers, possible solutions, and identify leverage points, in order to move towards a circular economy for construction, renovation, and demolition waste in Toronto. Visualizations illustrate the policy framework which influences Toronto's construction, renovation, and demolition waste (CRD) landscape, and explore strategy documents and processes produced by the City of Toronto. Inspiration for recommendations is drawn from policies, markets, and communities around the world.

Key words: circular economy, construction renovation and demolition waste, systems thinking, systems change, sustainable cities, sustainable, sharing economy, re-use remanufacturing and repurposing, waste management

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DEDICATION

To those who are working to make this world a better place for the future. This of course includes my brilliant classmates, friends and family. Thank you to Dave for motivating me and taking me for walks.

WHAT IS THIS PROJECT ABOUT?

The Project

- *Circular Solutions for CRD Waste in Toronto*
- *Limitations*
- *Contents*

Circular Solutions for CRD Waste in Toronto

The City of Toronto is constantly growing and evolving, even more now with the impacts of COVID-19 changing the way that people use and need space (Verma & Husain, n.d.). With changing markets and needs, many property owners opt to renovate or demolish and build new homes, all the while creating tonnes of waste, which is largely unmonitored or measured. This kind waste is often overlooked in conversations of building green, resilient, sustainable growth where energy conservation and reduction of toxic materials take centre stage. Though reducing operational energy needs and striving towards net-zero, as well as healthy buildings and toxic-free environments is integral to building a sustainable future, the waste and emissions produced by construction, demolition, and renovation of buildings needs to be included in the conversation. In Canada, CRD waste is classified as non-hazardous waste; hazardous waste is classified based on its flammability, toxicity and corrosivity (Canada, n.d.-b, n.d.-a). Though CRD waste is not an imminently hazardous kind of waste, it can contain dangerous chemicals that are harmful to humans and the environment if they are not managed properly (Canada, n.d.-b).

Often, the public discourse around carbon footprints and waste reduction or elimination focuses on consumer level goods much like the fashion industry(Berg et al., n.d.),beauty products (Bailly, 2020)and food related emissions and packaging (Marquis, 2021). This project aims to take inspiration from the success of bringing these sustainable future focused conversations to the fore, to shine a light on a less publicized form of waste; waste produced by construction, renovation, and demolition of residential homes in Toronto.

Planners work with a multitude of complex systems within cities. They strive to solve endless wicked problems and question not just what elements a system is comprised of, but what systems do, do not do, and could be doing to create significant change (Rittel & Webber, 1973). To understand the context, the housing market in Toronto is outlined and the current state of CRD waste in Canada is examined. In an effort to understand the problem, this project examines the current policy framework that Toronto's CRD waste system sits within, from federal to municipal, to better understand where missed opportunities and barriers may lie. Exploring successes seen in other cities across the world at each stage of the building life-cycle is matched with circular solutions and tactics. Throughout, visuals such as graphs, charts, infographics, maps, and diagrams are used to clearly communicate and quickly show complex concepts in an attempt to bring an understanding of the system, problems, and solutions to a broader audience. Visualization techniques clearly identify, illuminate and explore barriers in the current system, possible future solutions, and identify leverage points for creating change and moving towards a circular economy for construction, renovation, and demolition waste in Toronto. Graphic analysis and information design curates and communicates a large body of research from across the world.

Limitations

Looking at the entire system of construction, demolition, and renovation of properties, there are countless places where environmental impacts can be reduced. Driving industry to adhere to sustainable extraction practices, reduce fuel consumption by shrinking the distances that materials are transported, and develop buildings for operational energy efficiency all contribute to reducing carbon emissions and waste associated with buildings and urban development. This project specifically looks at understanding and curating solutions for the system in which waste is created by demolishing and renovating existing residential buildings in Toronto. The choice to focus on residential renovation and demolition waste reduction is informed by research published by the Canadian Council of Minister of the Environment (CCME), which finds that this type of waste makes up the largest portion of building related waste, even when compared to industry scale building waste. Though this project takes this residential renovation focus by adopting a similar life-cycle mindset at a larger scale, industrial waste can also be reduced through intentionally working towards circularity. Further focusing, this project dives deeper into the key phases where waste can be reduced before the buildings end of life, by exploring policy levers which seeks to regulate the amount of allowable waste at the approvals phase and looking at alternative material and product choices in the design phase.

Contents

WHAT IS HAPPENING IN TORONTO?

The Context

- *People and Houses*
- *The Real-Estate Market*
- *Construction, Demolition, and Renovation*

People and Houses

Metropolitan areas like the Greater Toronto Area (GTA) are consistently growing year over year. It is known that concentrating growth in dense urban centres is much more sustainable when compared to sprawling sub-urban development (Blais, 2010). The Ontario Growth Plan, which will be explored in more depth later, designates where growth should be focused. This focus is based on strategies, targets, and objectives which are intended to "promote economic growth, increase housing supply, create jobs and build communities that make life easier, healthier and more affordable for people of all ages" (Ontario, n.d.).

> *"Toronto's population is expected to grow by 1.03 million people between 2016 and 2041."*
>
> *– Toronto Housing Market Analysis, City of Toronto, 2019*

The province has identified four Toronto areas as growth centres with density targets to support this projected growth. The table below shows these targets, which all align with the municipal targets, within Downtown, North York Centre, Scarborough Centre and Etobicoke Centre (Neptis, n.d.). These locations were selected due to their access to public transit and the goal to improve the commute for many residents and spread density throughout the city, rather than just in the downtown core (Ontario, n.d.). Each of the Growth Centres has a Secondary Plan and the land within the Centre often has a

URBAN GROWTH CENTRE MINIMUM DENSITY TARGETS IN TORONTO

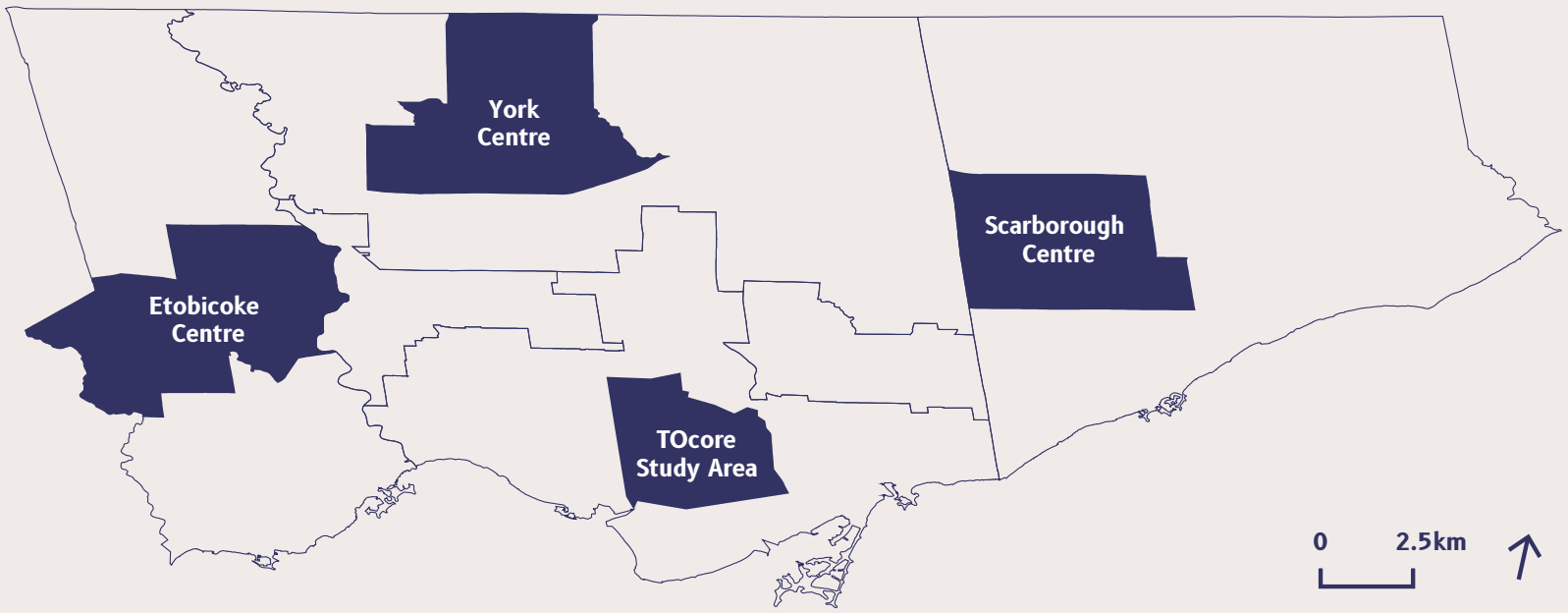
Urban Growth Centre Name	Area (ha)	2006 Density (people + jobs/ha)	2031 Growth Plan Density Target and Municipal Density Target (p+j/ha)	Increase in Population and Jobs (2006-2031) Required to Meet the Minimum Density Target (%)[1]
Downtown	2,120	280	400	43%
North York Centre	191	391	400	2%
Scarborough Centre	174	143	400	180%
Etobicoke Centre	165	131	400	205%

Source: (Neptis, n.d.)

Land Use Designation of Mixed Use (Mirabelli, 2017).

It is expected that Toronto's population will grow by 1.03 million residents between 2016 and 2041, and, according to the 2016 Census, there are 1,112,930 households in the city (Toronto Housing Market Analysis: From Insight to Action, 2019). Comparing these two statistics alone, it is clear that there must be more development to accommodate the nearly doubling demand for housing due to this increase in population. As demand for housing increases due to popula-tion growth, the market is becoming more and more expensive, and people are being priced out of the downtown core and drawn to the suburbs like Etobicoke and Scarborough (Simonpillai, 2021). According to the 2016 Census, Scarborough Centre and Etobicoke Centre's housing stock is comprised of 34% and 48% single-detached housing, respectively (Etobicoke Centre: City of Toronto Ward Profiles, 2018; Scarborough Centre: City of Toronto Ward Profiles, 2018). According to their profiles, these two wards had a combined 85,335 households in the same year. Most of the ground related dwellings (including single-detached and semi-detached homes) were constructed before the 1960's. This not only means that the existing housing stock is not sufficient to serve the future populations, but this also means that the infrastruc-ture is aging and will need repair or replacement and was designed to suit residents with much different lifestyles as compared to the current and future populations.

WHERE GROWTH IS DESIGNATED IN TORONTO



Map by the author, data sources:
City of Toronto. [2018]. Wards [Data file]. Retrieved from https://open.toronto.ca/dataset/city-wards/; City of Toronto. [n.d.]. Regional Municipal Boundary [Data file]. Retrieved from https://open.toronto.ca/dataset/regional-municipal-boundary/

The Real Estate Market

The COVID-19 pandemic has magnified the importance of way that that people use their space at home. With much of the workforce in Toronto now working from home and spending nearly all day, every day in the same building, people have had to find creative ways to adapt to their needs by adding home offices and shifting their possessions around their spaces. Many families are either home schooling or doing virtual school, turning their homes into classrooms. Spending more time at home and going out to eat less, or not at all, they are now cooking more at home. There is no doubt that people are looking for more flexibility in and different uses from their homes.

At the same time, with people spending this additional time at home with less entertainment and connection, many have found the time to renovate and finally tackle projects at home. Building supply stores have been open for curb side pick-up and in store shopping on and off. Contractors, let alone homeowners doing smaller projects, have had to spend an increasing amount of time searching for lumber supply (Armstrong, 2021). This is in part due to international borders being closed, reducing and slowing down delivery of supplies (Armstrong, 2021), and reduced lumber supply due to closed lumber mills in BC due to fires and pine beetle infestation, and temporary reductions in production due the COVID-19 pandemic and lockdowns (Healing, 2020). The demand and lack of supply this year has resulted in record high prices of lumber adding of anywhere between $5000-$30,000 to the price of building a new single-family home (Armstrong, 2021; Healing, 2020).

A survey published by RE/MAX in September 2020 found that:

> *“44% of Canadians would like a home with more space for personal amenities”.*
>
> *– RE/MAX, 2020*

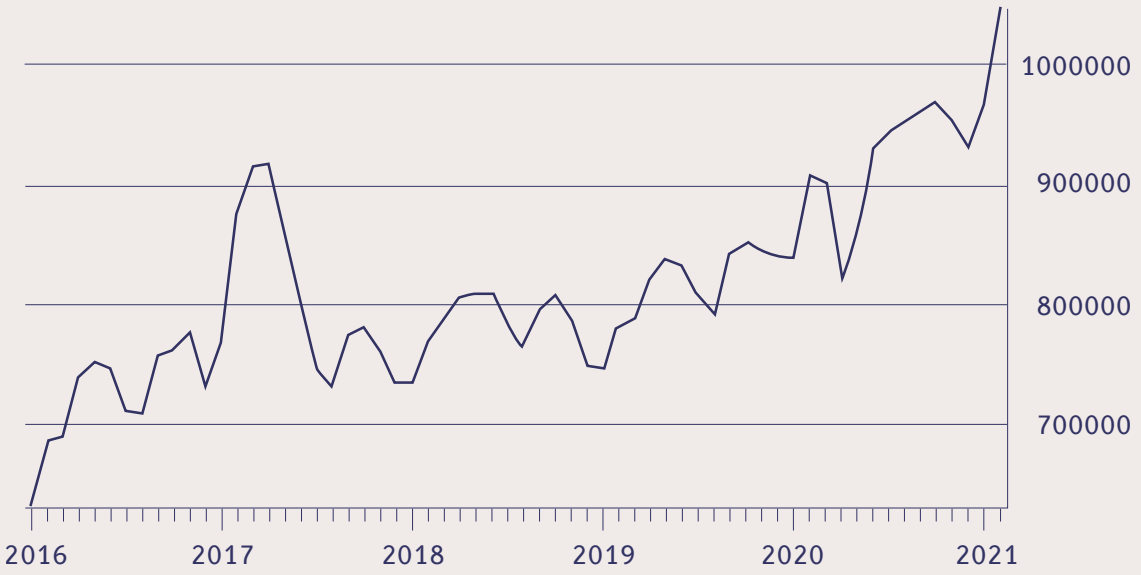
The combination of these factors, a lack of supply and an increased demand for housing due to long term population increases and the very present desire for more and different space at home, has created a seller’s market (Ireland, 2021). The average price for a Toronto property has now reached $1 million Canadian for the first time (“Toronto’s Average Property Price Tops C$1m for the First Time,” n.d.). Just in the last two weeks of March 2021, 9,148 homes were sold in the GTA according to the Toronto Regional Real Estate Board (TRREB).

Motivated by money, home-owners have been inspired to quickly renovate and sell their property for a much larger profit than imagined, otherwise known as ‘flipping’ (How Toronto Real Estate Is Shifting From ‘Fixer-Upper’ Flips To ‘Tear Down’ New Construction, 2019). Real-estate agencies like Royal Lepage have published lists of home renovation ideas and tips that ensure sellers will maximize profits. Homeowners can most efficiently increase their earning by renovating or

remodelling their kitchens ; it is claimed that renovating these rooms alone can potentially increase the selling price by up to 12.5% per room (Armani, 2020).

With such a competitive market, buyers are not guaranteed to find a property that suits their individual specific needs. Many buyers (and house flippers) are turning to a trend known as the 'teardown' to achieve more house (Rawcliffe, 2008). Buyers are purchasing cheaper properties for the land, knocking the existing house down and to rebuild a new bigger or more luxury home to their liking or to sell at a luxury rate (Tear Downs In Toronto: The Growing Trend Continues, n.d.). There is no doubt that there are many constantly changing factors that increase CRD waste across the GTA: housing demands are changing rapidly, resources and building materials are being bought up, and waste is being generated and will continue to be generated as these trends show no signs of slowing.

TORONTO'S AVERAGE PROPERTY PRICE EXCEEDS C$1M



Toronto's Average property price tops C$1m for the first time. [Average selling price C$]

Data source: ["Toronto's Average Property Price Tops C$1m for the First Time," n.d.]

Construction, Renovation, and Demolition

RENOVATION SPENDING

Considering the high rates of return on investment alone, it is no surprise that Ontarians spend $34.2 Billion or 61% of housing spending on renovations (Housing Report: COVID-19 to Dent Renovation Spending, a Vital Driver of Canadian Economic Activity, 2020). Of that 61%, 26.8 billion is spent on alterations, improvements and conversions, the remaining is spent on repairs (Housing Report: COVID-19 to Dent Renovation Spending, a Vital Driver of Canadian Economic Activity, 2020).

RENOVATION WASTE

In Canada, the main source of CRD waste is residential renovations. 61% of all CRD waste is residential, with the remaining it attributed to non-residential buildings which includes office and industrial structures (Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019). Of the residential CRD waste generated, 57% of that waste is from renovations (Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and

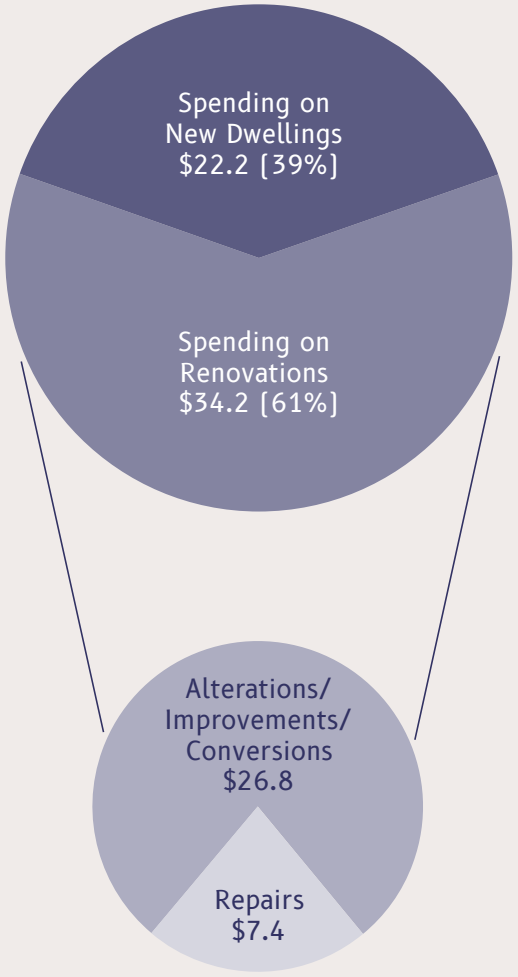
TYPES OF WASTE GENERATED FROM CRD

Building Stage	Residential	Non-residential	Total CRD waste
Construction	15%	5%	444,700 tonnes [11%]
Renovation	57%	32%	1,873,200 tonnes [47%]
Demolition	28%	63%	1,668,900 [42%]
Total amount of CRD waste	2,443,900 tonnes [61%]	1,562,800 tonnes [39%]	~4 million tonnes [100%]

Data from: [Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019].

RESIDENTIAL CONSTRUCTION SPENDING IN ONTARIO

$ Billions annually in 2019



Graphic adapted from: [Housing Report: COVID-19 to Dent Renovation Spending, a Vital Driver of Canadian Economic Activity, 2020].

From Materials to Landfill

CRD waste is often consolidated or all thrown into one big bin which is then picked up by private waste management firms like WM – Waste Management or 'Rid of It – Junk Removal'. Without separating and sorting the contents at the work site, these bins are hard to retrieve salvageable materials from without appropriate services at the Materials Recovery Facility(MRF) (Green Blue, n.d.). Without the participation of the waste generator or demolition crew, recycling and re-use of CRD materials does not work in practice (Green Blue, n.d.).

Based on a study of CRD waste in Canada, the waste generated from CRD is made up of, by weight, the materials shown here on this page. Though there are markets for salvageable materials, in many cases, there is a lack of education and awareness of how to deconstruct buildings, dispose of waste, and connections to markets for this waste (Green Blue, n.d.). Outside of studies like this, facilities are not mandated to publish their diversion rates and waste goes largely unmonitored.

KEY CRD WASTE MATERIALS

40%
WOOD

- 49% – Clean wood
- 23% – Engineered Wood
- 20% – Painted wood
- 8% – Treated wood

9%
DRYWALL

4%
CONCRETE

4%
PLASTICS

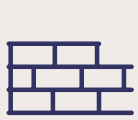
- Rigid insulation
- Carpet
- Other plastics

3%
METALS

10%
ASPHALT ROOFING

1%
CARDBOARD

29%
OTHER



- Aggregates
- Asphalt paving
- Bricks
- Ceiling tiles
- Equipment
- Fibreglass
- Paint
- Mixed glass (Windows, Mirrors etc.)

29%
ARCHITECTURAL SALVAGE

High Value Items:

- Steel and wood beams
- Plumbing fixtures etc.

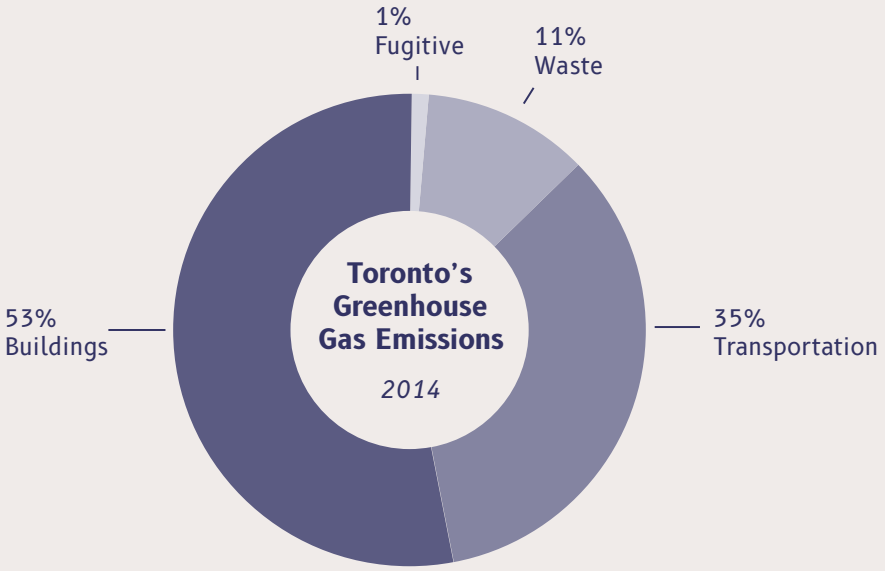
Graphic created by the author. Data from: [Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019].

WHAT IS THE IMPACT OF ALL OF THIS?

The Problem

- *The Climate Crisis*
- *Embodied Carbon*

The Climate Crisis



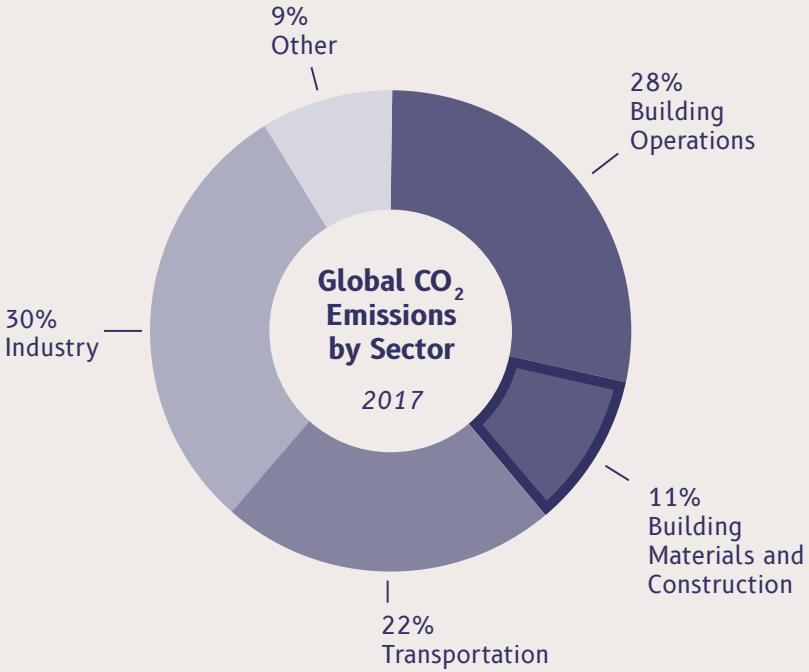
Data Source: [The City of Toronto Zero Emissions Buildings Framework, 2017].

GREEN HOUSE GASES

Not only in Toronto, but globally, societies are extracting, transporting, and disposing of valuable resources at an unsustainable rate (Special Report: Global Warming of 1.5 oC, n.d.). It has been known for decades that physical growth and dependence of extracting non-renewable resources cannot be exponential (Meadows, 1972). This continued practice contributes to the release of dangerous greenhouse gas emissions which result in climate change and the many deadly impacts that come along with it (Special Report: Global Warming of 1.5 oC, n.d.). The International Panel on Climate Change, IPCC, the United Nations' science body which assesses climate change, stated that global emissions must fall by 45 percent from the 2010 measurements by the year 2030 in order to prevent global temperature increases which are detrimental to human and other life (Hunziker, 2021; Special Report: Global Warming of 1.5 oC, n.d.). We are not on track to meet these emissions targets set by the IPCC. Human activity in urban centres, though it is becoming more energy efficient with increased awareness and application of things like passive house design reducing energy consumption and smart grid technology improving energy delivery efficiency, urban development is still incredibly wasteful and resource dependant (Simovic, 2019). Toronto's Green Building Standards(TGS) Version 3 has been largely focused on measuring and reducing greenhouse gas emissions caused by buildings, of which, 53% of Toronto's total GHG's are created by (The City of Toronto Zero Emissions Buildings Framework, 2017). This measurement however only factors the energy consumption performance that is required to operate these buildings, it does not encapsulate the GHG or carbon emissions that the building materials themselves make up. The TGS were last updated in 2018 (Toronto Green Standard, n.d.). With version 4 under development, there are opportunities to transition towards embodied carbon and crd waste reduction.

EMBODIED CARBON

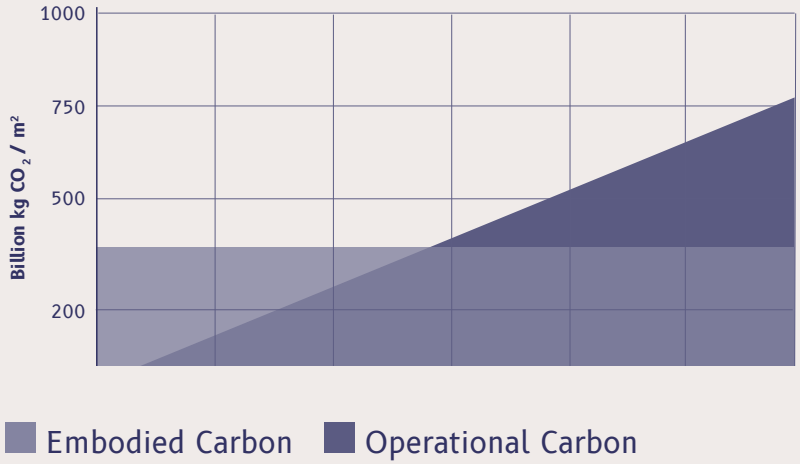
To understand the entire picture, it is important to measure embodied carbon. This is a scientific approach which factors in the



Graphic created by author based on data from [NEW BUILDINGS: EMBODIED CARBON, n.d.].

TOTAL CARBON EMISSION OF GLOBAL NEW CONSTRUCTION FROM 2020-2050

BUSINESS AS USUAL PROJECTION



Graphic created by author based on data from [NEW BUILDINGS: EMBODIED CARBON, n.d.].

lifecycle of GHG's a material or process generates from a wholistic view. It is a measure of the amount of Greenhouse Gases, including Co2, released during the whole lifecycle of a material, from extraction and manufacturing (Peck, n.d.). For example, a common building material such as steel begins its life at extraction. The various elements that make up steel, like carbon and manganese must be mined, refined and combined, to oversimplify. An embodied carbon measurement takes a complete lifecycle view of what it takes to bring buildings into existence, as compared to an operational view of emissions released as buildings are being used, through heating, cooling, and other energy consumption-based activities. This type of measurement widens the timeframe in which emissions are measured and examined and includes emissions from created by extraction, manufacturing/processing, transportation and assembly of every part of a building before it existed (NESEA Building Energy Boston 2019 Keynote-Carbon Drawdown Now, 2019).

LIFE CYCLE ASSESSMENT

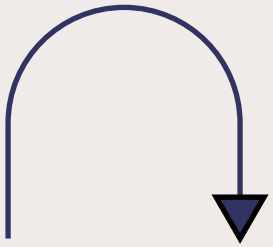
A life cycle assessment is a process, framed by ISO standards, that can be used to assess the environmental impact of a product or an entire building (Peck, n.d.). Each stage at which resources are consumed and emissions or substances are released is examined, beginning with natural resource extraction through to the final stage of a product's life (Peck, n.d.). Though LCA's are not the only method for measuring the entire start to finish embodied carbon and environmental impacts of a product, it is among the most common (Peck, n.d.).

HOW CAN THE CIRCULAR ECONOMY HELP?

The Solution

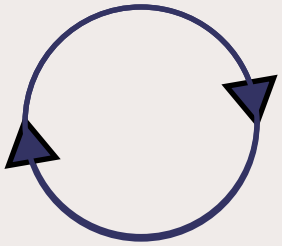
- *What the Circular Economy Is Not*
- *What the Circular Economy Is*
- *The Ellen MacArthur Foundation*
- *Sustainable Materials Management, Lund University*

The Circular Economy



WHAT IT IS NOT

The current economic model supports a linear take-make-dispose structure. Exponential consumption cannot continue within the bounds of our global resource reality and there are very real natural limits that are being ignored (Meadows et al., 1972; Rockström et al., 2009; Steffen et al., 2015). If we continue in the same linear way, we will run out of safe, useable resources, carbon emissions will soar, and our landfills will continue to fill and we will need to find other places to dispose of materials that are less 'away' than we like (Bocken et al., 2016).



WHAT IT IS

The origin of the concept of the Circular Economy(CE) cannot be pinned to one person or event, though it began to surface and gain traction in the late 1970's (Schools of Thought, n.d.). CE is an emerging concept seen as an alternative to the current linear economy(Cavaleiro de Ferreira & Fuso-Nerini, 2019). Waste and emissions are designed out of the system by 'slowing, closing, and narrowing material and energy loops. through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling (Florez Ayala & Alberton, 2020; Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019).

There are many schools of thought that fall under the umbrella of CE, including the cradle to cradle(C2C) concept. C2C is a design philosophy which adopts a biomimicry-like approach by positioning resources as nutrients which feed into the broader 'food chain' or ecosystem of matter(Benyus, 2008; Florez Ayala & Alberton, 2020; Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019); (McDonough et al., 2008). Eliminating the concept of waste, materials are designed to decompose or be deconstructed into their elements and absorbed back into a cycle where they will 'feed' the system, to be used again to create new things .

Discussion around the circular economy and its benefits has not fully saturated the North American market. Thought leadership and adoption of the concept on a systemic scale is more prominent in the UK and Europe, notably in the Netherlands, Scandinavia and Belgium (Alnajem et al., 2021; Korhonen et al., 2018) . Though, Canada is beginning to

[Graphics based on: 'Circular Economy framework' Nancy M. P. Bocken, Ingrid de Pauw, Conny Bakker & Bram van der Grinten (2016)

explore circularity at all levels of government (see the policy framework section starting on page 35). This movement comes at a time when the concept of Zero Waste (another school of thought that has ties to the circular economy) has gained traction in many communities thanks to the work of activist and environmental circles who have been working hard to get the government at many levels to ban single use plastics (Environment and Climate Change Canada, 2020). Due to a myriad of efforts and information, the Canadian government has now issued a ban of harmful single use plastics with a goal of zero plastic waste by 2030 (Environment and Climate Change Canada, 2020). A proposed order will be published to add 'plastic manufactured items' to the Canadian Environmental Protection Act, 1999 (CEPA). CEPA is one of Canada's key laws for protecting the environment and preventing pollution. CEPA now includes tools for addressing plastic pollution throughout different lifecycle stages of plastic items and will be updated to state that all have the right to safe and healthy environments (Taylor, 2021; The Canadian Environmental Protection Act, 1999 (CEPA 1999), 2017).

For significant economic transformation, a circular transition from the prevalent "linear economy" to a closed-loop model where a product is sold, consumed, collected and then reused, remade into a new product, returned as a nutrient to the environment or incorporated into global energy flows is needed (Giroux Environmental Consulting 2014, CCME, 2019). CE is rooted in taking a holistic view of a system and this kind of transformation relies on making connections, collaboration and communication to solve such a wicked problem; a complex social, organizational, and political system that requires multidimensional approaches and relationships to unravel (Ritchey, 2011).

Communication and dissemination of the Circular Economy can most often be tracked back to the Ellen Macarthur Foundation (EMF). Their work covers industry's and issues spanning from food, to plastic, to buildings, often partnering with large multinational corporations like Unilever, H&M, IDEO, and IKEA . The open-source publications the foundation produces provide inspiration through case studies, resources for learning circular basics through to application toolkits, videos in conversation with international subject matter experts, and so much more (The Ellen MacArthur Foundation, n.d.).

SUSTAINABLE MATERIALS MANAGEMENT, LUND UNIVERSITY

In an effort to share the knowledge and In an effort to share the knowledge and successes gained through implementing circularity, the University of Lund in Sweden, in partnerships with other institutions and research agencies, created the massive open online course (MOOC) called 'Circular Economy - Sustainable Materials Management' (Dalhammar et al., 2019; Peck, n.d.). The course covers deep dives on critical materials and extraction, circular business models, circular design and innovation, life-cycle assessment, circular policies and engagement (Peck, n.d.). Video lectures and case studies, curated literature, and skill-building tools and activities for applying circular thinking are all delivered by expert researchers and practitioners from across Europe (Peck, n.d.). Much of the foundational information and many research leads for this work began with course material and lessons from this MOOC.

WHAT IS IT LIKE NOW?

The System

- *Mapping and Visualization*
- *From Resources to Buildings*
- *Waste Hierarchy*
- *Stakeholder Mapping*
- *Policy Framework*

Mapping and Visualization

Systems thinking principles are rooted in challenging the underlying structure of a system by asking why a system exists the way it does, not just what the system does (Meadows & Wright, 2008). Donnella Meadows was among the preeminent thought leaders in the study of systems. She was also an environmentalist, founding the Sustainability Institute (now called Academy for Systems Change) in the mid 1990's (Staff, n.d.). She emphasized that systems change must begin with a vision for a sustainable future (Meadows, 1994). With this vision and an understanding of how a system work, the structure and behaviour of it, we can begin to shift the system (Meadows & Wright, 2008). Seeing a whole system requires understanding relationships and flows and understanding that the system is more than the sum of its parts (Meadows & Wright, 2008). Leverage points, or opportunities to create change and shifts, then become clear (Meadows, 1999). For example, when a building permit is required, the information provided to the applicant should include waste reduction resources. It is key to locate responsibility within the systems and to identify the consequences of decision making (Meadows & Wright, 2008). Peter Checkland's work in systems thinking, 'soft systems methodology', connects to decision making in real-life problematic situations which need improving (Checkland & Poulter, 2010). Visualizations of thinking, systems, data and concepts help to communicate complexity and bring understanding and common ground amongst diverse disciplines and have the potential to make information accessible to diverse audiences (Bamforth, 2011; Checkland & Poulter, 2010). For these reasons, this project brings in many visualizations of information and creates visual maps of systems.

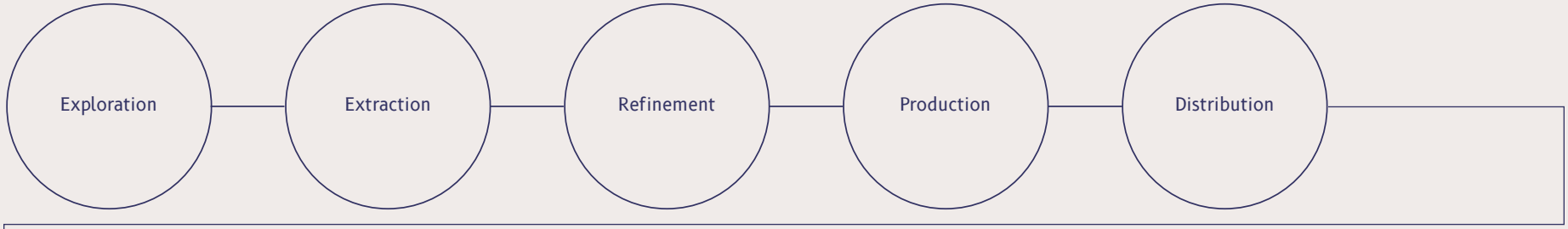
MAP THE SYSTEM

Map the System (MTS) is an international competition initiated by Oxford University in the UK which challenges students globally to think about social and environmental issues in a visual and systemic way (Map the System, 2020). As part of this challenge, Ryerson University's School of Social Innovation hosts a series of collaborative skill-building workshops and shares many resources developed internally, specifically to support students in creating a submission to MTS. Many of the tools and resources provided through the school have been used as a jumping off point and supportive community for developing the visualizations in this document (School of Social Innovation, 2020).

SEVEN GENERATIONS

Through the School of Social Innovations MTS workshops, the tie to Seven Generations thinking was made (Ryerson, 2021). System mapping cannot be discussed without acknowledging its ties to the seven generations model. This world view places each of us in the middle of seven generations of existence passed on from elders to be handed off to our children in order to build continuous community knowledge. "Sharing information and building collaborative ways of engagement are central to a seven generations model" (Jojola, 2013).

From Resources to Buildings

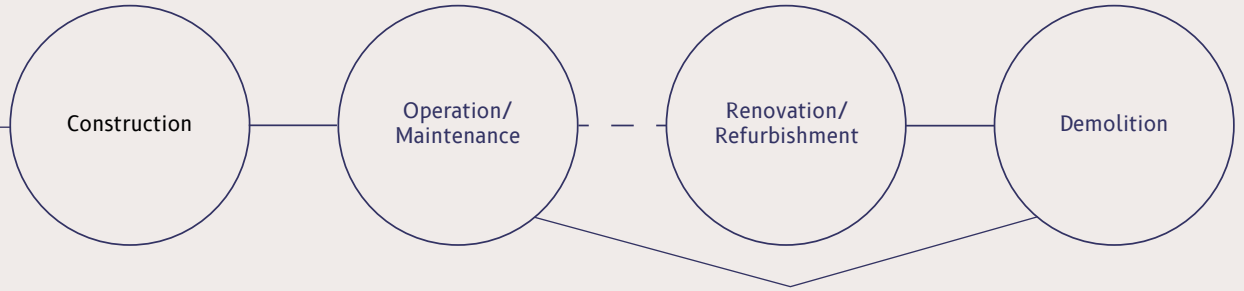


RESOURCES TO MATERIALS

Before a building exists, the materials that it is comprises of must find their way to the building site. The phases visualized above trace the common, high-level journey of how resources become brand new materials (Dalhammar et al., 2019; Peck, n.d.). GHG are emitted at each stage. First, a particular resource must be 'discovered' or located. Next, refinement, which typically refers to mixed resources that are extracted through mining processes. Often when elements are brought out from the earth, they are bound to many other materials and must be refined to produce more pure materials like copper, and alloys like steel (Peck, n.d.). Production takes raw materials and turns them into building materials like steel beams, wires, nails, and different types and sizes of lumber. Finally, to get these products to building sites, they must be shipped, stored, and sold through distributors.

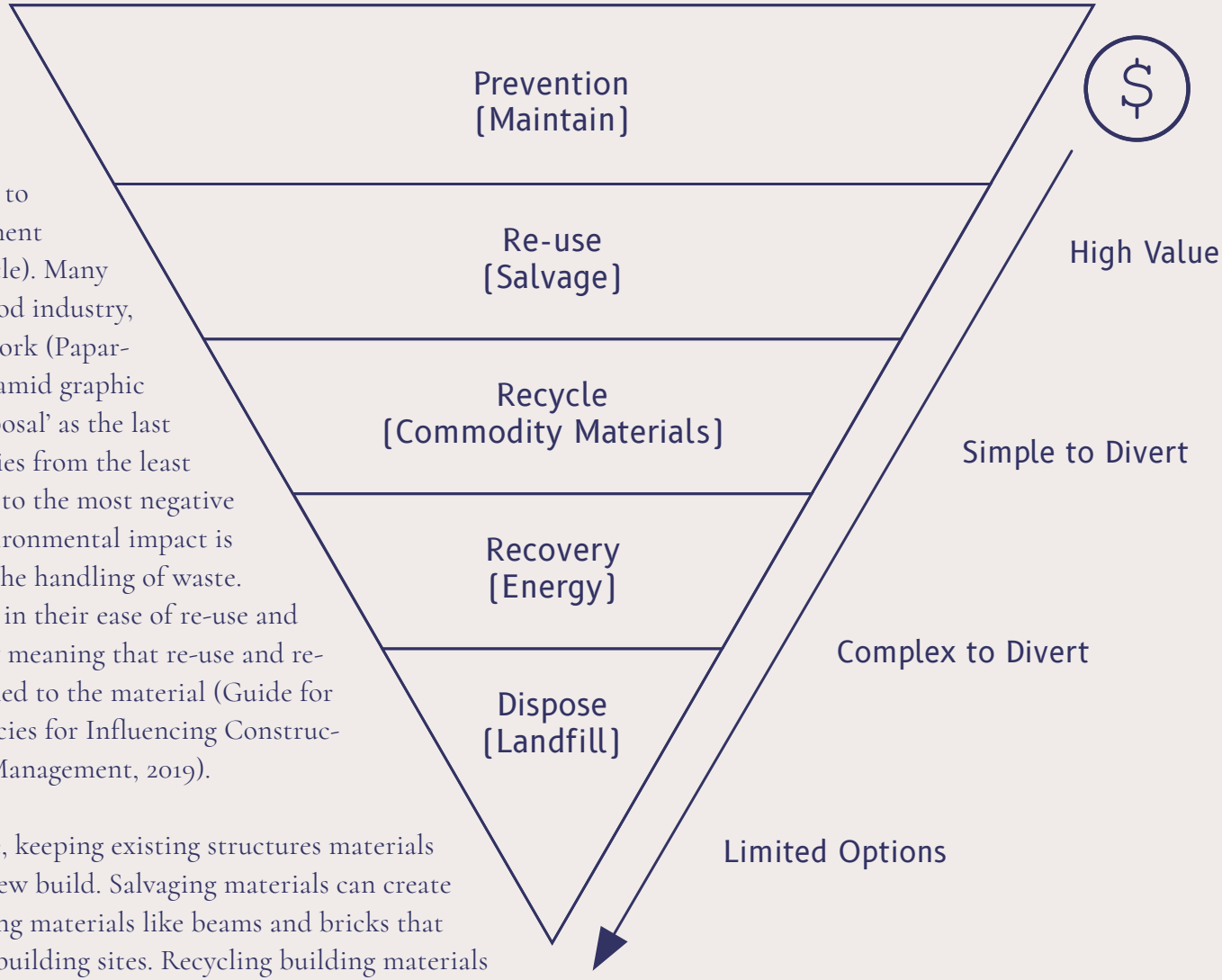
RESOURCES TO BUILDINGS

The typical linear building life-cycle can be distilled into these four basic phases. Many activities happen before construction including planning and design, which dictate the kind of building that is allowed on a site and the materials that will be used to construct a building. For the purposes of this visualization, the stages shown follow the flow of the newly produced materials which makes the next logical step after material distribution, construction. The materials are then transformed into a livable building which requires services like water and energy and occasionally additional materials to maintain and repair the building throughout operation. Some may opt to renovate and change the building with additions or remodelled rooms, bringing more materials into the mix. At the end of the life-cycle, a building that is no longer live-able or desirable is typically demolished in whole or in part (Foster, 2020).



Waste Hierarchy

A hierarchy of ways to handle waste helps to bring an understanding of waste management beyond the 3 R's (reduce, re-use, and recycle). Many waste producing industries, such as the food industry, have their own waste hierarchy or framework (Papargyropoulou et al., 2014). This inverted pyramid graphic ranks 'Prevention' above all else, and 'Disposal' as the last resort, ranking the waste handling strategies from the least negative environmental impact at the top to the most negative impact at the bottom. Unfortunately, environmental impact is not the only way the industry prioritizes the handling of waste. The market value of waste materials, both in their ease of re-use and end user market demand, factor in greatly meaning that re-use and recycling are only possible with value attached to the material (Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019).



Prevention can encompass adaptive re-use, keeping existing structures materials on site and incorporating them into the new build. Salvaging materials can create new local industry and markets for building materials like beams and bricks that are transported, stored and used at other building sites. Recycling building materials like copper is an existing common practice due to its high market value as a raw material. Recovery of energy by using wood as fuel is better than disposing of it in a landfill, however, any of the above options rank higher in reducing environmental impacts.

Graphic created by author with inspiration from [Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019; Papargyropoulou et al., 2014].

Stakeholder Mapping

Stakeholder mapping is a people centred approach within the system mapping and service design toolkit which is designed to represent and communicate complex relationships within systems (Service Design). Stakeholder maps can help facilitate conversations which help decision makers understand, analyze, imagine, and design new solutions (ibid). Creating a stakeholder map like the one on the next page serves as an illustration of the present CRD waste generation processes, stakeholder relationships, and the current exchanges of value within the system are. It helps to clarify the roles of actors and their relationships by spatially and visually organizing their relationships and their power dynamics. Illuminating this power dynamic can shine a light on equity challenges and highlight barriers or missing connections between actors in a system. For the purposes of this project, this stakeholder map has been created using high-level stakeholder groups or actors as the entry point to a complex system involving many sub-actors who play similar roles.

THE BUILDING BLOCKS OF A STAKEHOLDER MAP ARE:

POWER

A base-map which represents how integral a stakeholder is or how much power a stakeholder has based on their placement in proximity to the center of the map.

STAKEHOLDERS

A symbolic or text-based representation of either the high-level actors in the system or an in-depth mapping of all stakeholders who influence, participate in, and uphold the system.

END USERS AND MARKETS

RELATIONSHIPS

An arrow or connecting line between stakeholders to represent their relationship in the system.

EXCHANGES

Usually a text-based representation of the contribution or value transfer from one stakeholder to another.

Based on

Actors Involved in the Production and Management of CRD waste*

CRD WASTE GENERATORS

Entities that generate waste and have a role in reducing volumes created.

- Homeowners
- Designers (architects, engineers etc.)
- Building owners and developers
- Builders (contractors, trades)
- Demolition contractors, salvagers

REGULATORS

Governments, agencies and standards orga-nizzations responsible for controlling CRD waste management.

- Federal, provincial and municipal gov-ernments
- Standards organizations

TRANSPORTERS

Companies that move waste from the point of generations to the facilities and end users.

- Hauling companies

FACILITIES

Companies and agencies responsible for re-ceiving, sorting and processing CRD waste.

- CRD waste processors, also known as material recovery facilities (MRF's)
- Transfer stations
- Waste/material haulers and equipment renters
- Landfill operators

END USERS AND MARKETS

Organizations involved in the sale and reuse of CRD materials

- Public procurement agencies
- Product manufacturers and suppliers
- Wholesalers, retailers (with or without deconstruction or installation services)
- Materials exchanges

OTHER STAKEHOLDERS

Organization with interests in CRD waste management.

- Industry associations and councils (e.g., trade associations and procduct coun-cils)
- producer responsibility organizations (PROs)
- NGOs
- R&D centres

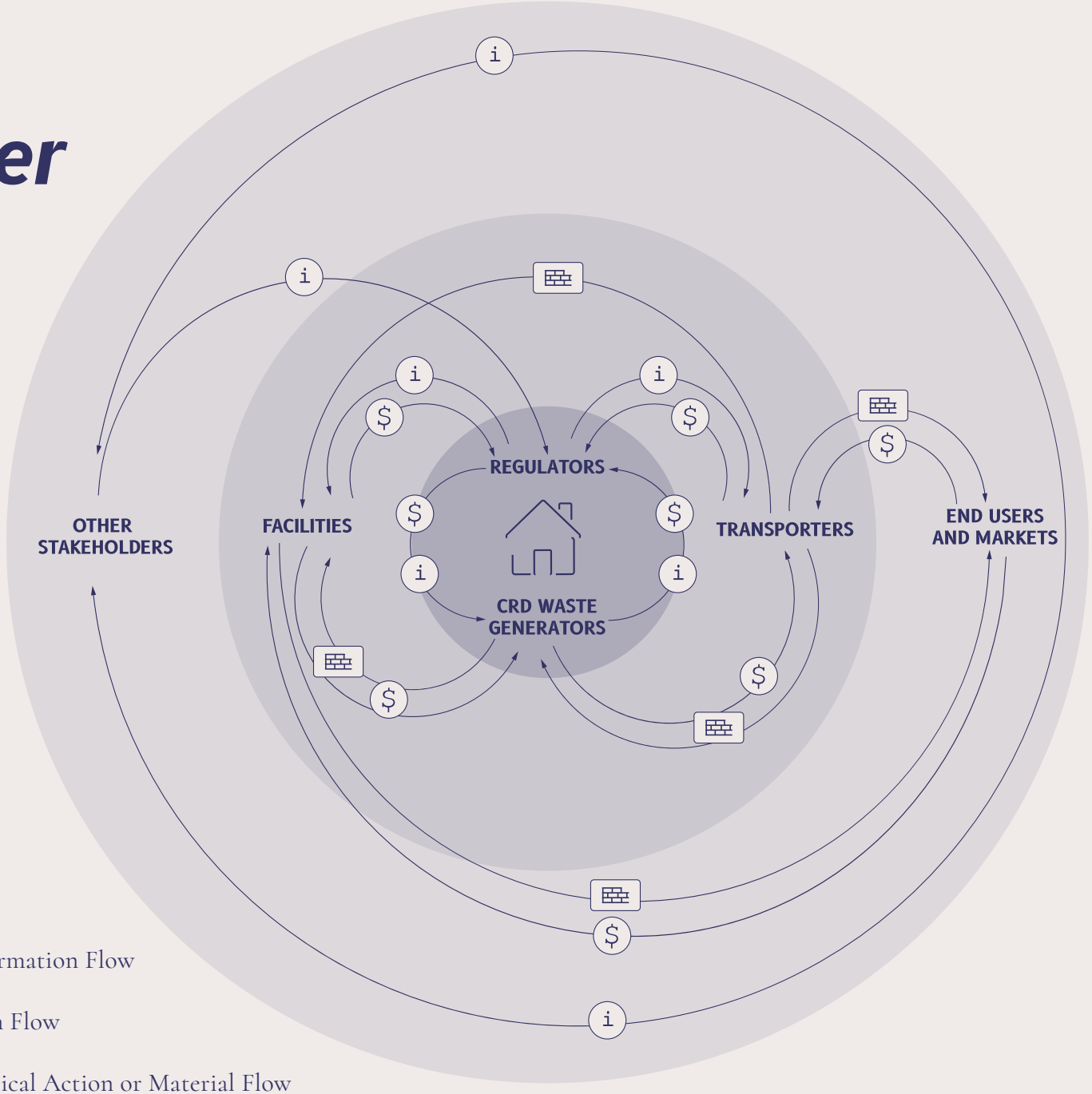
**This table was originally published in the "GUIDE FOR IDENTIFYING, EVALUATING AND SELECTING POLICIES FOR INFLUENCING CONSTRUCTION, RENO-VATION AND DEMOLITION WASTE MANAGEMENT "[CMMA, 2019].*

This table was visually translated from the information provided in the [Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019].

THE SYSTEM

Stakeholder Map

This stakeholder map takes the high-level actors listed on the last page and maps them based on their hierarchy of power and ability to impact the system or generate waste; those that hold the most power are in the centre. A layer of inter-related arrows shows the relationships between each actor and what is exchanged in the relationship. There is a flow of information, money, and materials.



RELATIONSHIPS, VALUE EXACHANGES, AND IMPACT

High Impact
Medium Impact
Low Impact

Information Flow
Cash Flow
Physical Action or Material Flow

Graphic by Author, information analyzed from [Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019; Rau et al., 2020].

Stakeholder Relationships

REGULATORS + GENERATORS/ TRANSPORTERS/ FACILITIES

Regulators uphold policy which informs generators, transporters, and facilities on how to handle waste. Regulators may provide incentives for meeting waste reduction targets set by policy. Mandatory regulations must be complied with, otherwise the generators, transporters, and facilities are subject to paying fees for non-compliance.

GENERATORS AND TRANSPORTERS

Waste Generators work with Transporters and exchange money to remove unwanted waste materials.

GENERATORS AND FACILITIES

Some Generators may not hire a transportation or hauling company and may work directly with a Waste Facility to receive, store and sort materials. Depending on the type of materials and their current market value, payment for receiving materials may go to the generator or the generator may have to pay a fee to dispose of waste materials.

TRANSPORTERS AND FACILITIES

The relationship between transporters and facilities is similar to generators, the main difference is the added step of professional transportation services on behalf of the generator.

FACILITIES/ TRANSPORTERS AND END USERS AND MARKETS

End Users and Markets can work with facilities and transporters to source materials that have market value.

OTHER STAKEHOLDERS AND REGULATORS

Organizations just outside of the system include those that produce research on waste and materials. This information is often provided directly to regulators who may then make policy decisions based on the information provided. Advocacy groups and special interest groups often create campaigns and communicate broadly about waste and material related information or interact directly with council members to influence decisions.

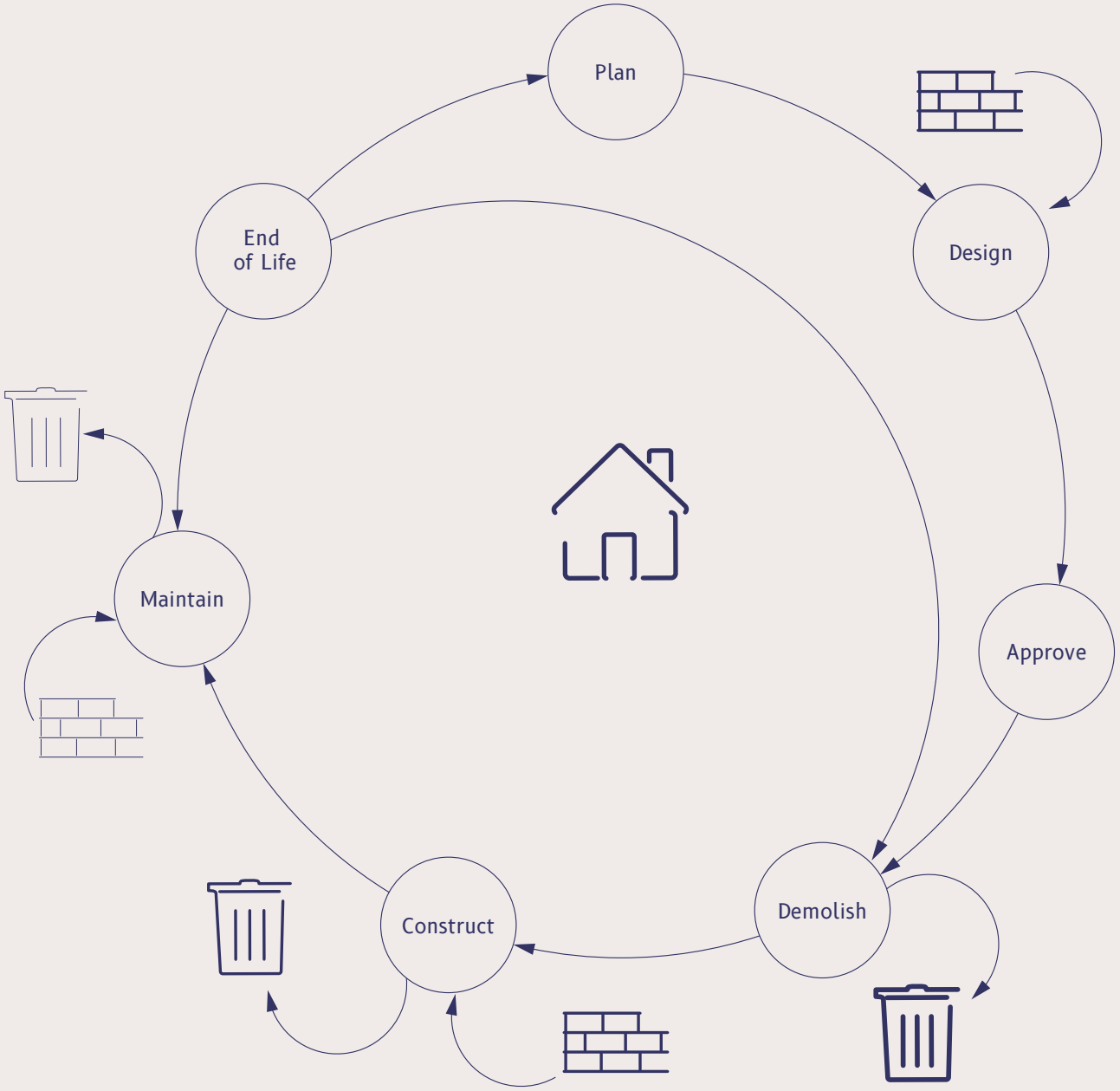
Graphic Created by Author, Value exchange concept inspired in part by: https://www.researchgate.net/publication/341418573_Physical_Responsibility_Versus_Financial_Responsibility_of_Producers_for_E-Wastes ; Information that this map was built on came from [CMMA, 2019].

THE SYSTEM

High-Level Process Flow Map

MATERIALS IN, WASTE OUT

A process flow map is a helpful visualization tool which shows the high-level sequence of events. Seeing when and where phases connect with one another helps to emphasize the fact that each phase is interrelated and builds on the last, whether the stakeholders involved are intentionally working together or against one another. At every step in the life cycle of a building, decisions are made to bring new materials in or push waste out from the building site. In this process flow map, 'materials in' is symbolized by a brick icon and 'waste out' is symbolized by a trash can. The current most typical process that the building industry follows is composed of the 7 phases.



Graphic developed by author with inspiration from [Ali Akhtar, Ajit K. Sarmah, 2018, Foster 2019]

Policy Framework

Within this section, policy relating to CRD waste regulation and monitoring is examined from Federal through to Municipal. Canada's approach to Municipal solid waste (MSW) is decentralized, meaning responsibility is spread across levels of government by waste type or location for instance (CANADA National Reporting to CSD-18/19 Thematic Profile: Waste Management, 2019). MSW in Canada includes waste produced by residential, institutional, business activities, and construction and demolition waste (ibid). The Government of Canada provides broad guidance, support, tools, and funding to other levels of government to encourage sustainable MSW practices (Canada, n.d.-a, n.d.-b). The federal government does not otherwise get involved in waste related issues unless their lands or resources are impacted or in some instance the issues involve toxic substances or GHG. At the next level of government, the Provinces are responsible for regulation and policy frameworks which inform waste management operations like approvals, licensing and monitoring for their municipalities. Collection, diversion, and disposal of MSW is the responsibility of the municipality (Canada, n.d.-a, n.d.-b).

The policy framework which influences Toronto's construction, renovation, and demolition waste landscape, is explored through reviewing law, policy, strategy documents and processes produced by the Federal Government of Canada, the Province of Ontario, and the City of Toronto. Inspiration for new policy recommendations and change is drawn from policies, markets, and communities around the world.

The Federal Goverment

Collaborating with the provinces, territories, municipalities and indigenous partners, the federal government co-develops and implement standards for waste related matters that are of common concern (Canada.ca, n.d.). Stated early in this project, CRD waste is classified in Canada as non-hazardous waste (Canada, n.d.-b, n.d.-a). Federally, the prevention of hazardous waste and pollution is of primary concern over any non-hazardous waste management like CRD waste (Canada, n.d.-b). Guiding the approach to waste and the environment are many laws, strategies, and handbooks.

FEDERAL SUSTAINABLE DEVELOPMENT ACT

The Federal Sustainable Development Act (S.C. 2008, c. 33) provides the legal framework for a Federal Sustainable Development Strategy(FSDS). Sustainable development is defined within the act as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Government of Canada, 2021; Report to The House Of Commons Standing Committee on Environment And Sustainable Development On The Federal Sustainable Development Act, 2017). This harkens back to what is known by many Indigenous peoples as a Seven Generations Principle; 'decisions we make today should result in a sustainable world seven generations into the future' (What Is the Seventh Generation Principle?, 2020). The FSDS includes "goals, targets, an implementation strategy for each target, and a minister responsible for meeting each target". This law does not mention waste or demolition at all (Government of Canada, 2021), however, the first sustainable development principle within the law which lays the foundation for what follows states that the "efficient use of natural, social and economic resources" must be integrated in all decision making (Government of Canada, 2021).

CANADIAN ENVIRONMENTAL PROTECTION ACT

In 1989, the Canadian Environmental Protection Act (CEPA 1999), one of the paramount Canadian environmental laws, was created. This law protects the environment and the health and wellbeing of Canadians with focus on preventing pollution and addressing exposure to dangerous chemicals. Again, CRD is not considered hazardous and is not specifically mentioned in this act. Though, if not disposed of correctly, CRD does pose a threat to human health (Canada.ca, n.d.). Very recently it has been proposed through Bill C-28 that updates to CEPA incorporating 35 new recommendations which would include the recognition of peoples' right to a healthy environment through (NOTICE PAPER No. 78, 2021, p. 78; Taylor, 2021).

THE CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT

The Canadian Council of Ministers of the Environment (CCME) is composed of environment ministers from the federal, provincial and territorial governments. They all work together to improve waste reduction policies and practices across Canada, among other objectives. In 2019 they produced the "Guide for Identifying, Evaluating and Selecting Policies for Influencing Con-struction, Renovation and Demolition Waste Management". The comprehensive 151-page guide covers strategies to assess, prioritize, and evaluate policy for CRD waste reduction (Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management, 2019). This is an integral asset for all levels of government seeking to move towards a circular economy with their CRD policy approach. Much of the data presented in this guide as well as the frameworks and concepts were foundational for this pro-ject.

THE ENVIRONMENTALLY RESPONSIBLE CONSTRUCTION AND RENOVATION HANDBOOK

Produced by the private sector for Public Works and Government Services, 'The Environmentally Responsible Construction and Renovation Handbook' addresses environmental concerns at-tached to construction and renovation and provides examples and strategies for industry to im-plement sustainable construction and renovation practices (2001). This document is mentioned within other government or related industry documents but occasionally links to a broken or missing webpage. It is also hard to find online just by searching the title. Though the document is comprehensive and contains countless useful strategies and concepts, it is likely outdated and at 179 pages, it is not digestible or accessible for a public audience, many who may find it most useful.

THE CIRCULAR ECONOMY AT THE FEDERAL LEVEL

TThe Circular Economy is not often mentioned in strategies and never mentioned in related law at the Federal level. A Circular Economy landing page providing a high-level definition on Canada.ca leads to four simple high-level informational pages (What Is the Circular Economy?, n.d.). The 'Get Involved' webpage lists 6 actions encouraging individuals to change their consumption behaviours and links out to the related 'Zero Plastic Waste' landing page. The 'Canadian Businesses' page defines, again at a very high level, what circular design, manufacturing can be along with approaches to recycling and waste reduction. An event landing page shows that Canada is hosting the 2021 World Circular Economy Forum, the first in North America (World Circular Economy Forum 2021, n.d.). On April 16th, 2021 the Federal Economic Development Agency for Southern Ontario announced that the federal government would be providing $5 million dollars to support the creation of 400 circular economy jobs in the food and environment sectors and to develop a Circular Opportunity Innovation Launchpad (COIL) (Government of Canada Invests in Canada's First Circular Economy Focused Accelerator and Test Platform, n.d.). It is clear that CE in the CRD industry specifically is still nascent in Canada in comparison to some more established European nations, and conversation around CE is currently addressing a broad range of industry's which seldom prioritizes CRD waste. Nevertheless, CE is emerging and has the potential to take root.

The Provincial Goverment

Provincially, the Ontario government delivers regulation and policy frameworks to municipalities which inform waste management operations like approvals, licensing and monitoring. The core planning policies that impact municipal growth are the Planning Act, the Provincial Policy Statement (PPS), and the Growth Plan. The graphic representation of the system to the right represents the way that different land-use policies and procedures interact in Ontario. The Planning Act guides the Policy Statement and the Growth Plan which all set objectives and guidelines which the City of Toronto must abide by. This section explores what the province's policies and programs say, or do not say, about CRD waste in relation to development.

LAND-USE PLANNING SYSTEM IN ONTARIO

Graphic translated from [Torrie et al., 2018]

THE PLANNING ACT

The Planning Act serves six main functions including the promotion of sustainable economic development, the provision of a land use planning system-led by policy, the integration of provincial and municipal planning decisions, the provision of a planning process, encouragement of co-operation and co-ordination , and recognition of the authority and accountability that municipal council hold with regard to planning (Planning Act, R.S.O. 1990, c. P.13, 2021). Relating to CRD waste and growth, at a high-level, matters of provincial interest include the adequate provision and efficient use of waste management systems and the minimization of waste. Under site plan requirements there is mention of the need for waste management plans to be included in the future built form such as placement of waste and recycling receptacles and storage for larger residential builds. No CRD waste related matters are of explicit concern to the province under this act.

The Act also states that a municipality has the ability by-law to designate any area in its bounds as a Demolition Control Area (Planning Act, R.S.O. 1990, c. P.13, 2021). Meaning, that without a demolition permit granted by the City, demolition cannot happen. Council is granted permission to refuse or issue permits for residential properties. Under the Act, permission to demolish may be granted under the condition that a new structure be built within a 2-year time-frame. Under this section health and safety concerns for occupants are of provincial concern and there is no proactive stance taken to reduce waste.

PROVINCIAL POLICY STATEMENT

The Provincial Policy Statement (PPS) gives direction on matters of provincial interest in relation to land use planning and development, and sets the foundation for regulation and minimum standards, all of which is done in coordination with municipalities. Resource is a term used broadly but can be understood as land, structures, water, minerals and might be interpreted to incorporate building materials. The PPS includes a specific waste management section that, like the Planning Act, addresses the need for waste management systems to be in place to receive and accommodate volumes of waste that meet the needs of the present and the future. These systems are required to "facilitate, encourage and promote reduction, reuse and recycling objectives", though it does not specify that this waste reduction effort be adopted during the development of new infrastructure (Provincial Policy Statement, 2020). There is certainly room for interpretation.

GROWTH PLAN

The Places to Grow Act states that a Growth Plan may address land supply for residential, employment and other uses, and outline municipal waste management planning, among many other items (Places to Grow Act, 2020). 'A Place to Grow, Growth Plan for the Greater Golden Horseshoe' (the Growth Plan), is an implementation framework by the province to plan for growth in ways that support economic prosperity, protection of the environment and ensure a high quality of life for residents (Ontario, n.d.). The Growth Plan addresses the need for wastewater management throughout the document but does not reach solid waste management until 50 pages into the document. The first mention of waste management is within the 'Culture of Conservation' section which outlines what municipalities are required to develop and implement within their official plan policies and other strategies to address conservation. Under this section, the municipality is required to, where appropriate, enhance and create a plan for waste reduction, reuse, and diversion. Directly related to CRD, municipalities must promote building conservation and adaptive reuse which include the reuse of and recycling of CRD materials. Waste management initiatives should be considered in a long-term, regional planning context and

be in collaboration with neighbouring municipalities. Under the 'Climate Change' section, upper and single-tier municipalities like Toronto, are to develop policies in the official plans which identify actions to reduce GHG emissions and protect the environment. Municipalities are encouraged but not required to inventory emissions and climate impact data for buildings and waste management, among other items.

BYLAW 103/94

Under the Ontario Environmental Protection Act (R.S.O. 1990, c. E.19), Bill 103/94, regulates the development of source separation programs for non-residential purposes (Industrial, Commercial and Institutional Source Separation Programs, 2011). Though the bylaw covers multi-unit residential buildings and the need to offer source separation programs for waste generated at the building, it does not explicitly cover CRD waste. There is mention of large construction and demolition waste for demolition projects that are at least 2,000 square metres, a typical single detached home is around 200 square metres. This large demolition project waste section specifically requires source separation for just brick, cement, cardboard, drywall, steel, and wood (Industrial, Commercial and Institutional Source Separation Programs, 2011). There is no mention of glass, plastics, appliances, roofing asphalt, or metals other than steel, which make up significant portions of CRD waste.

CITY OF TORONTO ACT

The City of Toronto Act is a framework of broad powers which relate to the public interest and needs of the City that the City is granted by the province (City of Toronto Act, 2020). Under this act, the City, for its own purposes, may exercise its powers with respect to waste management. The City is also permitted, for the purpose of information gathering, to conduct waste disposal tests through obtaining land samples or extracts.

The Municipal Goverment

The City of Toronto is a creature of the Province, meaning that it's power to create policy is granted by the Province through the City of Toronto Act. There are a number of policies which dictate how growth and development are permitted, as well as how waste management is handled. The City operates seven Waste Transfer Stations and many drop-off depots where residents can dispose of items (Drop-Off Depots, n.d.). Many privately owned waste management companies are permitted to operate within the city and offer private collection.

OFFICIAL PLAN AND ZONING BY-LAWS

The Planning Act requires the City to have an Official Plan(OP). It is a legal document that outlines the policies and objectives for the future of land use in the City (Lintern, 2019). The Planning Act gives authority to the City through the ability to create zoning by-laws(ZBL), which are laws that regulate the use and development of buildings and land by stating the types of uses that are permitted on land and how properties are permitted to be developed (lot size, setbacks, height form etc.). To change the use or form of the land in any significant way requires amendments to the OP and the ZBL are required (Lintern, 2019). Various plans and forms are required for both; additional information and studies are required for OP amendments including an energy strategy, heritage impact statement, and a natural heritage impact study among others. Decisions about changes are determined through a process that involves community input and ultimately a decision by City Council. There is an opportunity to re-examine the required documents, information and studies through the amendment process to include waste management and reduction plans for demolition and construction phases. Much like tree protection and an energy strategy are required for environmental protection, so should waste be (Application Support Material: Terms of Reference, 2021).

BUILDING AND DEMOLITION PERMITS

Building permits function largely to ensure that safety is a priority and that changes, growth and development requirements set by the City and guided by the Province are met (Toronto Building: Homeowner's Guide to Building Permits, n.d.). The building permit application process covers new builds, major remodels and renovations, and additions. The process follows 5 phases:

- determining if the project complies with existing zoning and laws
- drafting plans or hiring a designer to prepare plans and the application
- applying for the building and obtaining it
- starting construction
- closing the permit with a final inspection

Permits cover specific items like Tree protection, heritage conservation, and considerations environmental or conservation matters related to the Toronto Regional Conservation Authority (TRCA) dependent on whether the building site is close to environmentally

sensitive areas, wetlands and/or shorelines (Apply for a Building Permit, n.d.). Throughout the building permit process, the only mention of waste is the 'tip' that states 'do not burn construction waste' (Toronto Building: Homeowner's Guide to Building Permits, n.d.). Waste reduction related information is not provided to encourage, incentivize or enforce circular choices at this time. There is an opportunity to include information about demolition waste and material selection in permitting communications.

SOLID WASTE DIVISION

In short, the Solid Waste Division at the City of Toronto does not mandate anything to do with CRD waste aside from stating that it is prohibited in the residential municipal waste collection stream (Chapter 844). This leaves contractors and home owners to deal with the waste privately, which leaves the management of the waste up to the private waste handler and whatever solution make the most business sense to them.

THE CIRCULAR ECONOMY UNIT

In 2016, the City of Toronto created a new Long-Term Waste Management Strategy (LTWMS), recognizing that the global and local problem of excessive amounts of waste, along with natural resource depletion and pollution, is not sustainable (Waste Strategy Overview, n.d.). As a part of this new strategy to begin "working towards an aspirational goal of zero waste and a circular economy" (Working Toward a Circular Economy, n.d.), the recommendation was made to create a Unit for Research, Innovation & a Circular Economy. Supporting this strategy, the Circular Economy and Innovation division (CEI) is working to move Toronto away from a linear take-make-dispose culture through a great variety of work including research, pilot programs, and systems design.

TORONTO GREEN BUILDING STANDARDS

The Toronto Green Building Standards (TGS) is the City of Toronto's green building design re-quirements for new development. It is currently undergoing review for version 4. Publicly, ver-sion 3 has been active since May 2018 (Toronto Green Standard, n.d.). The TGS is broken out into a few categories including low-rise residential and mid to high-rise residential and non-residential. It offers a development charge refund program which incentivises developers to achieve higher than mandatory levels of sustainable performance compliance (Toronto Green Standard, n.d.). There are four tiers, tier one is mandatory and tiers 2,3, and 4 are voluntary, with increasing requirements and incentives (LEED Supplement, 2019). Overall, emphasis of the program is on larger buildings in order to reduce operational energy consumption. Require-ments for new low-rise residential development include storage for waste including garbage, recycling and

organics and documentation of construction waste, in compliance with the Pro-vincial Regulation O. Reg. 103/94: Industrial, Commercial and Institutional Source Separation Programs (Industrial, Commercial and Institutional Source Separation Programs, 2011). This documentation of waste may impact the consideration of waste reduction, though it is not reg-ulated and there is no standard for tracking CRD waste within the City. Optional waste reduction measures will contribute to achieving higher Tier levels and increased incentives. Construction waste diversion of at least 75% for Tier 2 and 95% achieves Tier 3. Tier 2 can also be achieved through re-use and salvaging of the building materials by 50% of the buildings surface area (LEED Supplement, 2019). Tier 2 also includes the use of at least 25%, by cost, sustainable building materials. With much of the waste reduction and diversion left optional, it is clear CRD waste is slipping through the gaps.

CAGBC AND LEED 4.1

The Canadian Green Building Council (CaGBC) is a not-for-profit organization which advances green building and sustainable development practices (CaGBC, n.d.). The CaGBC holder the Canadian license for the LEED green building rating system (CaGBC, n.d.). LEED is a voluntary Green Building certification awarded to buildings that meet milestones and targets in making green building development choices that include reducing overall building emissions. In order to achieve LEED certification, a certain number of points across multiple categories must add up to meet a minimum requirement. Until recently it has not put much emphasis on waste related carbon reductions. The latest update, 4.1, includes in the materials and resources section, a construction and demolition waste management section (Materials and Resources: Construction and Demolition Waste Management, 2021). There is much more emphasis placed on identifying strategies to reduce and prevent, rather than recycle and reuse, waste generated during design and construction. Points are given for diverting over 50-75% of waste and when recycling is required, the facility must be a 'regulated facility' (Materials and Resources: Construction and Demolition Waste Management, 2021). This is a sign that change is coming and, leaders in green building including but not limited to CGBC, the industry is listening.

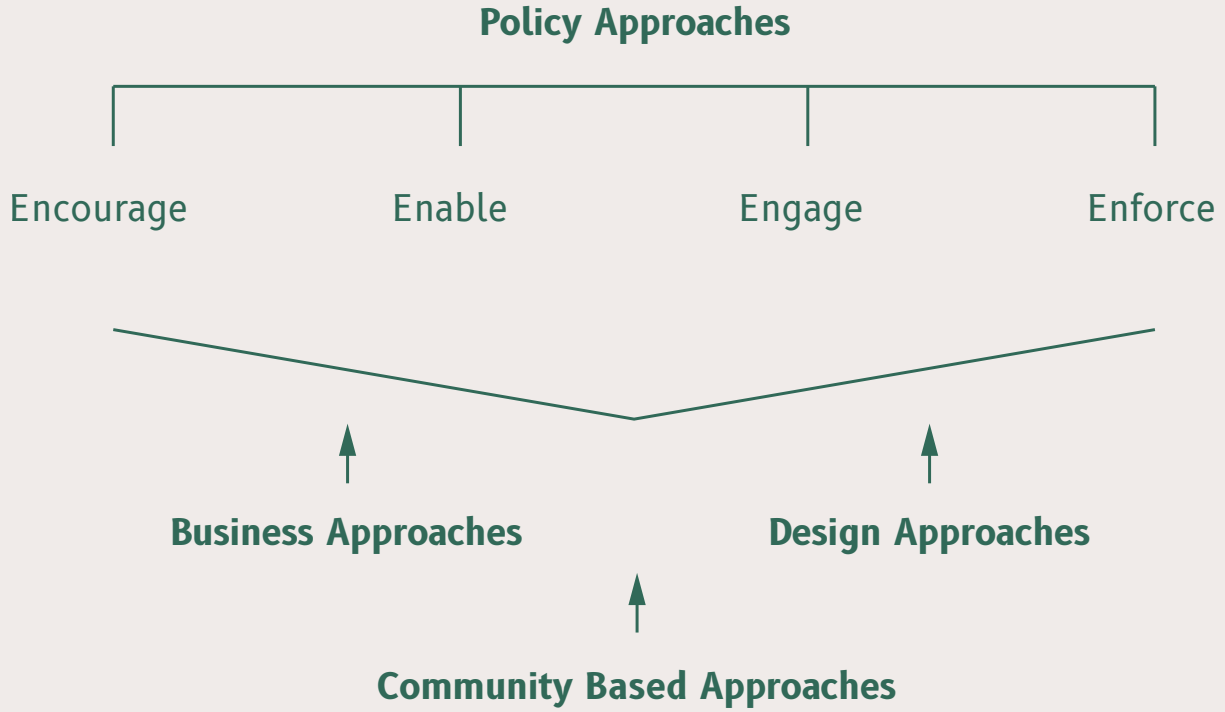
WHAT CAN BE DONE ABOUT THIS?

The Changes

- *Policy Levers: Encourage, Enable, Engage, Enforce*
- *Policy and Market Scans*
- *Circular Process Flow Map*

Policy

Policy can encourage, enable, engage, and enforce changes towards a circular economy (Dalhammar et al., 2019; Peck, n.d.). Some of the changes. As much as policy can dictate positive change, innovation and activism from business, design and community-based approaches can influence the system and change policy in turn. Recalling the stakeholder map, other stakeholders like CaGBC, research and development actors, community groups and non-governmental organizations directly share information and influence with different levels of government. Throughout the development process, choices, shifts, and swaps can be made across each of the seven stages shown in the process flow map earlier and on the next pages. This section outlines possible tools, tactics, and programs that have worked in contexts inside and outside of Toronto at different scales.



Encourage

- Tax cuts
- Subsidies
- Refunds
- Reward schemes

Engage

- Media campaigns
- Voluntary agreements

- Remove barriers
- Provide skills
- Provide information

Enable

- Penalties
- Fines

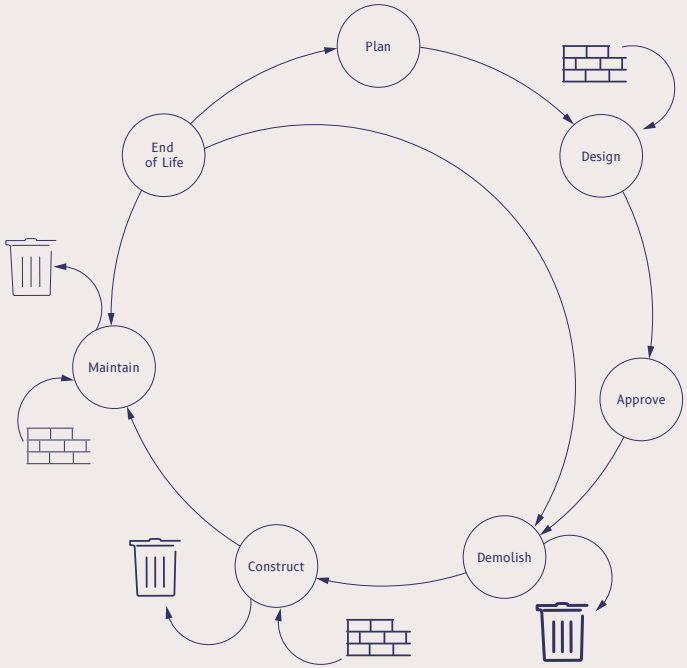
Enforce

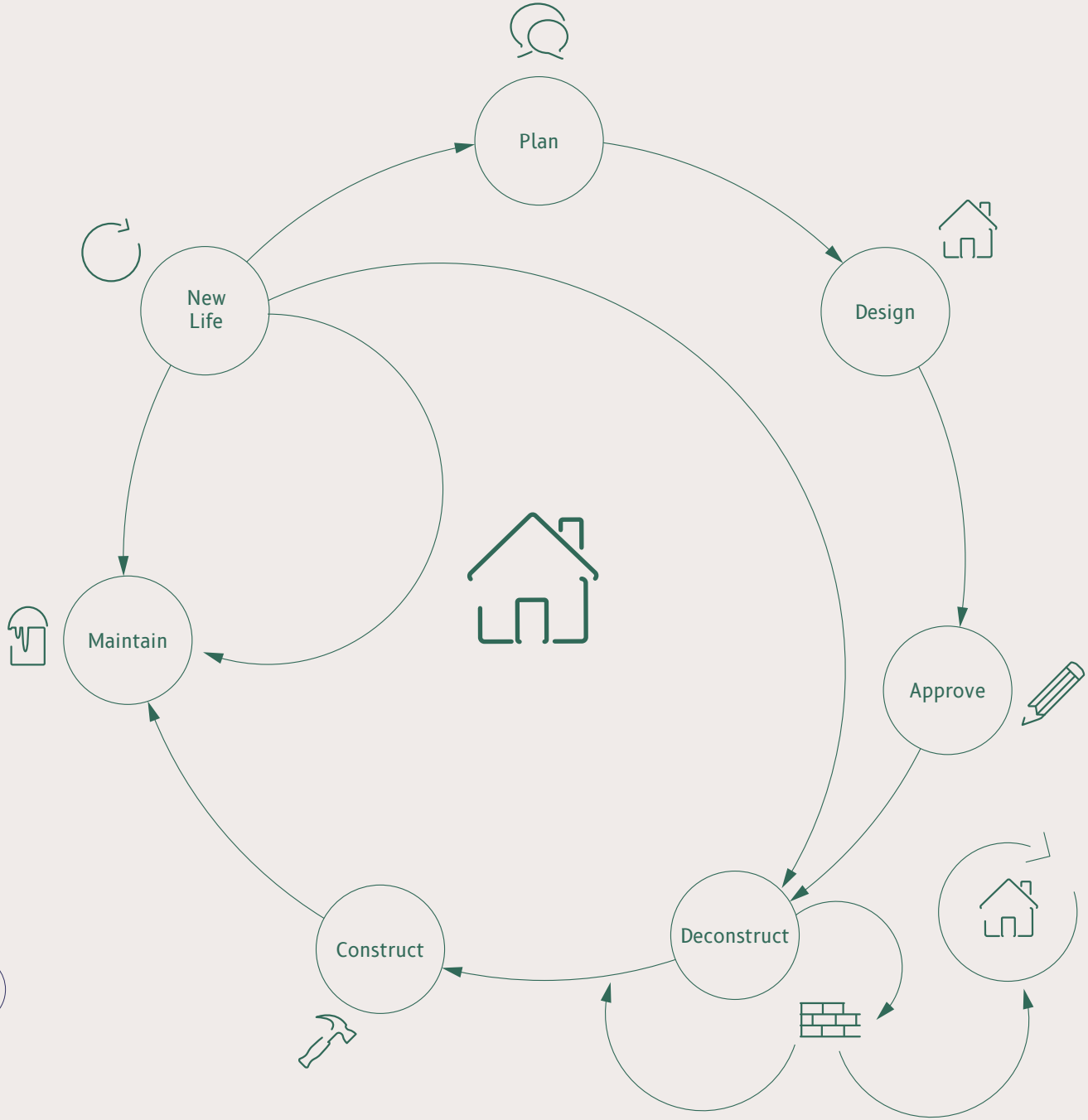
Graphic representation created by the author with information from [Dalhammar et al., 2019; Peck, n.d.]

THE CHANGES

Circular Process Flow Map

For comparison, this is the previously drawn flow map which shows where materials are brought in and waste exits. Notable changes to the process include rethinking 'demolition' phase as a 'deconstruction' phase and 'end of life' as 'new life'. Look for the icons in the top right to see which phase the solution matches.





Graphic developed by author with inspiration from [Ali Akhtar, Ajit K. Sarmah, 2018, Foster 2019]

Circular Product Design

Circular product design can include any methods which find innovative ways to design waste out of a system through slowing, closing, and narrowing loops (circularity) by making design choices that increase durability, repairability, recyclability and re-usability (Bocken et al., 2016).

RECYCLABILITY

Recycled products are a great alternative to new materials; however, many recycled items are not designed to be recycled again and again and only slow linear streams rather than create closed loop product life-cycles. Truly circular products are recyclable. They able to be recycled and re-used after their current use has been fulfilled. A product is only considered recyclable if one third of the population can access facilities or drop-off points which ensure the product is recycled (The Environmentally Responsible Construction and Renovation Handbook, 2001). Products made of fewer materials and less adhesives are much easier to recycle (The Environmentally Responsible Construction and Renovation Handbook, 2001).

DURABILITY

Durable products that are made well from the start and stand the test of time require less maintenance and require less replacing (The Environmentally Responsible Construction and Renovation Handbook, 2001). Manufacturers warranties help measure durability, though, many warranties are not designed to be transparent to consumers. Purchasing products with a life-time warranty is only a solution if the warranty is navigable (The Environmentally Responsible Construction and Renovation Handbook, 2001). There are currently testing procedures under development which would help to standardize warranties and durability claims to make warranties effective for environmental impact reductions (The Environmentally Responsible Construction and Renovation Handbook, 2001).

SERVICE DESIGN

Product-service systems(PSS), business models that integrate both product and service value offerings, are important components to making circular product design successful (Milios, 2018). Without considering the user of the product and how they play a role in maintaining a closed loop over time and use of their product, the circularity of the product will be lost and the product, however well designed, will not remain part of a circular economy. Governments have a big role in promoting this approach and encouraging innovation in this sector (Milios, 2018). Logistics and public education are key factors in ensuring that circular business models are successful. It is important to have a well-developed logistics plan which considers how materials will be retrieved, transported and processed after use. For the system to really work, consumers and other key stakeholders like construction and demolition workers play a significant role in the logistics of keeping materials in the loop rather than sending things to landfill. Education is essential for informing consumers of the process and changing their behaviour to ensure participation in the new system.

CIRCULAR PRODUCT SWAPS

Though many of these circular products are available in Canada, there are often barriers including the need to ship circular products from Europe where they are more prevalent, and of course affordability. Encouraging circular product design locally and nationally will improve access and affordability, as well as reduce emissions from shipping material overseas.

CARBON STORING MATERIALS

Not only are these materials renewable, but they are also able to remove and sink carbon from the atmosphere. Carbon drawn is in and stored in the plants as they are grown. Materials that store carbon include: timber, wood fiber board, cork, ReWall, waste textiles, cellulose, straw, mycelium, rice hulls, bamboo/BamCore, coconut coir, hemp OSB and others (NESEA Building Energy Boston 2019 Keynote- Carbon Drawdown Now, 2019).

EXAMPLE: SPRAY FOAM INSULATION VS. RECYCLED DENIM INSULATION

Though spray foam insulation has been touted as a sustainable insulation option in terms of efficiency and effectiveness for reducing wasted heat and energy, though, if not installed properly, its efficacy significantly decreases (Alter, 2019). Spray foam is also full of chemicals and packed with embodied carbon (Alter, 2019). It also ranks low for affordability and high for health hazards (Guidance for Specifying Healthier Insulation and Air-Sealing Materials, 2019). Once spray foam has been applied, it is permanent. Which may sound like a good thing, but any material it adheres to loses any possibility of being safely salvaged or recycled.

Denim insulation is a circular product which reduces the fashion industry's waste by diverting clothing items like jeans from landfill. Batts of denim insulation behave much like traditional fiberglass batts and not require adhesive to install which makes them easy to install, remove and re-use. Cotton is a natural and renewable fabric and does not contain toxins like formaldehyde, like fiberglass does. It is more expensive when compared to fiberglass. Using denim insulation helps add points when working towards a LEED certified building (Fischer, 2015; Guidance for Specifying Healthier Insulation and Air-Sealing Materials, 2019).

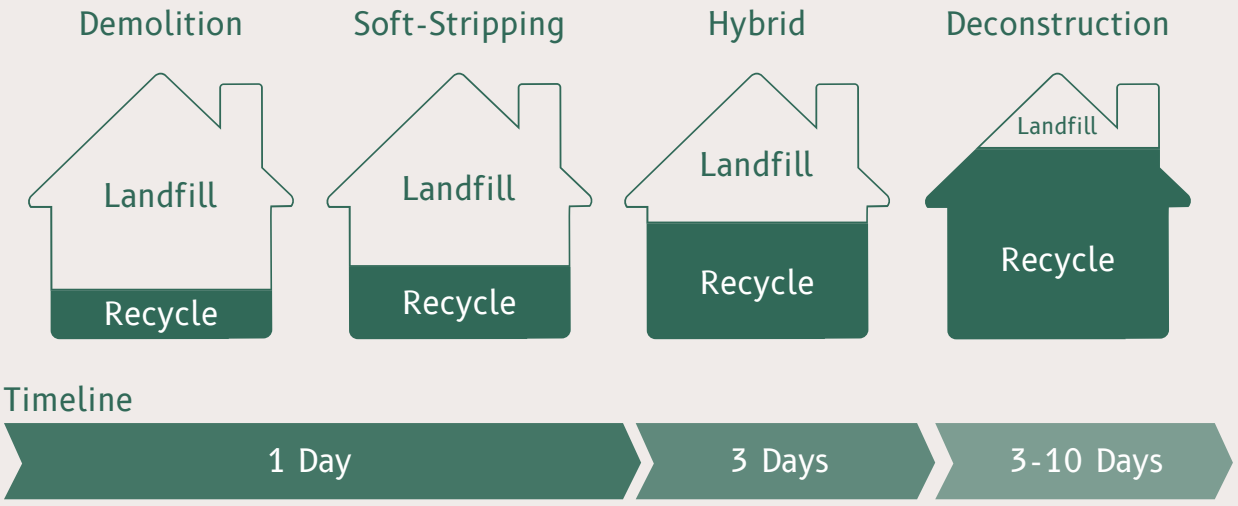
LEED CERTIFIED PRODUCTS

To earn LEED certification points, there are specific LEED compliant products that can be chosen instead of traditional materials. A helpful product guide tailored to general contractors has been compiled by the private company Green Badger. The guide covers products from insulation to flooring, paint to doors and more (Linstroth & Badger, n.d.).

Deconstruction

An alternate to demolition of existing buildings is deconstruction. The manual removal of the existing structures materials should be done with care. Though it may be more time consum-ing, it helps to preserve potentially salvageable materials like drywall, lumber, wiring, pipes, and ceiling panels (The Environmentally Responsible Construction and Renovation Handbook, 2001). The City of Vancouver has instated a Green Demolition By-Law which, to be granted a building permit, requires buildings of a certain age to salvage or divert a significant portion of the buildings weight (Green Demolition By-Law, 2020; Green Demolition By-Law Update, 2018). Huge amounts of waste reduction, at least 75% of a building by weight for certain buildings un-der Vancouver's Green Demolition By-Law for example, are not the only benefit. Property own-ers are able to qualify for significant deposit refunds, and provincial and federal tax credits which result in the average deconstruction project being cheaper than a traditional demolition (Unbuilders, n.d.). A local Vancouver business, Unbuilders, is leading the deconstruction way in Canada and has found innovative ways to connect their construction and deconstruction work to salvage markets to increase jobs and profit (Unbuilders, n.d.). Throughout BC many other mu-nicipalities have begun to implement similar by-laws. There are also a number of programs and projects in various states initiated by the non-profit Delta Institute. They have produced a comprehensive guide for deconstruction based on their experience and (Deconstruction & Build-ing Material Reuse: A Tool for Local Governments & Economic Development, 2018).

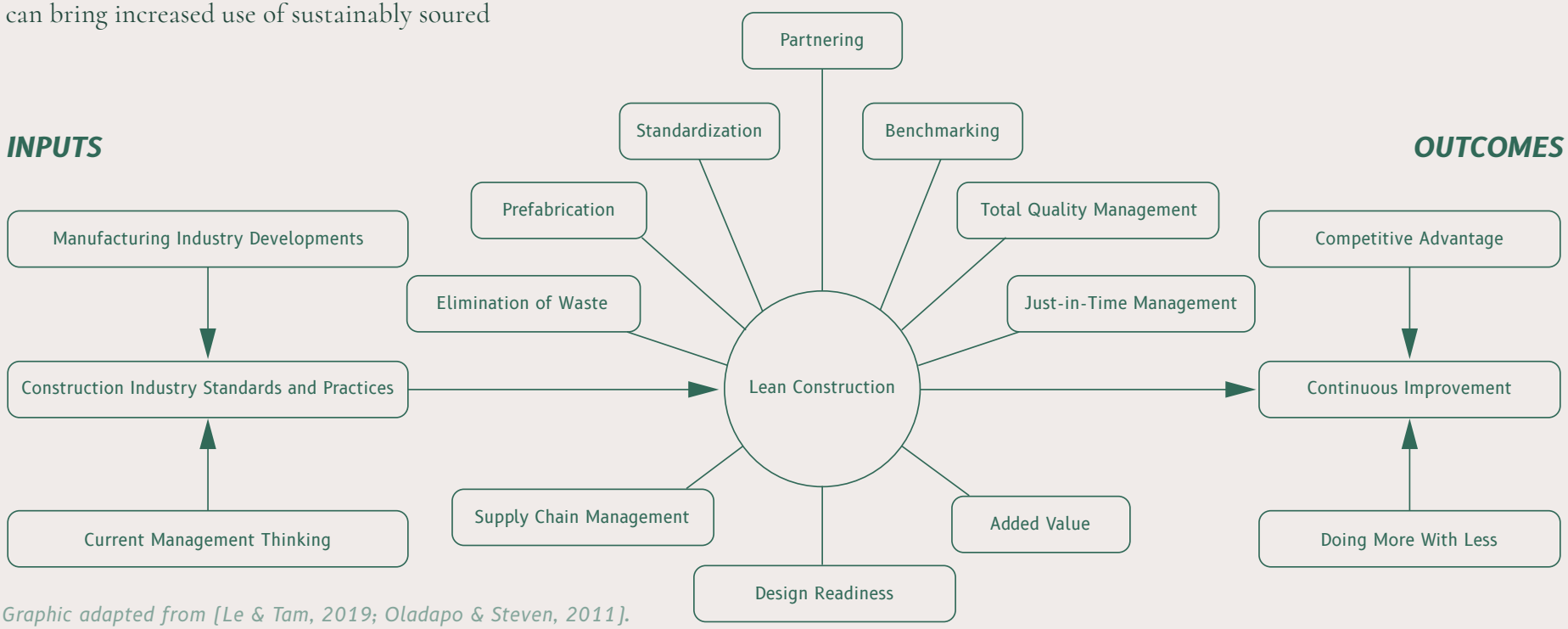
DEMOLITION METHODS, TIME INVESTMENT, AND WASTE DIVERTED



Graphic by the author with information and inspiration from [Deconstruction & Building Material Reuse: A Tool for Local Governments & Economic Development, 2018; McDonald, 2018].

Lean Construction

Lean is a borrowed concept from other industries which essentially can be understood as a project management philosophy which target quality and efficiency (Oladapo & Steven, 2011). Lean and sustainable construction both focus on the removal of waste and cost reduction in the building process (Le & Tam, 2019; Oladapo & Steven, 2011). Making the construction process a 'cyclic process' can bring increased use of sustainably soured materials and reduced consumption of energy and natural resources (ibid). Lean approach identifies 'seven types of waste: overproduction, overstocking, excessive motion, waiting time, transportation, extra-processing and defects'(Le & Tam, 2019; Oladapo & Steven, 2011). Reducing this waste is achieved through improved organizational and supply chain communication. The basics of lean construction are 'waste reduction, process focus in production planning and control, end customer focus, continuous improvements, cooperative relationship, and systems perspective' (Le & Tam, 2019; Oladapo & Steven, 2011). The graphic below illustrates the inputs of the construction process, the principles of lean construction, and the outcomes.

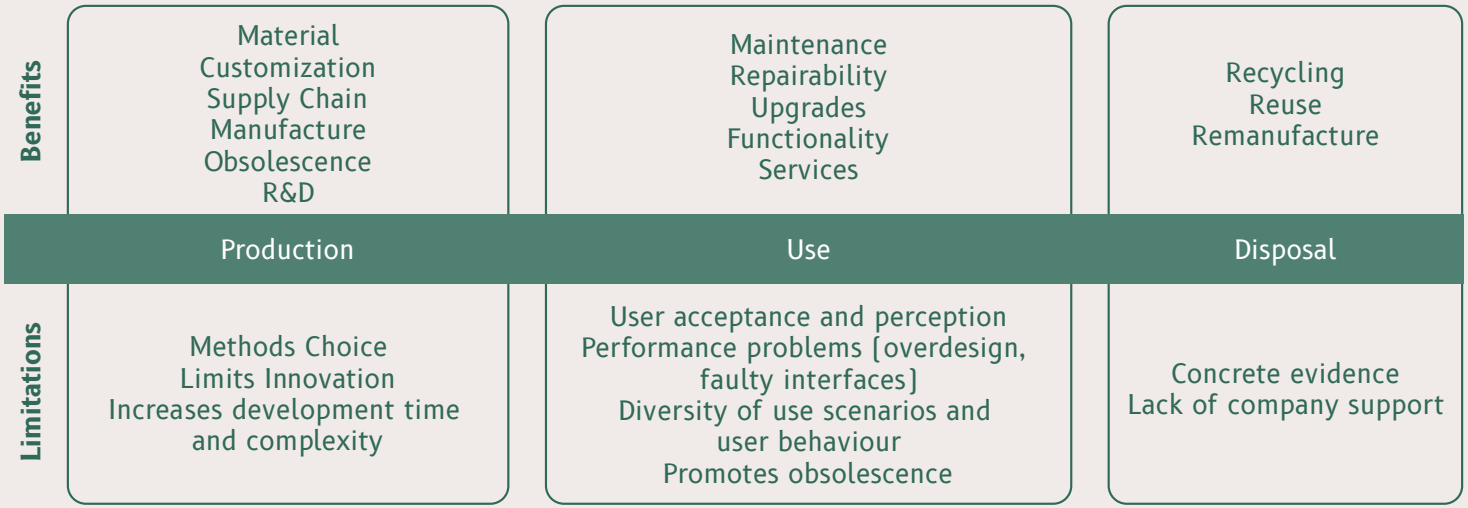


Graphic adapted from [Le & Tam, 2019; Oladapo & Steven, 2011].

Modularity

Modular housing is factory built with a focus on precision, resulting in speedy production, high quality and energy efficient construction (Levitt, 2014). The prefabrication of modular housing and home-additions can reduce waste, emissions, noise pollutions, construction related traffic and road closure due to the majority of the fabrication time being offsite (Norman & Bray, 2020). Modular housing can also be cheaper for similar reasons, which makes it not only a sustainable option but an affordable one (Levitt, 2014). Though there are some limitations to modularity depending on choices made by the designer or user, there is still potential for modular construction as a sustainable construction option (Sonego et al., 2018). See the graphic below for a high-level life-cycle analysis of the benefits and limitations of modularity.

BENEFITS AND LIMITATIONS OF MODULARITY IN EACH STAGE OF THE PRODUCT LIFE CYCLE



Adapted from: (Sonego et al., 2018)

Sharing Economy

Markets for salvaged materials and products can extend use and prevent or slow resources from ending up in the landfill with second-hand stores like Habitat for Humanity's Restore or through alternative avenues like trading, donating and sharing within communities (Prendeville et al., 2018). The sharing economy is an alternative to the current profit-driven capitalist model (Richardson, 2015). Much like the circular economy inspires us to think differently about materials, the sharing economy is a new way of thinking about what possession of materials means. The sharing economy can be aided by digital platforms which allow peers to exchange goods and services freely, without currency (Richardson, 2015). Not only can the sharing economy promote the exchange of second-hand goods, it encourages repairing skills which help extend the life of products and materials (Prendeville et al., 2018).

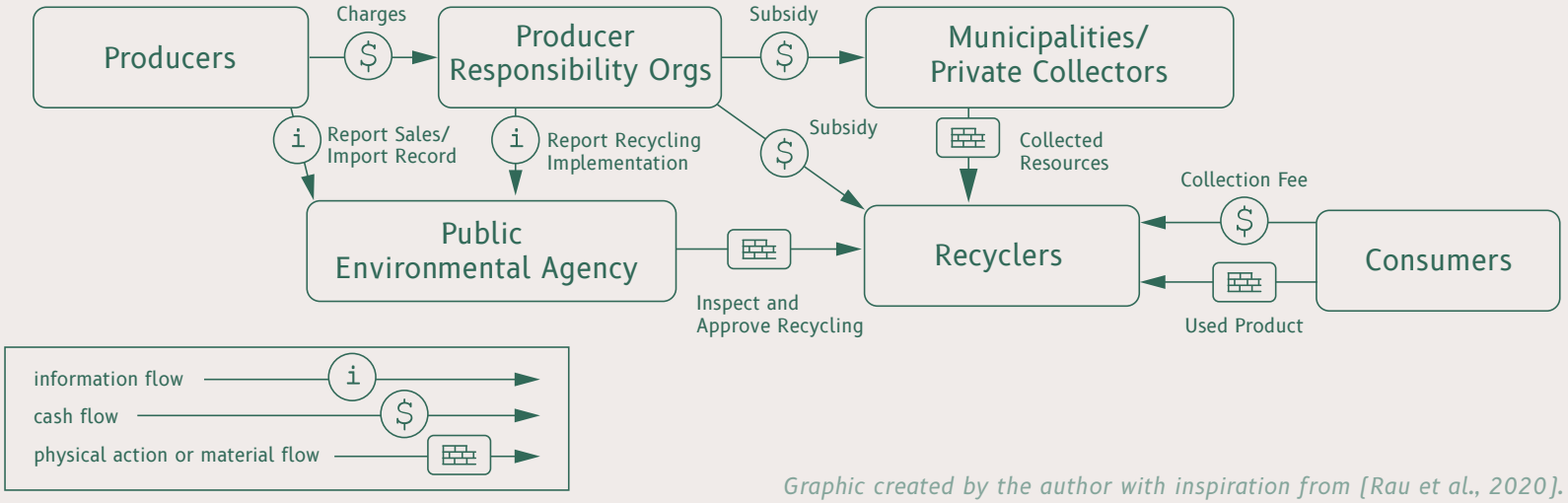
A 'Free Store' in Cornwall, Ontario has diverted more than four tonnes of waste from landfill in just 5 months.

(Vandermeer, 2021).

The City of Cornwall has provided a space at the local landfill where salvageable goods and supplies are displayed (Vandermeer, 2021). The city-owned landfill is estimated to have a life expectancy of 12 years, after which it will have to close and con no longer take more waste (Vandermeer, 2021). This simple 'Free Store' program is a win-win for both the city and residents. Many other towns across the province have reportedly reached out to the township to inquire about how they set this up and maintain it in hopes to start their own.

Extended Producer Responsibility

The province of Ontario has several programs which place the responsibility of waste diversion and end-of-life handling on producers (Waste Management, n.d.). These programs cover items like tires, electronics, hazardous waste, batteries, and bottle deposits through the Beer Store (Waste Management, n.d.). These types of programs and mandates leverage the concept of extended producer responsibility(EPR). EPR can take shape as a policy or program which puts the cost ("producer pays"), and often coordination of handling waste materials back into the hands of the original producer (What Is Extended Producer Responsibility?, n.d.). In their "Guide for Identifying, Evaluating and Selecting Policies for Influencing Construction, Renovation and Demolition Waste Management", the CCME recommends that governments look into creating producer responsibility programs for flooring, drywall, window glass, brick, asphalt roofing and engineering/treated wood (2019). Mandatory and voluntary EPR can encourage producers to re- design their products to make them easier to retrieve, re-use and recycle (Rau et al., 2020). While these programs are not always mandatory, this practice can be a wise business choice with potential to save money by salvaging materials as well as the ability to market their business as a sustainable option, setting them apart from competition. EPR policies require systems changes like the example shown below. Fees, subsidies, and inspections are used to ensure that materials are handled responsibly by producers and consumers(Rau et al., 2020).



Graphic created by the author with inspiration from [Rau et al., 2020].

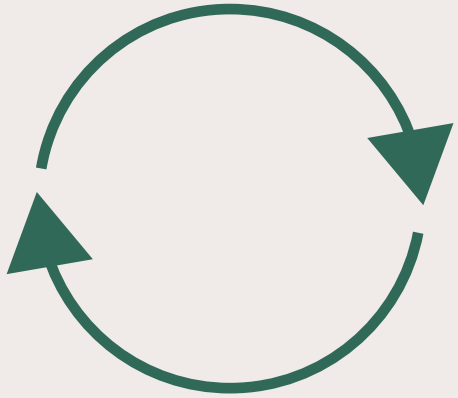
WHAT'S NEXT?

The Future

- *Recommendations*
- *Towards a Circular Economy*

THE FUTURE

Towards a Circular Economy



SOME RECOMMENDATIONS FOR THE CITY OF TORONTO:

- Develop or enable the development of programming to train industry on deconstruction practices and designate funding incentives.
- Provide waste reduction or deconstruction information and encourage the selection of circular product options early to permit seekers.
- Create a local, circular product and practitioner roster to highlight businesses that are working towards waste reduction.

On the global scale, policy makers, regulating and enforcing bodies, and waste generators must work together to reduce carbon emissions across industries in order to ensure there is a chance for a resilient future. Without intentional, strategic action and design, there is no stopping the amount of CRD waste that is on the horizon. This waste is generated for a multitude of reasons; changing needs, potential profit, aging infrastructure etc. Knowing that the future of sustainable growth cannot simply be left to reducing operational emissions, the embodied carbon and impacts on the environment and land-use as a result of unmonitored CRD waste must be reduced. There is plenty of research to back up why moving towards a circular economy would achieve significant waste prevention and reductions in the City of Toronto, and other cities globally.

To take action towards shifting the current take-make-dispose system towards a circular economy system, a multitude of strategies must be leveraged to address the many reasons waste is generated. Policies need to evolve to explicitly include regulations around construction, renovation and demolition waste. Education about the negative impacts of CRD waste and communication of the benefits of circular solutions geared towards the public and to industry is needed, and needed at strategic, critical times when decisions about design and demolition are being made. Providing the right information early in the process will enable decision makers to make circular choices by preventing and reducing waste through circular design, salvaged material selection, and creative re-use. It is a shared responsibility among stakeholders, though ultimately, producers must be held accountable for their negative impacts and must evolve to meet the new needs of the present and future generations.

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