Accelerating the Circular Built Environment Sector in Canada

Workshop SUMMARY REPORT

June 2021

CIRCULAR ECONOMY SOLUTIONS SERIES

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1. Background

In Canada, construction is one of the most important economic sectors, generating $141 billion in GDP in 2020. Simultaneously, Canada's construction sector generates one-third of total solid waste in Canada (equal to more than 4 million tonnes of waste per year). Much of the value from these waste materials and resources are currently being lost from Canada's economy at end of life.

Applying circular economy principles to Canada's construction and real estate sector could generate multiple benefits, including reducing waste and greenhouse gas (GHG) emissions; improving the resiliency of supply chains; creating new economic, investment, and employment opportunities; enhancing natural ecosystems and urban green spaces; and providing greater equity and related social benefits.

On May 27, 2021, Circular Economy Leadership Canada (CELC) and GLOBE Series convened a group of stakeholders for a solutions-oriented, interactive, virtual workshop, focusing on pathways to achieving a more circular built environment in Canada. The workshop, part of the Circular Economy (CE) Solutions Series Built Environment work stream, featured expert insights into practical applications, as well as interactive breakout discussions that allowed participants to strategize together on how to scale ideas and overcome barriers to advancing a more circular built environment in Canada. See **Appendix A** for the Workshop Agenda.

The workshop was informed by a Discussion Paper which assessed the current state of circular built environment across Canada, in line with global trends and circular economy strategies. The assessment was carried out by the Delphi Group, in collaboration with Scius Advisory, and co-sponsored by Forestry Innovation Investment and the Canadian Forestry Service within Natural Resources Canada.

The insights and recommendations from this Summary Report will be used to guide future research and virtual events or activities, including potential programming and side events linked to the World Circular Economy Forum in September 2021 and the development of a 'playbook' of resources as a deliverable from Phase 2 activities of the CE Solutions Series Built Environment Track.

Participant Profile

More than 150 stakeholders participated in the workshop from 10 provinces / territories across Canada, including representatives from construction firms, manufacturers, suppliers, property managers, educational institutions, not-for-profits, consultants, financial institutions, standards bodies, and from all levels of government. See **Appendix B** for the list of participating organizations.

In the beginning of the workshop, participants were invited to take part in a poll that assessed their organizations' awareness of circular economy (see Figure 1). In response to poll question #2: "*why is your organization considering or already working with circular economy principles*", 23% attributed it to new products or product differentiation, while 17% to risk reduction. An equal percentage of participants (13%) suggested that new revenue streams and cost reduction benefits of circular principles are motivating its adoption.

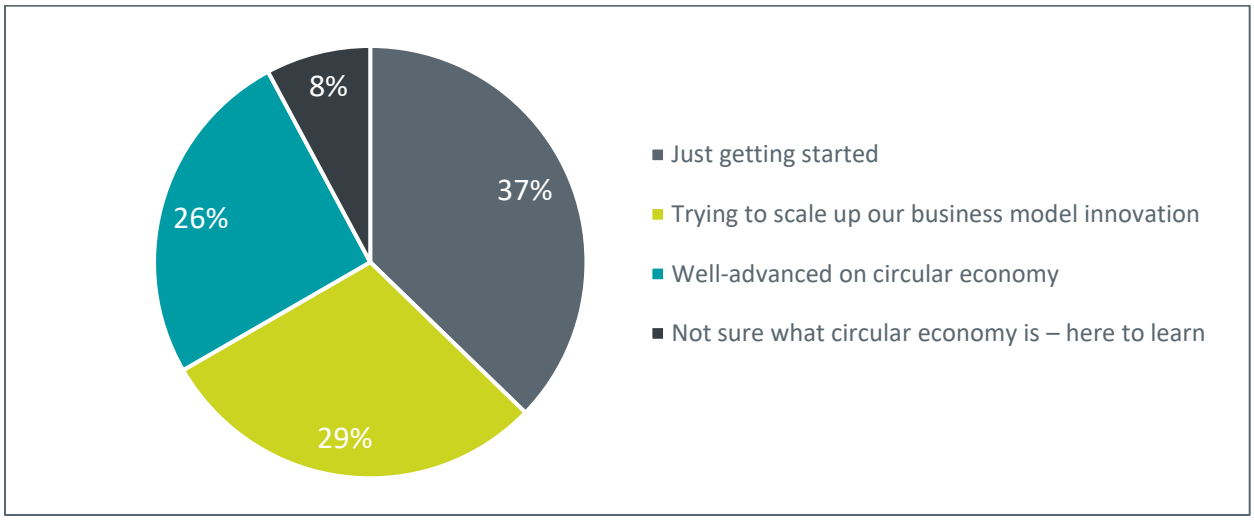


Figure 1: Responses to poll question #1: "Where is your organization in terms of circular economy awareness and business model adoption?" (N=102)

2. Key Takeaways: Plenary Presentations

Participants heard from Paul Shorthouse, Managing Director of Circular Economy Leadership Canada and the Circular Economy Solutions Series, who covered highlights from the Discussion Paper that set a foundation for the workshop. Following that, a series of industry leaders presented different perspectives on how circularity is being applied or considered across a building's life cycle.

To view a recording of the presentations, click the 'Play' button.

Context-Setting Presentations

Presenter: **Paul Shorthouse, Circular Economy Leadership Canada**

Topic: Discussion Paper Highlights

Paul is a Senior Director with the Delphi Group leading its Green and Circular Economy practice nation-wide. In February 2021, Paul took on the additional role of Managing Director at CELC, a network of leaders from all industries and sectors who are fostering collaboration, innovation, and knowledge exchange to accelerate the transition to a circular economy in Canada.

Insights

The circular economy is based on the principles of rethinking resource lifecycles, optimizing material usage, and regenerating natural systems. The circular economy seeks to design out the concept of waste from product and services, which exists in four fundamental forms:

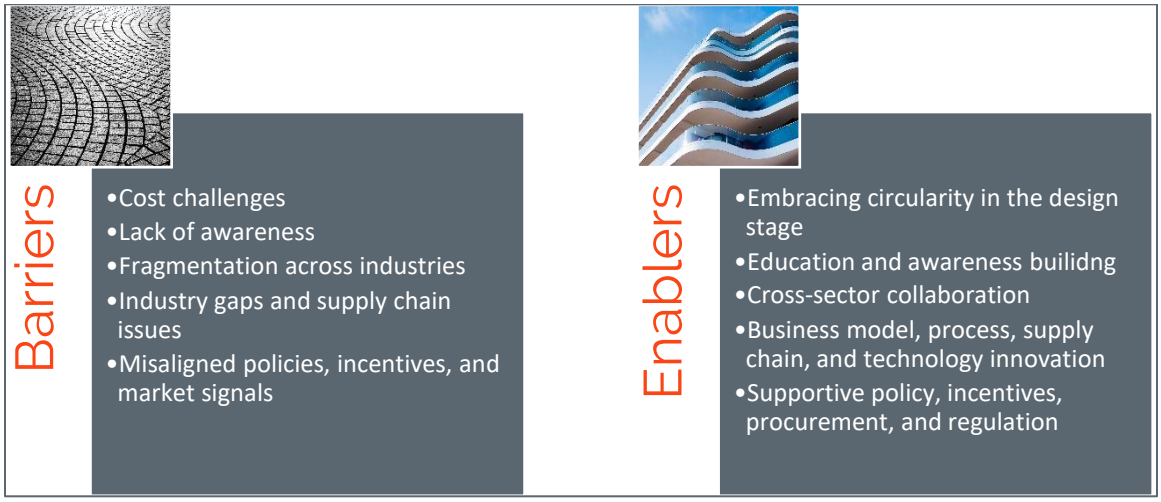
- **Wasted resources** (i.e., the use of materials and energy that cannot be continually regenerated).
- **Wasted or underutilized assets** (e.g., buildings that sit empty).
- **Wasted life cycles** (i.e., the premature end of use of buildings due to lack of repair, maintenance and/or reuse and adaptability); and
- **Wasted embedded value** (i.e., materials, components, and energy from buildings not recovered at the time of disposal or demolition through deconstruction and material recovery).

There are five circular economy business models that apply to the construction sector:

- **Circular inputs** – uses renewable energy, renewable materials (e.g., mass timber), and recycled content in products (e.g., concrete)
- **Resource recovery** – seeks to recover usable resources at the end of the product life cycle
- **Sharing platforms** – increases usage of the products by providing shared community access, often through digital platforms
- **Product-as-a service** – involves leasing or renting out assets while the producer retains ownership

- **Product-use-extension** – focuses on extending the lifetime of assets through repair, maintenance, or refurbishment

The paper outlines the enabling ecosystem which has supported the development of the circular built environment in Canada through collaboration, knowledge exchange, and stakeholder engagement. Barriers to circularity in the built environment can be overcome through the enablers that drive the adoption of circular practices (see Figure 2 below).



Source: Accelerating the Circular Built Environment in Canada Discussion Paper[1]

Figure 2: Barriers and enablers for advanicing a circular built environment in Canada.

Presenter: **Alexander Flash, Senior Architectural Designer, Arup**

Topic: Circular Design in the Built Environment

Originally from the UK, Alexander is a senior architectural designer in Arup's Toronto Office. He is a leader in Arup's Circular Economy Skills Network, which is a group dedicated to advancing the adoption and dissemination of circular economy principles in North America.

Insights:

Since 2016, Arup has been the Ellen McArthur Foundation's global knowledge partner for built environment. Alex's presentation suggests that design is only part of the puzzle, and that we need the following four circular strategies to achieve a circular economy ecosystem:

[1] See: https://circulareconomyleaders.ca/wp-content/uploads/2021/05/Circularity-in-Canadas-Built-Environment-Discussion-Paper.pdf

- **Circular policy:** The regulatory framework and includes economic activity and land use planning (e.g., planning policy that meets changing market and social demands, and district-wide resource flow strategies).
- **Circular business**: The role of the client and their operations, which cycle materials through the supply chain. It is the organizational-level value creation strategy (e.g., retrofit first policies and maximum residual value mandates).
- **Circular design:** Comprises development briefs and asset design, and is key to achieving reduced resource consumption, reduced construction and operational costs, and extended material and asset life (e.g., design layers for flexibility, adaptability, ease of maintenance, and deconstruction).
- **Circular materials:** Entails material selection and management (e.g., material passports and EPDs).

Design strategies:

- **Building in layers** – buildings should be designed in separate but interlinking layers as each layer has a different lifespan. This makes it easier to upgrade or replace the layers independently.
- **Design for adaptability** - considering the floor-to-floor heights, the floor plate depth, and core configurations so that buildings can accommodate multiple capacities and uses.
- **Design for deconstruction** – dismantling rather than demolishing buildings at the end of their usage allows materials to be extracted for reuse at their highest possible value.

Examples of circular design strategies:

- Since 2018, Arup has worked with the City of Toronto on annual temporary parklets, which are designed using a **modular base**. Thus, the City of Toronto is able to fully reuse the timber from year to year.
- Digital layers help to achieve more efficient design, construction, and operations of a building (e.g., for a circular building in London, UK, all materials were tagged with **QR codes** to facilitate tracking after deconstruction).
- The People's Pavilion in Eindhoven, Netherlands, was constructed in 2017 using recycled and **borrowed materials**. Design included easily reversible connections. All borrowed materials were returned once the Pavilion had been dismantled, and many were reused in further projects.
- The refurbishment project of One Triton Square, London (UK), used **circular facades**. This included inspecting, cleaning, and renewing each panel in a temporary off-site setup near the project. The project achieved 54% reduction in embodied carbon and 100% waste diversion.
- **Material passports** use metadata that provide a log of each component in a building, informing how components can be repurposed. In the EU, initiatives such as Building as Material Banks (BAMB) and Madaster are coordinating with material asset databases and libraries to inform this metadata.

Presenter: **Peter Sanguineti, Vice President, Lafarge Canada**

Topic: Circular Innovations in the Building Materials Sector

Peter is Vice President and General Manager for the Aggregates Division in Eastern Canada at Lafarge Canada. Lafarge is a global leader in advancing circular business strategies within the cement and aggregates sector.

Insights:

- Material innovation can drastically reduce the environmental impact that results from construction and supports the pathway to net-zero carbon.
- In construction cycles, the key opportunities in diverting, re-using, and recycling materials lie in the land-fill/disposal and demolition stages.
- Waste as a non-traditional fuel – In Europe, 50% of the thermal energy used in cement production comes from the incineration of plastic bottles.
- Transportation is a huge contributor to CO_2 emissions, so having extraction and manufacturing sites close to markets can reduce carbon footprints. This could be solved by:
    - The type of transportation.
    - Ratio of fuel consumption versus materials moved; and
    - Proximity to market.
- To divert demolition materials back to manufacturing, we need to first answer the following questions:
    - How do we qualify the materials recovered so that when reintroduced the process is stable?
    - How do we certify the final products using these materials so that users can be confident in product performance?
    - How can we ensure that recovered materials end up with the right industry, and who can maximize their usage?
    - What regulatory, economic, and political levers are required to create an efficient and effective market?

A few examples of circular materials:

- Alternative fuels for cement production (e.g., plastic, wood)
- Recycled steel, copper, wood, and other construction materials
- Recycled asphalt and concrete aggregates
- Carbon capture for cement production, mineralization
- Concrete ingredient substitution (e.g., glass, alternative fillers, recycled aggregates)

Key catalysts in overcoming hurdles:

- Planning and design – introduce sustainability and circularity from the project's conceptualization stage
- Political will – a critical and powerful change agent
- Standards and regulations – modernization and awareness to incorporate "what's possible"

Presenter: **James Salazar, Senior Research Officer, Athena Sustainable Materials Institute**

Topic: Embodied Carbon and LCA Considerations in the Context of Circular Built Environment

James is a senior research officer at Athena Sustainable Materials Institute. He is also the director of their environmental product declaration (EPD) services and has over 15 years of experience as an expert in life cycle assessment (LCA). His background is in industrial engineering and products.

Insights:

- The concept of LCA originated with a comprehensive approach to manufacturing, recycling, and recovering materials, and weighing trade-offs with all these processes in mind.
- LCA is currently a linear framework, starting from the product stage, moving through construction, use, and completing at the end-of-life stage.
- To complete an LCA, researchers sum the inputs from nature and follow all the outflows and emissions back to nature.
- LCA considers the resource savings against the potential impacts, which includes global warming potential, acidification, eutrophication, ozone depletion, smog creation, and fossil fuel consumption.

Different LCA tools:

- Software options for whole-building LCA include **Athena's Impact Estimator for Buildings** which quickly generates and compares cradle-to-grave LCA results.
    - Other software includes: **One Click LCA** and **Tally**
- One of the newer tools is **Athena's Pathfinder for Embodied Impacts** – sponsored by Forestry Innovation Investment with support from Morrison Hershfield.
- **EC3 Low Carbon Procurement Tool** is driving low-embodied carbon procurement space integrating environment product information.
- **Low Carbon Assets through Life Cycle Assessment (LCA)^2 Initiative** - National Research Council is developing better LCA data and incorporating LCA and EPDs into procurement – whole building LCA guidelines will be published soon.

Presenter: **Adam Corneil, Founder & CEO, Unbuilders**

Topic: Deconstruction and Resource Recovery

Adam is the Founder and Chief Executive Officer of Unbuilders, as well as Heritage Lumber which is a reclaimed wood brokerage. He is a certified passive house builder, as well as a deconstruction and reclaimed wood expert.

Insights:

- The construction industry wastes valuable resources – almost 1.5 million tonnes of lumber are wasted annually.

- This includes highly valuable old growth lumber, which retails for four times more than new growth lumber.
- Old growth lumber is the main material recovered from buildings constructed prior to the 1970s. Old growth lumber also:
    - Carries the history and heritage of the land that was stewarded by First Nations.
    - Is a scarce resource, rarer with every demolition and will not grow back for generations?
    - Benefits of reclaimed old growth lumber includes that it contains 12 times less embodied carbon and is three times stronger than virgin lumber, making it one of the most sustainable building materials in the market.
- Unbuilders, together with Heritage Lumber, provide circular solutions to demolition by deconstructing and salvaging the materials. These materials are resold or remanufactured.
- Unbuilders works with Habitat for Humanity to donate used building materials from deconstruction.
- Two main hurdles to the transition to circular solutions: **time** and **cost**.

Sustainability and deconstruction:

- Environmental impact: huge positive impact on the environment
    - **Deconstruction diverts four million tonnes of waste and curbs 20 million tonnes of CO_2** that would be released from the decomposition of materials.
- Social impact: makes communities heathier and more affordable
    - Preservation of history through material salvage.
    - Partnership with Habitat for Humanity contributes to the construction of affordable housing.
    - Health benefits - not contaminating landfills, recycling facilities, and communities.
- Economic impact: creates jobs and stimulates the economy
    - Deconstruction contributes to **over 45,000 jobs in BC alone**, and **250,000 jobs** nationally.
    - **$3.4 billion is generated per year through deconstruction** and reclaimed wood sales in Metro Vancouver.

Future outlook:

- Policies currently favour demolition – need immediate changes to make unbuilding an industry standard.
- More opportunities to incorporate used building materials in new construction and renovations.
- Low impact design such as prefab, off-site construction, and design for disassembly can support waste minimization goals.

Presenter: **Jo-Anne St. Godard, Executive Director, Circular Innovation Council**

Topic: Driving the Demand for Circular Materials and Resource Recovery through Procurement

Jo-Anne is an Executive Director with the Circular Innovation Council, formerly known as the Recycling Council of Ontario. She also leads the Circular Procurement Center of Excellence. She brings a wealth of expertise to the development of policies and practices in environmental outcomes, using a market-based approach.

Insights:

- Circular procurement involves sustainable interventions within the linear economy to intersect the two different approaches. Looks at construction as a system not as a process.

Why public procurement?

- Circular products and services require circular buyers; we need to change the way we demand products.
- Governments are pacesetters and market shapers as it relates to their enormous buying power and funding power.
- Public procurement represents 13% of Canada's GDP, equal to $30 billion annually.
- Government directly influences public procurement - such as direct spending on goods and services (4,500 owned and operated facilities); stimulus to the economy; funding to other governments and organizations; training and employment.
- There is a disconnect between the economic, environmental, and social pillars in how the government buys. Circular procurement tries to bring these pillars, or triple bottom lines, together for more sustainable purchasing.
- Tendering for performance versus tendering for specification:
    - Look at procurement in terms of how it can satisfy broader objectives and drive performance as opposed to tendering for specific types of goods, materials, or designs.
    - These objectives include:
        - Carbon neutrality
        - Low impact goods
        - Zero waste
        - Local employment
        - Local economic stimulus
- Circular construction cheat sheet:
    - Planning, planning, and planning – forethought on outcomes and how to achieve them.
    - Defining values and focusing on outcomes – draft performance-based RFPs and challenge designers with those outcomes.
    - Lowest cost up front does not mean lowest cost overall - what might the economic cost be during the building, use, and end-of-life cycle?
    - Work early and often with contractors, tradespeople, and suppliers – encourage creativity and innovation.
    - Pick a few success indicators: track, measure, and share.
    - Use market insights and indicators to inform the development of circular procurement specifications to engage circularity in construction.


Credit: Unbuilders

3. Key Take-aways: Breakout Discussions

Following the context-setting presentations, participants joined breakout room discussions based on their areas of highest interest. The breakout rooms were designed to align with the circular building lifecycle that was identified in the Discussion Paper and other recent research. The breakout rooms were led by industry experts who guided the discussions using three overarching questions:

- **Question #1:** What is the current 'state of affairs' in Canada on this topic and what are the leading initiatives we should look to build off (either in Canada or internationally)?
- **Question #2:** What are the key issues and/or barriers we need to address to move the market (consider issues / barriers related to policy, technology, market, price, etc.)?
- **Question #3:** What are the top 3 priority areas we need to focus on in Canada over the next 12 months to address the key issues and move the dial?

Participants were invited to share their knowledge and apply learnings to tackle challenges in line with each of the pathways, and outline the next steps using open discussion and the chat box. Below is a summary of key points from each breakout room discussion.

Topic #1: Circular Design in the Built Environment

Room 1

Circular design considerations:

- Standards for DfD/A exist, however these are still voluntary.
- A significant problem is that buildings simply are not designed to incorporate used materials. Thus, this requires working closely with manufacturers and designers/engineers.
- How to make components more valuable for reuse? What is needed for reuse?
- The 9 Rs circular economy framework (see Figure 4 here) for eliminating waste should be considered in the design stage.
- Supply chains need to include all materials and be performance-based, regardless of material.
- Life cycle assessment could be first introduced as an optional measure, but then made mandatory.
- In BC, the Energy Step Code is moving building towards high performance, but the focus is only around energy efficiency and does not include other environmental performance metrics.

Education and awareness building:

- There is a lack of awareness for how to recycle and reuse materials. For instance, suppliers do not really know what circular products are.
- More communication and understanding are required around circular design and deconstruction.
- Currently, an ISO standard is being developed, which may aid the understanding of circular initiatives.
- Education is really needed - people need to understand that design for deconstruction is possible and that it has benefits even if it is not immediately obvious.
- Skill gap – we need to have people who have the skills to deconstruct.

Policy and regulation:

- Provinces / states in North America are committed to having standards for waste, but they have not actually been enacted.
    - For instance, Washington State does not require engineers to recertify the integrity of materials for reuse (e.g., 2x4s).
- Creating incentives for developers and builders to incorporate deconstruction can be a solution. For instance, a deposit is put down and then a refund is issued depending on waste diverted.
- Regulations are needed that set foundations and then gradually need to be increased.
    - We need to make deconstruction policy the norm at the municipal level. This may include developing a list of products that have end-of-life problems
    - More unified approach – performance-based policies that consider all areas.
    - Federal and provincial leadership are necessary to push the circular economy forward.

Room 2

Client-side education to drive demand:

- Participants felt that more could be done with client-side education to promote circular design in the built environment.
    - Clients need to understand the monetary and ecological value of circular design, to drive more demand.
    - Moreover, architects also need to sell the aesthetics of circular design to clients, to increase demand.

- Designers and architects also need to be aware of the option for design for disassembly.
- If clients are given the option to save money, they will choose to do so. Thus, despite the growing interest in circular design, the cost differentials make it hard to persuade clients to choose this option.

Cultural shift around material usage:

- The construction industry currently takes a "fast fashion" approach, with short-term thinking and a "build quick, large, and cheap" mentality.
- A culture change is needed in North America through a systems view of the benefits across the economy. We can look to Europe, where they not only design for longer terms but also attribute value to the environment.
- The adoption of circular economy practices and principles, such as "industrial ecology", can change the premise of material usage:
    - This concept suggests that everything that is produced should be used in some stage or process.
    - If the materials produced cannot be used, then the process must be adjusted and revised to allow for perpetual re-engagement of outputs and inputs in material and energy processes.

Economic and policy incentives to create market demand:

- Design for disassembly is a familiar concept, yet it is not widely implemented due to a lack of incentives and demand from developers.
- Participants suggested integrating a rating system, similar to the green building certification standards, to encourage taking into account design for disassembly and embodied carbon.
- BREEAM and Building as Material Bank (BAMB) driving demand in Europe.
- Policies to mandate circular design can provide incentives for design for disassembly.
    - It can be a chicken or egg situation - if mandating comes in, then the infrastructure to reuse and recycle the material will be established.
    - But at the same time, we also need infrastructure for those implementing design and disassembly so mandates can be executed.
    - Thus, we need change on infrastructure and policy simultaneously.

Topic #2: Deconstruction and Resource Recovery

Room 1

Salvaging used materials and creating markets:

- The storage of materials from a deconstructed building can be challenging.
- Deconstruction does have several layers to it that are complicated and can appear as a deterrent to participation.
- For buildings that are deconstructed in parts, two separate hubs are required: one for receiving dismantled parts and another for sales.
- *Nexii* is a startup working on designing for deconstruction. which has a showroom in Squamish to demonstrate ease of deconstruction.
    - Key challenge faced by Nexii- what to do with panels when they are not reusable, and how to recycle and repurpose them into something else?
- *Trina* is a company developing micro urban infrastructure in Calgary using recycled/salvaged materials. Looking to build in public spaces.
- Next step - Supporting demand for recycled and reclaimed products to ensure a consistent market.

Creating demand for deconstructed materials through public procurement:

- One of the key barriers for local governments is they need to know if buildings are going to be deconstructed - will there be demand for that material and how will demand be created for the material?
- Currently, companies in forestry do not have clarity on how and where to sell their wood products. Circular procurement can create the infrastructure and regulation to sort the demand and supply, so that the market forces can be at play.
- The City of Richmond has a bylaw mandating 75% recycling in demolition, which is complemented by the circular procurement policy, led by their Sustainability Department.
- Addressing regulation for procurement:
    - Unbuilders wants to take on R&D around the process of regrading lumber.
    - Now that there is going to be a lot more reclaimed lumber on the market, there is a need for governments to clear red tape for reclaimed lumber to be used in new construction.

Cost considerations:

- Industries' reaction to cost is a challenge - how to communicate those costs in one area are leading to lower overall costs in deconstruction efforts or per tonne basis for GHG reduction?
- Is there a place for economies of scale or making the process more efficient to reduce cost?
    - They are working towards creating a market for the materials.
    - How to automate deconstruction? That is something the industry has not figured out (e.g., automating de-nailing).

Policy as an enabler:

- There is a challenge on multiple building codes or ambitions being pursued by cities (e.g., Vancouver is more ambitions than many other cities)
- Construction of buildings at the provincial level has many different policies and regulations involved, which makes the process very slow.
- Governments are trying to build confidence around deconstruction within the discussions around building codes, similar to what the BC Energy Step Code has done for green buildings.
- Would national policy on using reclaimed lumber in construction help in easing barriers to using materials?
    - There are differences across provinces in the use of reclaimed concrete and wood, which may pose a challenge.
- Next step - creating regulation/policy that reduces red tape.

Room 2

Market demand to support resource recovery:

- Currently, cost and supply chain issues are key barriers to deconstruction and resource recovery.
- Sorting is a big and vital component of resource recovery.
    - There are people who will sort through construction waste looking for valuable materials. In some locations, such as the City of Victoria, regulation is starting to embed C&D sorting requirements, but it remains largely voluntary across the country at the moment.
- There is a need to find space to deconstruct and sort materials; however, cities often lack affordable land and the infrastructure to allow for this.
- Should consider identifying and banning / avoiding materials that are problematic right from the design stage (e.g., spray foam).
- We need to make sure supply chains exist and then make connections between supply and demand.

- Example from the City of Toronto:
    - Toronto had an enormous amount of wood waste in landfill from urban forests / parks
    - A pilot project (micro economy level) was conducted to mill some of this wood. The City brought in a micro mill and set it up for this project.
    - The City distributed the wood into the local design community. Evidence for how to use this material – drove demand.
    - The project was very successful – it considered both supply and demand sides of the equation.
- The cost narrative around lumber is a challenge. We need to incentivize for material reuse to harness this opportunity.
- We need to raise awareness about the value of materials and new business models.
- Supply chain integration and business model innovation example:
    - A construction firm recently bought a deconstruction firm to tender on projects to ensure material quality.
    - The deconstruction firm supports the process behind their proposals for new buildings.
    - The construction firm also took over a digital platform as a marketplace for materials that are available.

<u>Training and capacity building:</u>

- Many organizations in the US are providing training to drive capacity building and employment in deconstruction. Examples include: Futures Minnesota (also houses people); Building Deconstruction Institute (in Bellingham, WA); Second Chance.
- Building Deconstruction Institute does a one-week training program in Bellingham. It provides an opportunity to bring new people into the sector with the 'green jobs' lens and build back better / recovery perspective (e.g., women, etc.).

<u>Issues around warranty and quality:</u>

- Knowledge of building materials and their traceability is important.
    - Breaking down materials by categories and looking for alignment on how materials are handled.
- Tracking materials and how they are used – material passports which allocate digital identities to products during the design stage is a good example of this.
- Cost of construction goes up if wood is not grade-stamped as engineers need to be paid to certify its safe use – this needs to be addressed to ensure reclaimed / recycled content materials can be integrated into projects in a cost competitive fashion.
- Also need to engage with and educate building inspectors, engineers, and those who write the codes to allow for the use of recovered materials.

Topic #3: Embodied Carbon and LCA Considerations in the Context of Circular Built Environment

Room 1

Accessibility to standardized metrics and information on best practices:

- In the last several years, the focus of the industry has been on getting the operation energy down to net zero. Now, the next step is to figure out how to achieve zero embodied carbon.
- One of the key challenges to this goal is the lack of standardized measures to track carbon footprints.
- NRCan has a carbon calculator tool that connects back to the operational side work. It considers operational carbon and embodied carbon emission reductions.
- The commercial building industry is yet to build a comprehensive guideline of low carbon materials
    - How can we make low carbon materials?
    - Given that the accessibility of lumber is challenging, are there other materials we can use to replace the traditional materials?
    - How to use substitutes effectively?
- Extensive data on embodied carbon of varied materials are lacking. We need to start developing standardized databases so we can "compare apples to apples."
- On the operations side, we need to document best practices to make maintenance more energy efficient so that we can develop the embodied carbon of a building's lifetime.

Education and engagement for professionals involved in all aspects of the construction industry:

- There is growing interest in embodied carbon among all levels of stakeholders in the construction industry.
- However, the expertise on this topic has been just limited to conversations, and not so much has been done to put potential policies into practice.
- To tackle this "lack of motivation," it might be helpful to engage different stakeholders to embrace this new idea of low carbon building.
    - The University of Waterloo has several student clubs that are looking at sustainable practices and low carbon emission practices in buildings.
    - The City of Richmond's sustainability team is now prioritizing engaging industry stakeholders from architects, suppliers, etc., to create readiness in the market. The focus is to create a fertile ground for policies through a good market ecosystem.

Room 2

Linking LCA with circular initiatives using a quantitative approach:

- So far, the discussion around materials and LCA have been mostly qualitative. We need to develop a material-specific strategy informed by the quantitative evaluations of materials and their current practices. This could be the foundation of developing a broader policy framework.
- There are intuitive connections between circular economy and embodied carbon, but how do we ensure that they are evaluated using comparable metrics?
    - Embodied carbon is explicitly based on carbon emissions, while circularity can be evaluated on a material's mass.
    - Whole-building LCA is calculated using material quantities – so there is an overlap with measures of circularity.
- The City of Vancouver has a target of 40% reduction of GHG emissions by 2030. Part of the challenge in achieving that goal is to establish and refine a baseline to evaluate the change.

- One of the barriers is having a clear definition of and tools to quantify the embodied carbon of a project and how these change at the end of a building's lifecycle.
- How can we use LCA to evaluate different end-of-life pathways for key materials as we are deconstructing or demolishing?
- How do we quantify the benefits of circularity associated with recycling or reusing materials for the next product using LCA?
    - All the recycled materials do not have equal "embodied carbon" benefit.
    - For instance, recycled metals have more carbon benefits than aggregates, which is not necessarily replacing concrete.

Collaborative models for contracts:

- We need a regulatory framework that espouses a collaborative model.
- Embodied carbon considerations are not top of mind when designing most projects.
- In the design-build scenario, the specifications are put out and designers often stay away from specifying embodied carbon given potential cost considerations that might put a project over budget.
- A collaborative model is beneficial from a design standpoint, as the contractor can exchange ideas back and forth with the designers.
- Designers can also take the time to find and source low-carbon materials.

Topic #4: Circular Innovations in the Building Materials Sector

Room 1

Incentivizing the use of circular and recycled materials:

- The huge amount of the single-use waste at job sites provides a large opportunity to rethink recycling of this material.
- The current policy framework makes it too cheap to throw materials into landfills.
- Policy at all levels can be a driver – governments could impose financial penalties for wasting materials and subsidize the cost of recycled materials instead of using virgin materials.
- Oftentimes, recycled materials are not allowed to be used in construction because of safety standards. A certification process is required to allow recycled wood to be used in buildings, for example.
- Similarly, municipalities do not permit the use of recycled materials in roads. A call for increased use of recycled materials is required.
- Developers need to be incentivized to use recycled materials – they are often not around for the end-of-life of a building so do not always see the value.
- Government procurement can be a solution – the government can mandate recycled content percentages in contracts and RFPs, such as the use of wood products and recycled aggregates.

Creating robust circular infrastructure:

- In Europe, higher tipping fees and lower availability of land has allowed for a more sophisticated system of waste management and classification to be developed.
    - For example, in England, plastic is pre-sorted before it arrives at landfill sites.
- Waste haulers have a significant role to play in this circular ecosystem.
    - If local landfills increase tipping fees, haulers may divert their attention to other landfills across the border. There is a need to take haulers into account while pushing for changes.
- Existing long-term contracts and incentives may make it difficult to set up new systems in municipalities.

- Circular buildings require long-term suppliers. Municipalities need to take control of the waste stream, to ensure a steady supply of recyclable materials.
- More formalized industrial symbiosis is now mandated in the EU, which involves structured processes with facilitators.

Room 2

Extending longevity of buildings using innovative materials:

- LCA considerations mean we need buildings that can last over a few centuries, to reduce the embodied carbon over a building's lifecycle.
- This raises the question of what kind of materials do we need, and what is the time required to regenerate them?
- The goal is to sustain the durability of buildings long enough for the materials used to construct them to regenerate.
- Further discussion and research are required in this area.

Mitigating investment risks associated with longer timelines for the built environment:

- The present investment system is set up to support and drive decisions based on short-term thinking.
- Buildings involve a high-risk and slow investment process as it takes a lot of time to design and build them.
- The investment costs that drive circular innovations are high. In general, investors have been reluctant to invest in this area.
- The "Valley of Death" perspective - it takes a significant investment to get the initial technologies and infrastructure in place.
- By introducing circularity, the timeline risk is further extended.
- Investments or innovation funding, supported by policies, are required to ease through the "Valley of Death" phase and mitigate the timeline risk.

Internalizing costs of environmental externalities:

- The current accounting system takes only the monetary value of materials into account and excludes environmental externalities. This creates a financial incentive to build with circularity, especially when the building takes longer to construct.
- The current "throw-away" culture is enormously powerful as there is no economic deterrent in place.
- We need to go beyond the accounting costs of materials and add valuation to ecological and environmental externalities. This way, the true benefit of adopting circularity is reflected, allowing market forces to operate in line with the goal of circularity.
- Regulatory frameworks can help quantify the economic benefits of circularity, as well as create a robust ecosystem for reusable and circular material markets.
- Policies that encourage investment and funding towards circularity can also aid in reducing the costs.

Topic #5: Driving the Demand for Circular Materials and Resource Recovery through Procurement

Room 1

Total cost of ownership as a central tool for procurement:

- Many projects are driven by time and financial constraints. For instance, Québec has severe limitations on pursuing anything other than the lowest-cost procurement options. As such, there is a need to specify circularity inherently within projects.
- Some engineering firms have been pushing for more circular approaches to municipal waste processing facilities but are facing barriers in that they were only supposed to be designing the basic physical structure of the facility, not elements such as:
    - The use of more sustainable building materials.
    - A programming plan for circularity once the facility is developed.
    - Effective management and ways to limit construction waste.
- Integration of a total cost of ownership model to all procurement may help circumvent the cost barrier as the lowest sticker price does not preclude long-term cost savings.

Introducing tangible criteria, specifications, and measures to create confidence:

- New and innovative circular material and product manufacturers / suppliers struggle to get specified into projects given lack of awareness and/or risk aversion from public sector buyers.
- The lack of confidence stems from unclear criteria and specifications in procurement.
- Tangible criteria, specifications, and measures for circularity that are staying within the law and other procurement rules could boost buyer confidence.
- Supportive policy and incentives for using specific product streams, like upcycled materials or third-party certifications, could aid in this regard.
- Another step could be translating minimums of performance from major policy priorities into more concrete directives at the procurement level.
- Clear directives mandating circular economy in government procurement can also be helpful.
    - For instance, public sector procurement at PSPC where GHG reductions mandated by the Government of Canada have made it easier for PSPC to pursue circular solutions - moving to a 25–30-year lifecycle of costs for both GHGs and money has made it even easier.

Education and change management within procurement departments:

- Cultural shifts inside procurement and design departments are required to develop an integrated design process.
- This also encompasses change management within all buying organizations.
- Back-end economic and industry capacity building could be helpful to prepare architects, engineers, and product suppliers to better integrate innovation into government, CE-oriented procurement processes.

Room 2

Addressing silos between municipal purchasing departments:

- Municipalities are large organizations, thus getting strategies and priorities to align can often be challenging.
- For instance, purchasing departments are usually focusing on first cost rather than life cycle cost, and there is a significant resistance to change.
- It can be difficult to have purchasing departments consider merging objectives around cost savings, bulk buying, and sustainability options.

- People working in procurement often have been given different directives. Capital procurement is in a different office from the people who manage operations and maintenance.
- There also seems to be political hesitancy to buy into things that may not have significant returns right away given typical 4-year cycles.
- Education and engagement are the key to solving some of these issues, including educating other departments (such as operations, maintenance, and purchasing) on sustainability goals and objectives to bridge the gap between high-level commitments on the group implementation.
    - For example, operations and maintenance and building users need education on how to optimize the sustainability features of buildings.

<u>Need for sectoral leadership to create a coordinated approach:</u>

- The standards for materials in the industry are currently varied and generally rely on prescriptive approaches. Thus, the actual demand for low-carbon materials is not well-documented (an example of such a material is recycled aggregates).
- The construction sector is heavily siloed, so we need a coalition to bring together the different stakeholders and advance together as an industry. Since competition is strong in the sector, the question remains: how can we unite to build a cohesive sector?
- The sectoral approach also requires a leading voice to coordinate the fragmentation. This needs to be a group effort and be industry wide.
- To incentivize demand for circular materials, we need to unify standards for building materials.
- The federal government could play a significant role in harmonizing a common baseline among provincial governments.

4. Cross-cutting Considerations

Throughout the breakout group conversations, a number of common cross-cutting themes emerged related to key issues and barriers as discussed below.

Cost challenges

- Industry attitude towards the higher costs of transition to a more circular built environment poses as a major deterrent.
- Traditional accounting approaches, which not only omit externalities but are heavily capital-focused, both over-state the upfront costs of circular approaches and also miss the long-term financial and non-financial benefits of circular approaches to capital assets.
- The industry has not yet developed or meaningfully adopted methods or processes that can generate significant economies of scale from deconstruction, such as whole-lifecycle cost accounting and inclusion of environmental and social externalities.

Industry resistance

- The construction industry is built around the myopic "build quick, large, and fast" mentality, which makes accommodating for circularity difficult – many government procurement processes similarly embed this thinking.

Infrastructure gaps

- There are no standards to circular materials, leading to ambiguous understanding of what the products entail.
- Lack of materials management infrastructure to allow for of sorting materials, which limits the supply chain for recycled/reused materials.
- Upcycled and recycled materials are deterred from being utilised in projects due to regulatory issues or potential liabilities stemming from lack of standards/ certification.
- Market demand mechanisms, such as procurement strategies, consumer awareness, and industry education, to stimulate consumer demand for circular and sustainable products are missing.
- Lack of standardised metrics around measuring embodied carbon.

Lack of information, knowledge, and awareness

- There is room for client-side education to drive up demand for circular solutions.
- There is a lack of understanding of the terms and significance of different circular built environment pathways, such as circular design and deconstruction – these are industry buzzwords that some people know but most do not fully comprehend.
- While standards exist for practices such as design for durability and deconstruction, there is a low level of awareness for these and their adoption.
- A lack of data on materials contained within existing buildings makes it challenging to know what value is contained, as well as how to extract this value at end of life.
- Plastic is highlighted more in waste/materials awareness campaigns, with little to no focus on other recyclable/reusable types of materials.

Disconnects across the stakeholder value chain

- Fragmentation across the construction sector prevents harmonized efforts on circular solutions.
- While models such as integrated design processes and integrated project delivery exist, they are not mainstream or mandatory, despite their potential to deliver more of the cross-sector approaches and systems thinking required for accelerating circularity in the built environment sector.

Lack of supportive policy and/or regulation

- There are no performance-based policies that take into account all of the full current and potential lifecycle of materials that could lead to greater circularity.
- Construction of buildings have many different policies and regulations involved across provinces and local governments, which makes industry-wide adoption and market transformation slow and challenging due to the lack of harmonization.
- Lack of coordination across jurisdictions and authorities results in sporadic and fractured action, which reduces or eliminates potential economies of scale.

Misaligned policies, incentives, and market signals.

- Design for disassembly is not new; however, it has not scaled up because of a lack of economic incentives and policy barriers, as well as low demand from developers and building owners who lack consideration for a building's end of life.
- The current economic and policy framework rewards a "throw away" culture, as it is cheaper to dispose of materials rather than to recover and/or recycle and reuse them.
- Public procurement is driven by prescriptive standards instead of based on performance measures, which means it is often the lowest-cost bidder who wins the RFP rather than the one with best overall value.

Additionally, a poll conducted during the workshop suggests that **nearly one-in-five (19%) of respondents felt that the present business case for circularity is challenging**, while an equal segment of respondents saw the **lack of demand** as hindering action and adoption of related business models.

Other common barriers reported include **difficulty making connections and collaboration across the value chai**n (13%), **supply chain barriers** (12%), **barriers to understanding related policies** (9%), a l**ack of training opportunities and access to relevant skilled workers** (9%), and **difficulty in securing financing** (7%).

Metric Modular, courtesy naturallywood.com

5. Summary of Actions & Recommendations

Participants identified the top areas to prioritize over the next 12 months in order to accelerate circularity in Canada's built environment, construction, and real estate sectors. These areas, summarized below, should be considered as opportunities for further engagement and research, enabling deeper dive discussions to address barriers and advance the solution pathways and strategies.

1. **Circular Design:**
   - Increase education and awareness around circular design among different stakeholders (such as clients, architects, and investors).
   - Support Integrated Design Processes and Integrated Project Delivery approaches with circular built environment principles.
   - Advocate for and provide capacity-building to create cultural change around circular design to accommodate not only the longevity of buildings but also to attribute value to the materials contained within buildings.
   - Establish policy, regulations, standards, and incentives, as well as infrastructure, to support design for disassembly and design for adaptability / flexible building use.

2. **Embodied Carbon and LCA Considerations:**
   - Increase accessibility to standardized measures of LCA and for embodied carbon.
   - Develop material specific LCA studies, recognizing the current practices, the regional differences, and the best uses and applications for these materials.
   - Update the National Buildings Strategy to be inclusive of operational and embodied carbon, resiliency, and circularity.

3. **Circular Materials and Supply Chain Innovation:**
   - Demonstrate the business case for the circular built environment through case studies, resource toolkits for industry, and knowledge sharing.
   - Support Integrated Design Processes and Integrated Project Delivery approaches with circular built environment principles. Advocate for a sectoral leadership strategy from industry to unite standards for materials and address the silos in various parts of the construction supply chain.
   - Begin tracking materials and how they are used, starting at the design stage, using a digital identity (e.g., material passports).
   - Internalize costs of environmental externalities using policies to make circular materials more economically competitive.
   - Develop an innovation fund and grants designed to support R&D and innovation into low-carbon and circular building products and materials.

4. **Deconstruction and Resource Recovery:**
   - Create supportive and harmonized policies, including regulation and incentives to drive more deconstruction practices, including a focus on addressing 'red tape', enhancing diversion targets and EPR, improving permitting, and banning specific problematic materials.
   - Develop and share best practices and case studies to shape the positive narrative, with the potential to link to economic recovery, better jobs, and other benefits to increase acceptance and awareness on deconstruction.
   - Improve knowledge and capacity (within trades, engineering professions, architects, and building officials and code inspectors) to support design for disassembly, deconstruction, and related practices from the beginning of a project, as well as the value of materials and resource recovery business models.
   - Engage with building inspectors, engineers, and those who write the codes to allow and encourage for the use of recovered and recycled materials.

5. **Circular Procurement:**
   - Utilize government procurement to drive the demand for recycled materials by allowing for circular products and more recycled content within building and construction RFPs and contracts, as well as demonstrate best practice to other buyers.
   - Support economic and industry capacity building to prepare architects, engineers, and product suppliers with integrating circular considerations into procurement processes.
   - Develop guidance for governments and major institutional buyers on circular procurement that includes specific criteria, measurements, and considerations for existing standards, to create both technical and and legal comfort with circularity practices.

Appendix A – Workshop Agenda

Below is the agenda from the workshop hosted on May 27, 2021.

Program Overview	**Timing**

<u>Plenary 1:</u> Opening and Context Setting Presentations
Format: Plenary
 	
<u>Introductions, Session Objectives & Agenda</u>
• Host: Paul Shorthouse, The Delphi Group / Circular Economy Leadership Canada
• Highlights from the Discussion Paper
 	
<u>Context-setting Presentations</u>
An overview of the circular built environment on the global level, the potential opportunities and challenges, and current landscape in Canada.
• Topic #1: Circular Design in the Built Environment
  ○ Presenter: Alexander Flash, Arup
• Topic #2: Circular Innovations in the Building Materials Sector
  ○ Presenter: Peter Sanguineti, Lafarge Canada
• Topic #3: Embodied Carbon and LCA Considerations in the Context of Circular Built Environment
  ○ James Salazar, Athena Sustainable Materials Institute
• Topic #4: Deconstruction and Resource Recovery
  ○ Presenter: Adam Corneil, Unbuilders
• Topic #5: Driving the Demand for Circular Materials and Resource Recovery through Procurement
  ○ Presenter: Jo-Anne St. Godard, Circular Innovation Council
	65 mins

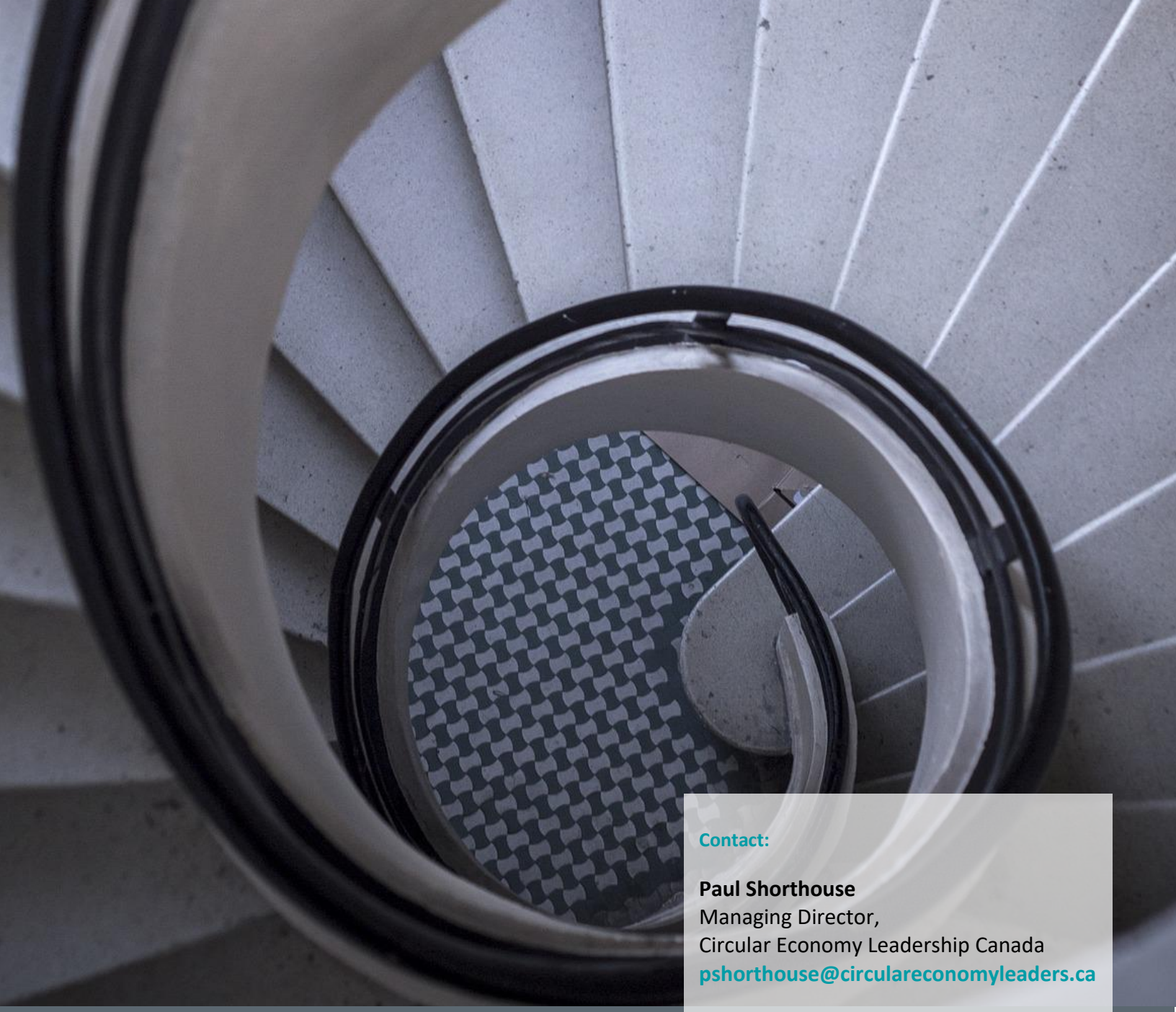
<u>Breakout Discussions:</u> *Format: Breakout Room Discussions* The breakout rooms were designed to align with key pathways that were identified in the Discussion Paper and other recent research, which is based on the circular building lifecycle. Participants pre-selected their breakout topics of highest interest as part of the registration process. <u>Topic #1: Circular Design in the Built Environment</u>: • Room 1 Lead: Alexander Flash, Arup • Room 2 Lead: Vince Cataldi <u>Topic #2: Deconstruction and Resource Recovery:</u> • Room 1 Lead: Adam Corneil, Unbuilders • Room 2 Lead: Rita Farkas, Metro Vancouver / NZWC	45 mins

<u>Topic #3: Embodied Carbon and LCA Considerations in the Context of Circular Built Environment</u> • Room 1 Lead: James Salazar, Athena Sustainable Materials Institute • Room 2 Lead: Alex Hebert, BCIT <u>Topic #4: Circular Innovations in the Building Materials Sector</u> • Room 1 Lead: Melissa MacDonald, Lafarge Canada • Room 2 Lead: Andrew Goodison, FPInnovations <u>Topic #5: Driving the Demand for Circular Materials and Resource Recovery through Procurement</u> • Room 1 Lead: Jo-Anne St. Godard, Circular Innovation Council / Circular Procurement Centre of Excellence • Room 2 Lead: Helen Goodland, Scius Group	
Plenary 3: Report Out & Wrap-up *Format: Plenary* Collective return to the plenary for close out, including: • Facilitators briefly report back on the key takeaways from group discussions. • Closing and next steps / wrap-up. ○ Host: Paul Shorthouse, The Delphi Group / CELC	10 mins

Appendix B – Participating Organizations

Abrafo Negajoule Inc.
Aduro Clean Technologies
Advanced Chemical Technologies Inc.
Allego Global Corp.
Arup
ASI
Astra Burka Design
BC Climate Action Secretariat
BC Ministry of Energy, Mines and Low Carbon Innovation
BC Ministry of Environment and Climate Change Strategy
BC Public Service
BCIT School of Construction and the Environment
Belnor Engineering
Bernhardt Contracting
BioApplied and Performance Biofilaments Inc.
Biosirus Inc.
BizBiz Share
BOMA Canada
BridgeTownWorks
Buildgreen Products
Building Resilience Coalition
Canada Green Building Council
Calmura Natural Walls Inc.
Canada Post
Canadian Health Association for Sustainability and Equity
Canadian Home Builders' Association
Canadian Wood Council
CANNOR
Capital Power
Case
CEI
Centre for Greening Government (Government of Canada)
CERIEC - ETS
Cermaq Canada
CG Toronto
Chandos Construction
CHC
CHE
ChopValue
Circular Innovation Council
City of Brampton
City of Calgary
City of Edmonton
City of Kamloops
City of Lethbridge
City of Montréal
City of Nanaimo
City of Richmond
City of Timmins
City of Toronto
City of Vancouver
City of Victoria
City of Windsor
City of Yellowknife
CoEnergy Co-operative
Concert Properties
Consulate General of the Kingdom of the Netherlands
CPC
CSA Group
Delphi Group
Demxx Deconstruction
Dillon Consulting
District of Squamish
DreamZero
Ecoinspire
eco-Options Energy Cooperative
Ecowaste Industries
ECPAR and Université laval
Enerpro Systems
Environment and Climate Change Canada
EOS Eco-Energy
Ethos Assets
Fiix Inc.
Force of Nature
Forestry Innovation Investment
FP Innovations
Geocycle Canada
Government of Manitoba Climate and Green Plan Implementation Office
Green Spark group
GreenDev Inc.
Halifax Regional Municipality
hcma Architecture + Design
HP Canada
HSR Zero Waste
Indigenous Services Canada
Innovation, Science, and Economic Development Canada
International Royalties Corp.
Ivanhoe Cambridge

Kraft Heinz Canada
Kwantlen Student Association
Lafarge
Lakehead University
Let's Talk Trash
Library of Parliament
Light House
Luiken International Inc.
Mantle Developments
Metro Vancouver
Morrison Hershfield
Municipality of Victoria County
Nanaimo Recycling Exchange Society
National Energy USA
Nav Sha Inc.
Nexii Building Solutions
NISP Canada
National Research Council of Canada
Natural Resources Canada
Odgers Berndtson
OSS
Packaging Association of Canada (PAC)
Pacific Institute for Climate Solutions
Perkins and Will
Petawawa Biofuel
Petro-Techna International
Provincial Health Services Authority
PLAEX Building Systems Inc.
Polytechnique Montréal
Prime Strategy and Planning
Priopta
Progressive Planet Solutions Inc.
Progressive Strategies
Project X
PSJJ Holdings
Public Services and Procurement Canada
Purpose Building
QuadReal
Royal Bank of Canada
RDH Building Science
Recycling Council of Alberta
RECYC-QUÉBEC
Research Money
Sage software
Saint-Gobain
Sea to Sky Removal
Senate of Canada
Share Reuse Repair Initiative
Smart Prosperity Institute
Spa Aqua Prima
Sustainable Waterloo Region
The Natural Step Canada
Town of Comox
Town of Fogo Island
Town of New Glasgow
Transport Canada
Trexiana
University of British Columbia
University of Manitoba
University of the Fraser Valley
University of Toronto
University of Waterloo
Up Marketing
USP
Vancity
Vancouver Coastal Health
Vancouver Economic Commission
Vancouver Electric Vehicle Association
Village of Tahsis
Walker Environmental Group
Waste Management
Waterloo Catholic District School Board
Western Economic Diversification
WSP Canada
ZS2 Technologies



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