



This webinar is
being recorded

Ecocities Webinar Series:

Exploring Buildings' Embodied Emissions

February 23, 2021

With support of



<https://commons.bcit.ca/ecocitycentre/>

- The world's first Centre for Ecocities supports the evolution of ecocities worldwide
- A legacy of the 2019 [Ecocity World Summit](#) in Vancouver
- It adds new capabilities to assess a city's energy and materials requirements relative to climate stability thresholds and ecological carrying capacity



"There are few more pressing issues today than helping humanity find ways to lighten its ecological footprint and live within the planet's ecological carrying capacity."

The BCIT Ecocity Centre of Excellence will contribute applied research, tools and training to help cities, in Canada and around the world, meet this essential challenge."

Kathy Kinloch, President of BCIT



Centre for Ecocities

HELPING BUILD SOCIALLY JUST CITIES IN BALANCE WITH NATURE

Key Initiatives

- Ecocity Pilot and Peer Network (ecoCity Footprint Tool + Lighter Footprint App)
- [Social Science and Humanities Research Council](#) (SSHRC) Knowledge Synthesis initiative
- IUCN Urban Nature Index
- UN Habitat Urban Monitoring Framework
- Potential North American hub for Ecocity Summit 2022

Agenda

Ecocities Webinar Series: *Exploring Buildings' Embodied Emissions*

1. Welcome + Introduction
2. Embodied energy and LCA Overview + Applications
 - Jeremy Caradonna, Province of BC
3. Application @ BCIT Centre for Ecocities + Program Offerings
 - Jennie Moore and Alex Hebert, BCIT
4. Developing Policy + Programs
 - Patrick Enright, City of Vancouver
5. Closing

FEATURED SPEAKERS

Ecocities Webinar Series: *Exploring Buildings' Embodied Emissions*



Dr. Jeremy Caradonna

Senior Policy Analyst
Ministry of Jobs, Economic Recovery, and
Innovation +
Adjunct Professor, Environmental Studies
University of Victoria



Patrick Enright

Senior Green Building Engineer
Sustainability Group
City of Vancouver's



Dr. Jennie Moore

Director of Institute
Sustainability BCIT



Alexandre Herbert

Manager of Zero Energy/ Emissions Buildings
BCIT



Polling Question 1 (LCA Knowledge)

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Advancing Lifecycle Assessment (LCA) Methods: Why Embodied Emissions Matter

Office of Mass Timber Implementation

Dr. Jeremy L. Caradonna

February, 2021

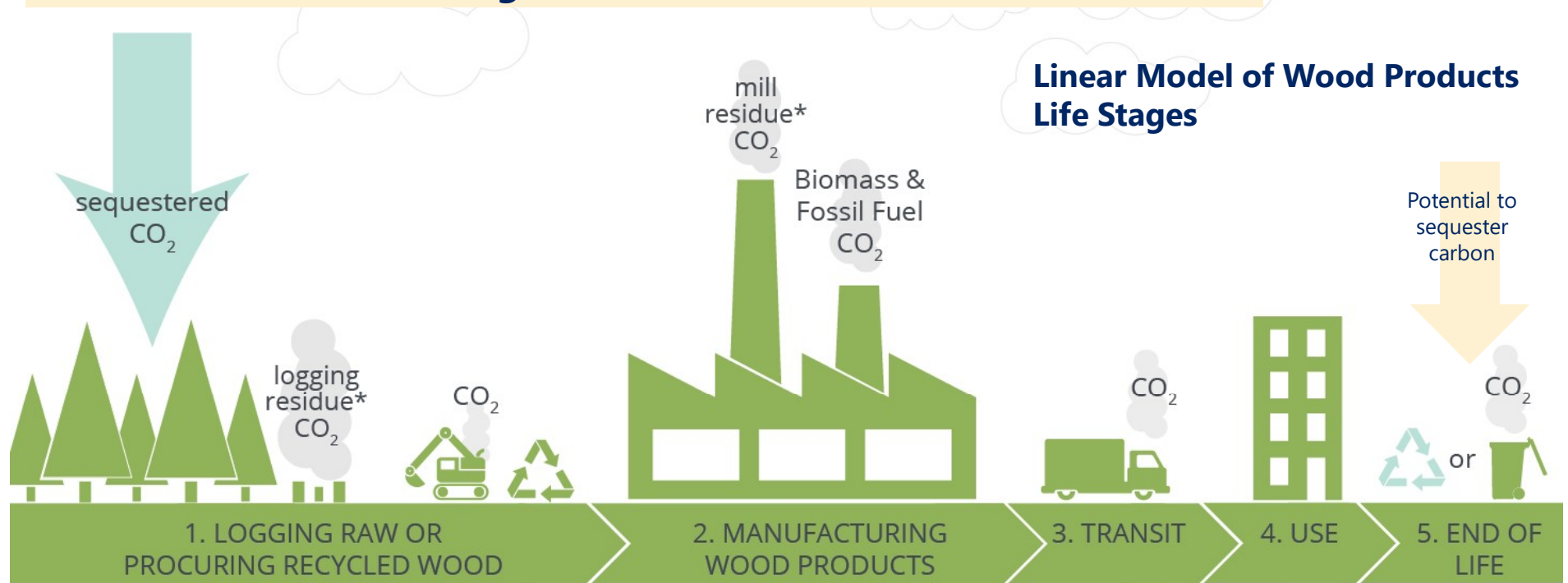
BCIT Presentation

Overview

- What is **LCA** and what are **embodied emissions**?
- How do embodied emissions differ from **operational emissions**?
- How does an embodied emissions lens allow us to **reconceptualize** emissions, green building, and climate action?
- How is the Office of Mass Timber Implementation (Province of B.C) **advancing lifecycle assessment** (LCA)?

What is **LCA** and what are **embodied emissions**?

GHGs and timber buildings

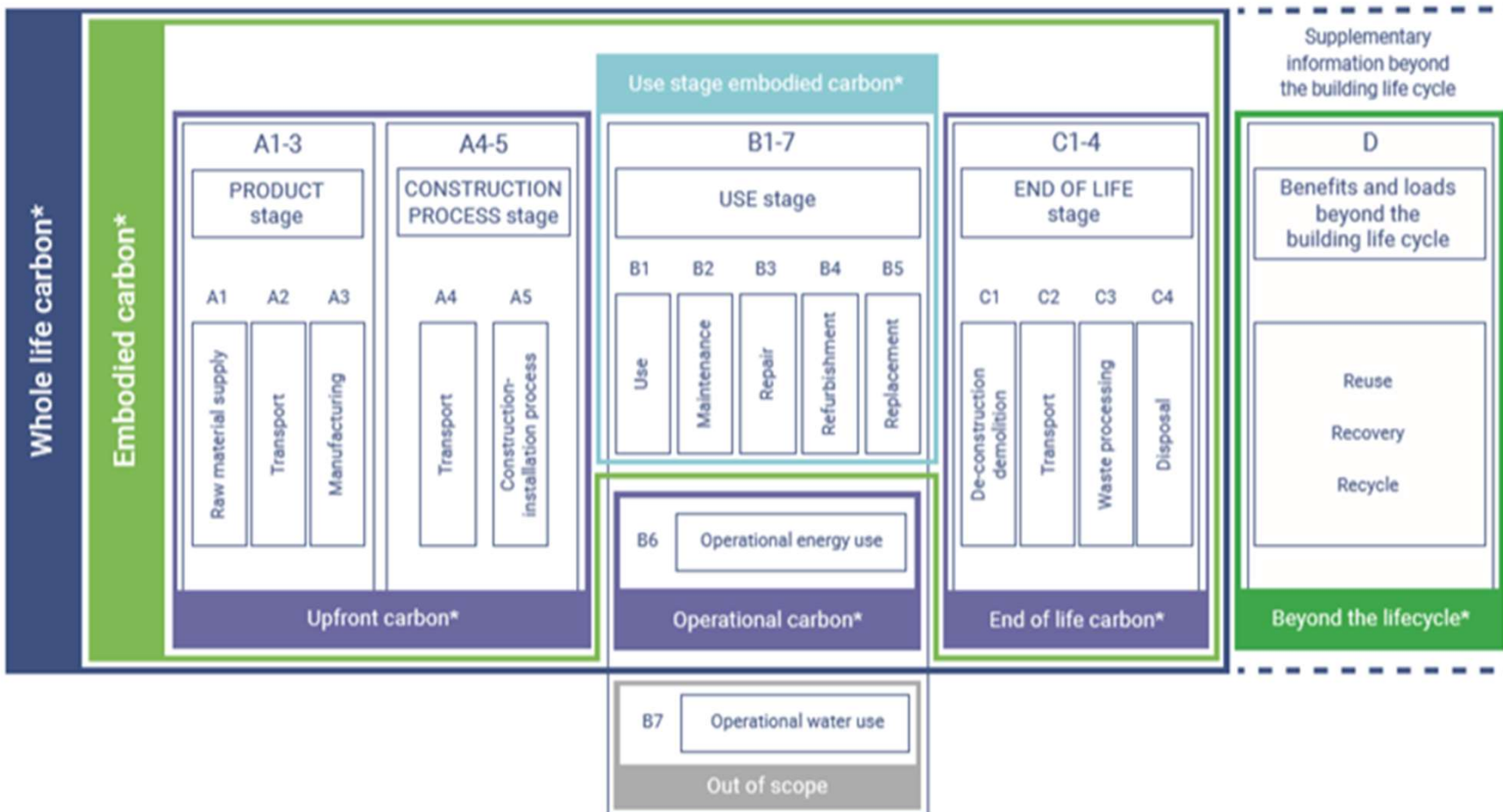


Emissions and GHGs created at all life stages

END OF LIFE:

Most wood products are disposed of at the end of the building's life, at which point any stored CO_2 is released through decomposition.

Some wood members can be recycled or reused.



Lifecycle analysis tracks building-related emissions beyond operational emissions.

One result is "embodied emissions" or "embodied carbon."

LCA Environmental Impact Categories

Embodied Carbon



**Global Warming
Potential (GWP)**



**Acidification
Potential (AP)**



**Eutrophication
Potential (EP)**



**Smog Formation
Potential (SFP)**



**Depletion of
Non-Renewable
Energy (NRE)**



**Ozone Depletion
Potential (ODP)**

Four Stages of a Whole-Building LCA

- **Goal and scope**
 - system boundaries
 - assumptions (cradle-to-gate, cradle-to-grave)
- **Lifecycle inventory (LCI)**
 - Gathering information on environmental impacts and materials
 - Environmental Product Declarations (**EPDs**)
 - Specific scenario data (e.g. transportation, end-of-life)
- **Lifecycle impact assessment (LCIA)**
 - Impact factors x materials, comparing different options; EPDs useful
- **Interpretation of results**

LCA and Embodied Emissions: Some Basics

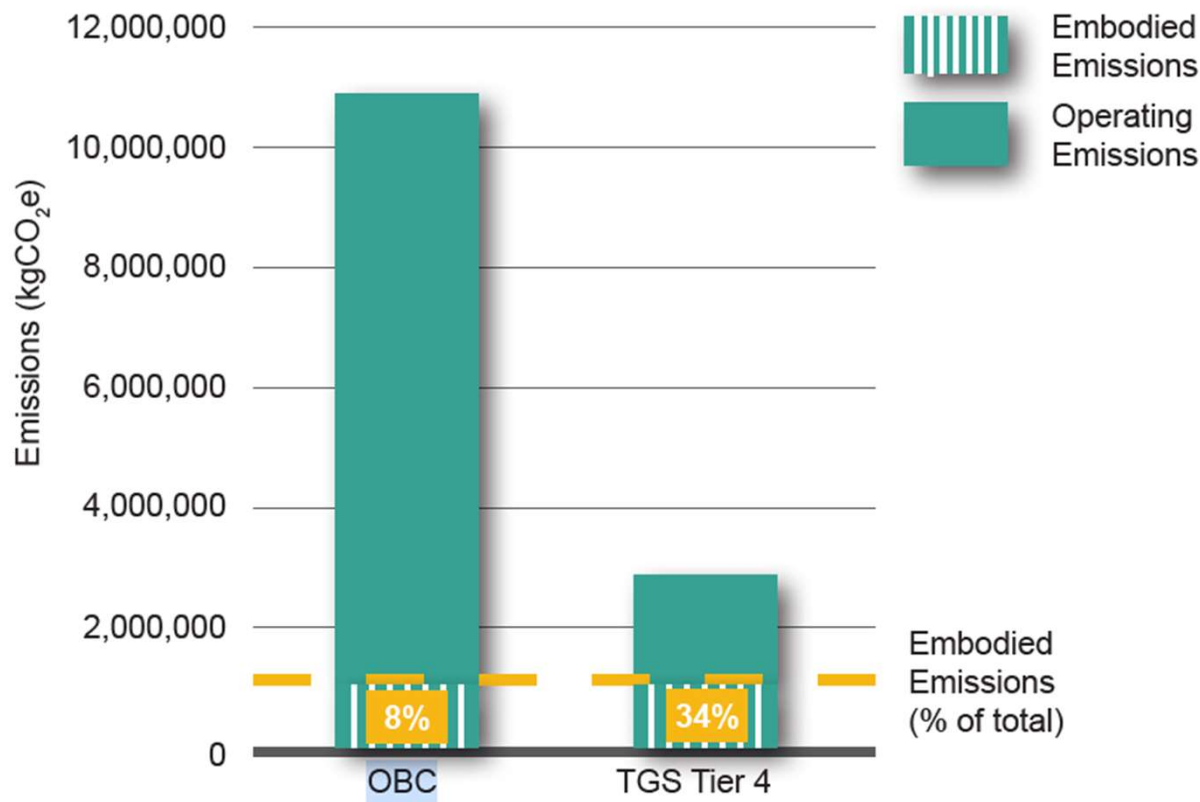
- Embodied carbon/emissions are NOT the same as sequestered carbon
- Embodied emissions of a building measured in kg CO₂e/m².
 - ~400 or 500 kg CO₂e/m² is considered the threshold for high embodied
 - Fairly arbitrary threshold; evolving field
- LCA and embodied emissions are imprecise
 - Methods relatively new
 - Lack of standardization between LCA tools (despite EN & ISO standards)
 - Field is evolving fast and addressing shortcomings; guidelines are coming from National Research Council of Canada

How do embodied differ from **operational emissions**?

Which is a Bigger Problem – Operational or Embodied Emissions?

- Currently, **operational emissions**: report by Sustainable Buildings Canada says that for a conventional concrete buildings, for lifetime emissions, 92% is operational and 8% is embodied. Varies by building type and grid.
- However, as operational emissions drop, **embodied emissions come to represent a bigger part of the lifecycle emissions pie**
- In Vancouver (2021), for new buildings, emissions are **split 50/50** between lifetime operational and embodied emissions. As the city reduces operational emissions to zero, embodied would represent the remaining (100%) lifecycle emissions.

Relative Contribution of Embodied Carbon



Embodied vs. Operational emissions.

The impact of embodied becomes relatively larger as building operations green.

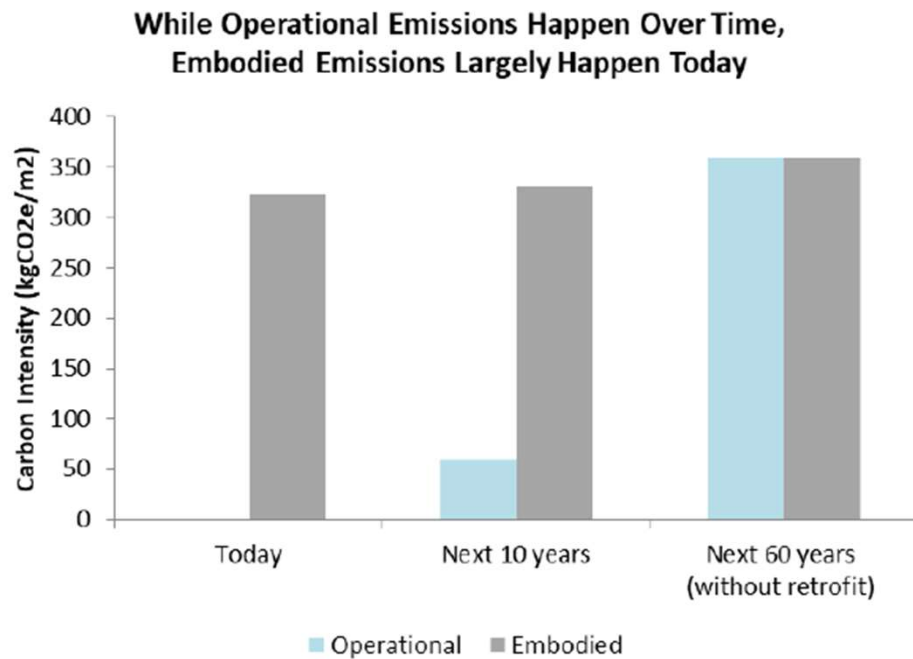


Figure 3: Emissions from new buildings over varying time horizons.

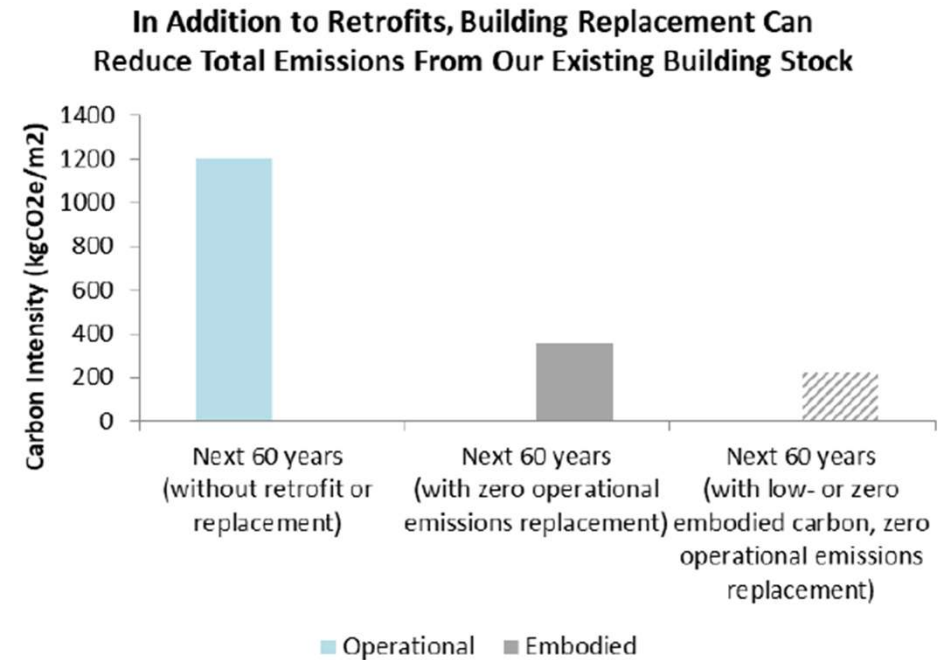


Figure 4: Emissions from existing buildings under varying scenarios.

As operational emissions decrease over time, embodied come to play a bigger role in the story of construction-related emissions. Embodied emissions are also “flatter” than operational emissions, which grow significantly over time.

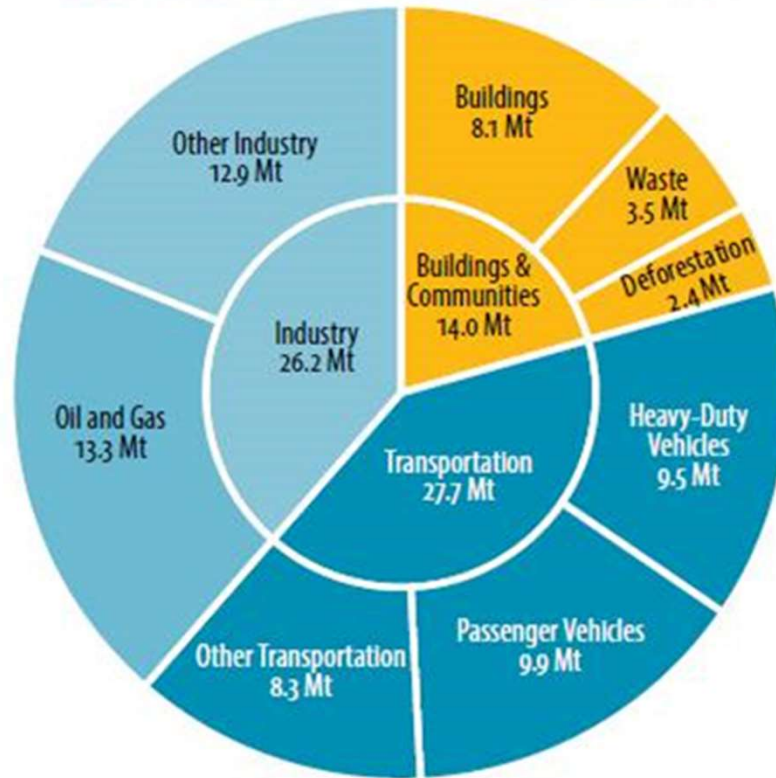
How do embodied emissions force us to **reconceptualize** emissions, green building, and climate action?



Globally, 28% of all emissions come from building operations and an additional 11% come from construction and materials (embodied).

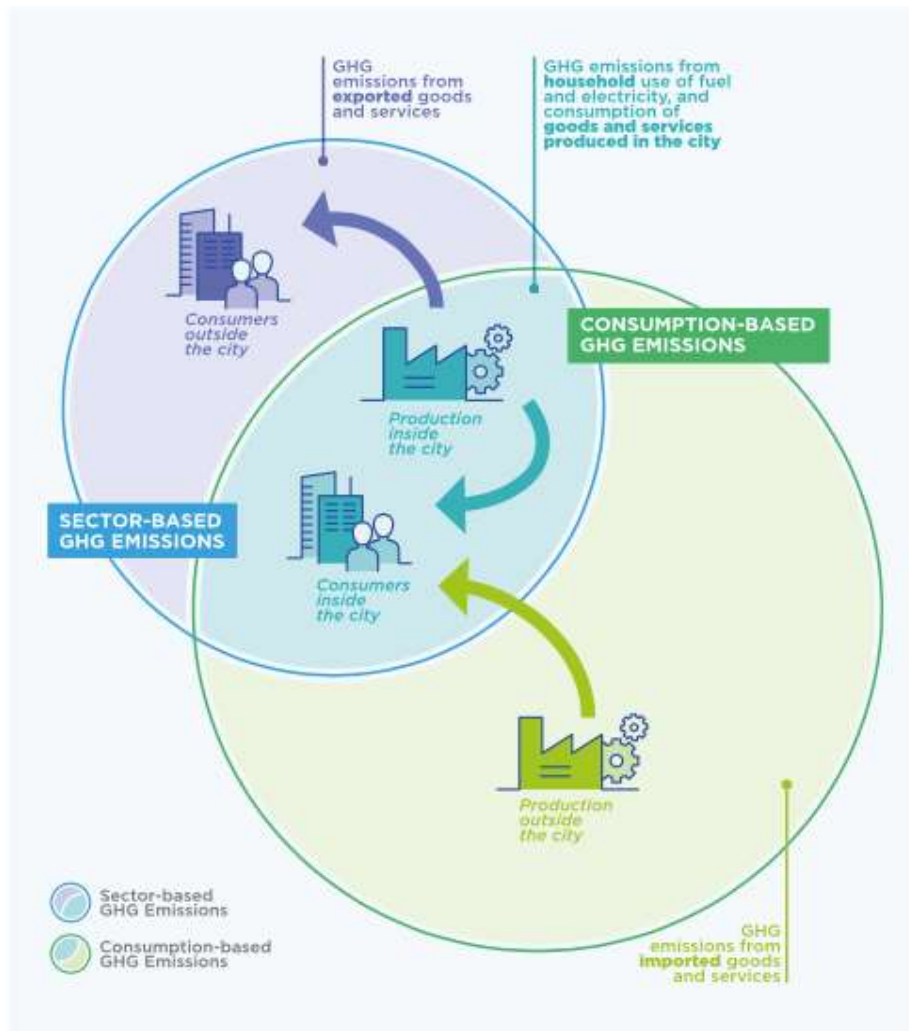
- Currently, buildings are mainly viewed as contributing to GHG emissions via operational emissions.
- Lifecycle approaches take a more holistic approach, including operational emissions, but also the upstream, downstream, and maintenance emissions associated with a building.
- Lifecycle accounting, or embodied emissions, is about **accountability** of the **total impacts of a building**

B.C.'s Gross Emissions by Sector in 2018



- B.C.'s gross emissions in 2018 were 67.9 Mt CO₂e. Net emissions were 66.9 Mt CO₂e after accounting for 1.0 Mt of GHG reductions achieved through offset projects that improve the storage of carbon dioxide in B.C.'s forests.
- Because we do not allocate these additional GHG reductions from offsets across different emissions sectors, just to the provincial total, we will refer to gross GHG emissions when discussing sectors in this document.

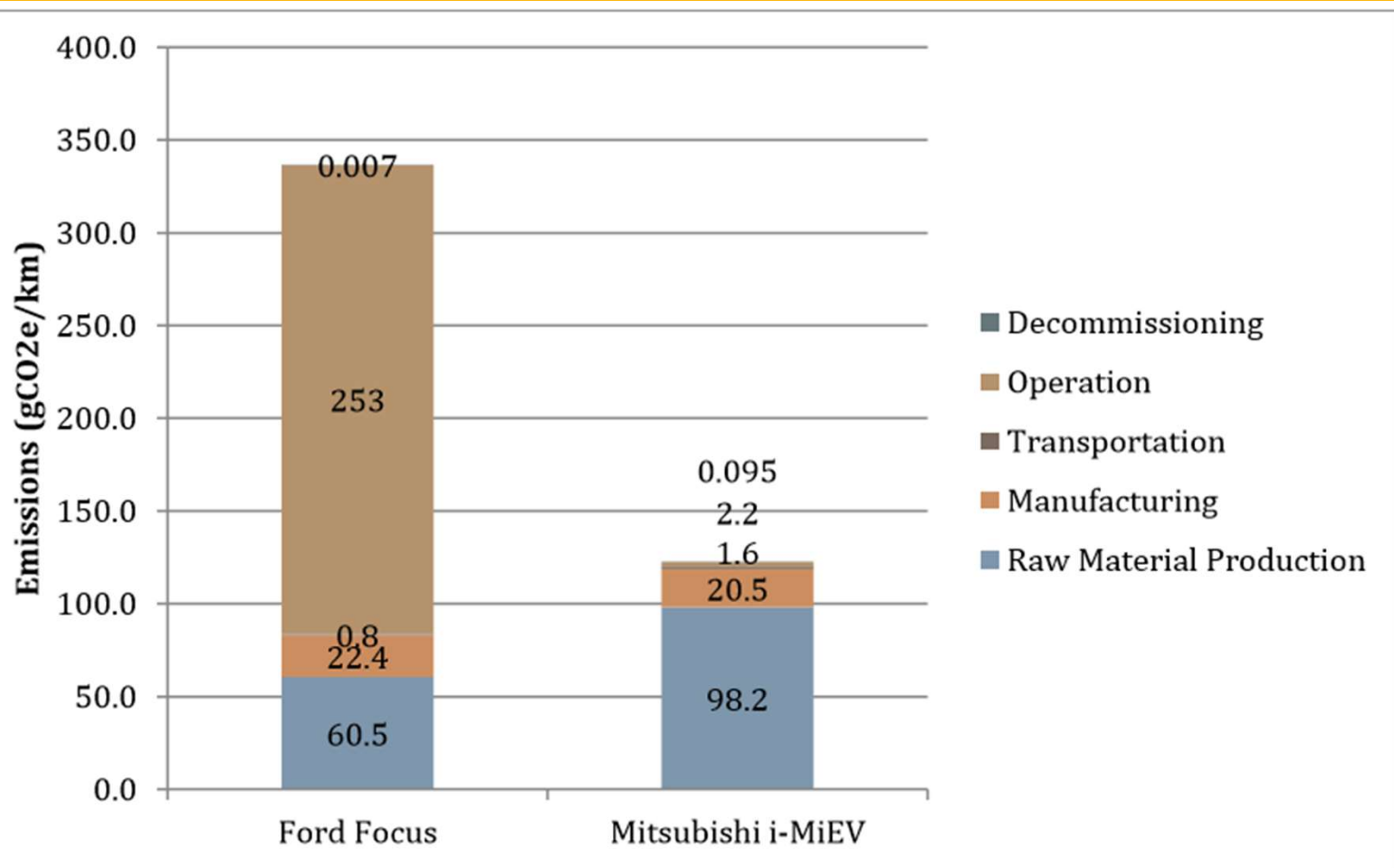
- BC's 2018 territorial emissions.
- Territorial and lifecycle emissions are two different ways of thinking about emissions
- GHG accounting currently centred on territorial



The Concept of Embodied Emissions

- **Territorial emissions** of a jurisdiction are akin to **operational emissions** of a building (with slight differences)
- The “**imported**” and “**exported**” emissions of a jurisdiction are akin to the **embodied emissions** of a building
- CBEI is thus similar to a whole-building LCA for *an entire jurisdiction*

Bottom line: The more recent trend in climate action and emissions tracking is towards holistic and lifecycle emissions accounting.



Gas car vs. EV, from an LCA conducted at UBC (assuming BC's grid and conditions)>

The operational emissions of the EV are almost zero, but an LCA shows lifecycle emissions are more substantial in the manufacturing and raw material phases. The emissions "savings" come in the operational phase.







Figure 7 – Graph comparing CO₂-equivalent emissions with a vehicle life of 250,000km.

How is the Office of Mass Timber Implementation
advancing lifecycle assessment (LCA)?

Some of the Shortcomings of LCA Methods and Tools

- Lack of consistency between LCA methods and tools
- Lack of professionalization in the LCA space
- Lack of a national lifecycle database and standards
 - Creates challenges for policymakers
 - NRC's LCA² (national LCI database) should eventually solve this problem
 - Guidance documents forthcoming; could become a Canadian standard?
- Simplistic and/or inaccurate assumptions about biogenic carbon (impacts from forests and wood waste at end of life)

LCA tools

	LCA Practitioner Tools	Whole Building LCA Design Tools
Examples	 	   
Uses	Detailed <u>product level</u> LCAs. Requires production level data.	Estimate and compare options. Assesses databases of product level LCA data and applies them to a building model.
Pros	<ul style="list-style-type: none"> - Very detailed - High accuracy 	<ul style="list-style-type: none"> - Free options with fees for additional features - Easier to use
Cons	<ul style="list-style-type: none"> - Expensive - Complicated 	<ul style="list-style-type: none"> - Limited to specific materials covered in the software

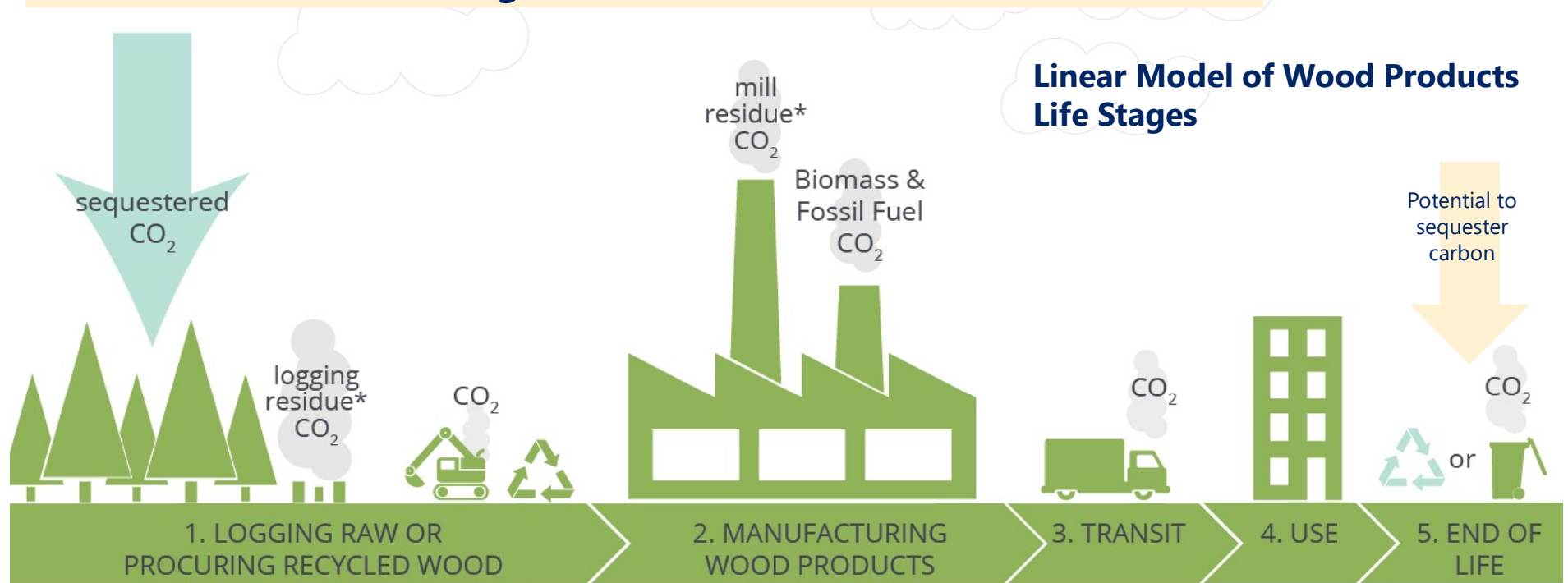
Proliferation of LCA tools.

ISO standards are behind all of these tools, but there are differences.

The Federal government is creating a national lifecycle database LCA².

OMTI is working with Athena, since it is free, Canadian-based, and widely respected.

GHGs and timber buildings



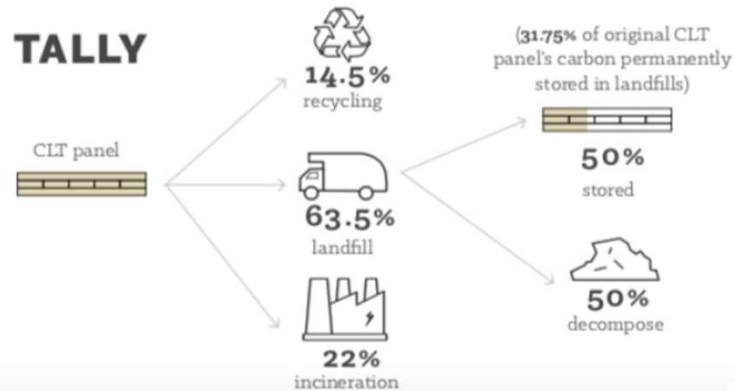
Emissions and GHGs created at all life stages

END OF LIFE:

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Some wood members can be recycled or reused.

END-OF-LIFE CLT ASSUMPTIONS



LCA tools and variability

Example of end-of-life assumptions regarding mass-timber product (Athena vs. Tally)

Partnership between OMTI/FII and Athena

- New environmental product declarations (**EPDs**) on wood products (helps Athena's tool and LCA²)
- New **Embodied Carbon Pathfinder tool** (essentially a simplified version of their tool that allows for high-level, building comparisons, and early-design estimates)
- **Harmonize** data within the existing tool
- Create an LCA **certification** program (professionalize LCA)
- **End-of-life scenario** modeling (what happens to construction materials after building is demolished)
- Integrate new data into the tool (the **Impact Estimator for Buildings**)

Rationale for the Project

- Demand from construction industry (engineers, developers, modellers) for better tools and more accurate data
- Interest from some jurisdictions (e.g. Vancouver) in creating tools to support policymaking and green building (e.g. the Embodied Carbon Pathfinder)
- Supporting the national database (both OMTI and Athena are partners)
- Advancing LCA science with Canada-centric data, models, assumptions; building up the knowledge base on embodied emissions

Links and Resources

- Office of Mass Timber Implementation
 - My contact: Jeremy.Caradonna@gov.bc.ca
- Athena Sustainable Materials Institute: www.athenasmi.org.
- UBC, "Policy Review of Carbon-Focused Life Cycle Assessment in Green Building Design and Performance at the University of British Columbia," [UBC Embodied Carbon Pilot: Study of life cycle assessment protocols and tools at the University of British Columbia](#)
- Tallwood Design Institute: www.tallwoodinstitute.org.

Questions?



FEATURED SPEAKERS

Ecocities Webinar Series: *Exploring Buildings' Embodied Emissions*



Dr. Jennie Moore

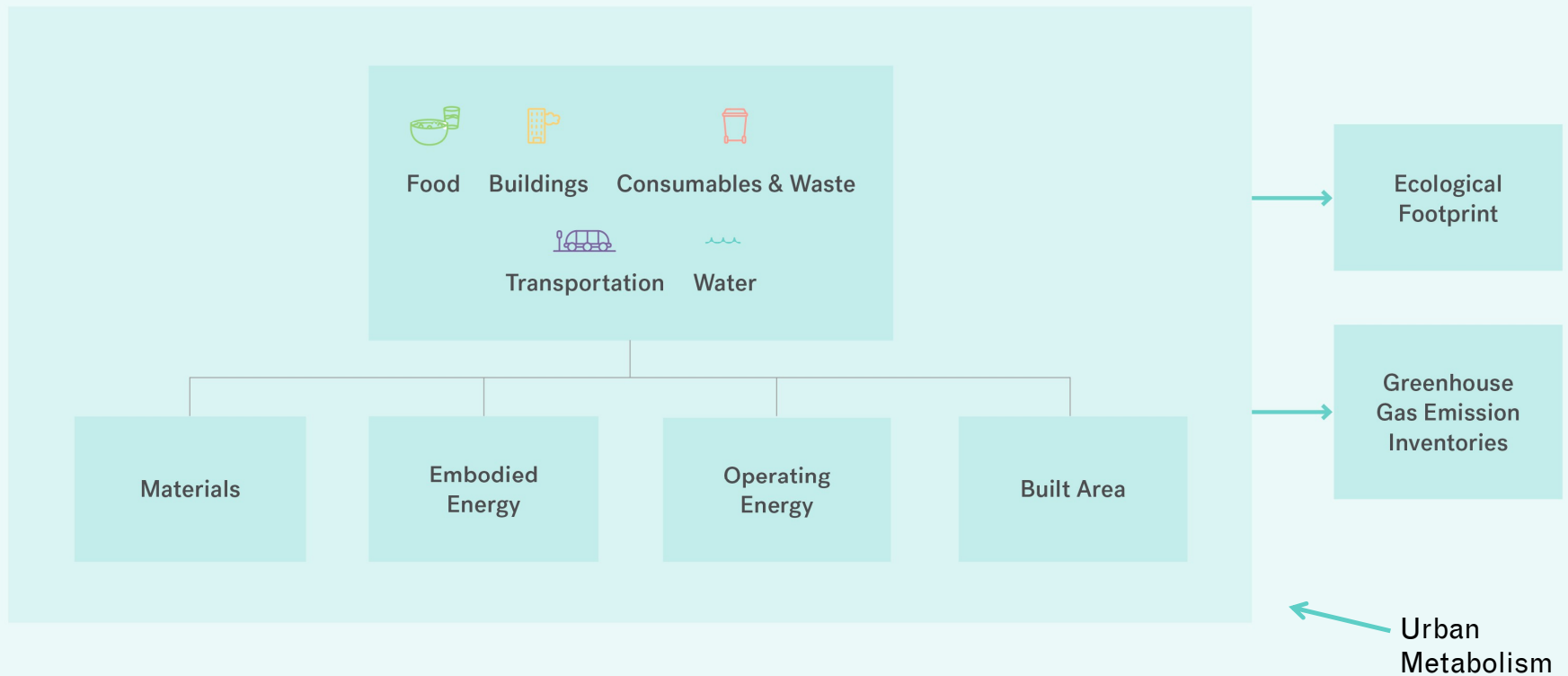
Director of Institute
Sustainability BCIT



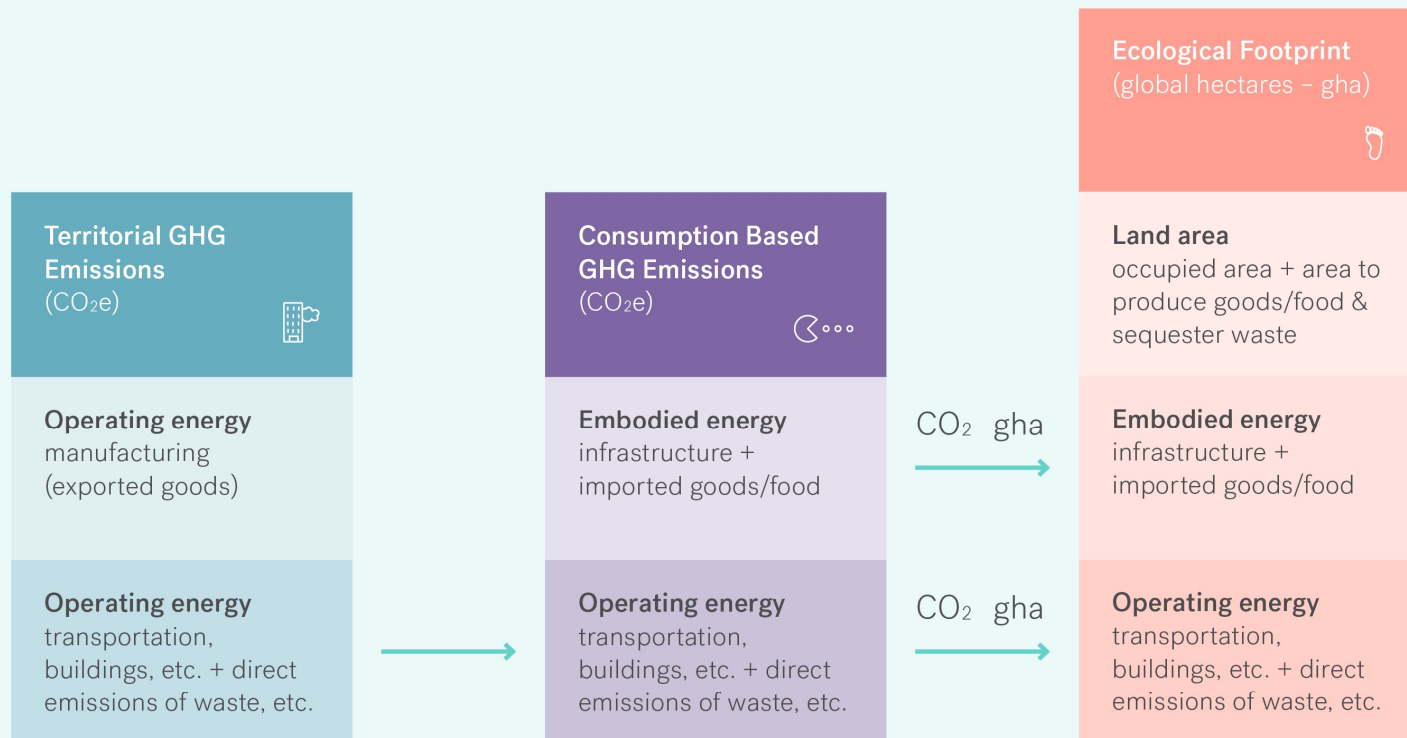
Alexandre Herbert

Manager of Zero Energy/ Emissions
Buildings
BCIT

Calculating the Footprint Using the ecoCity Footprint Tool



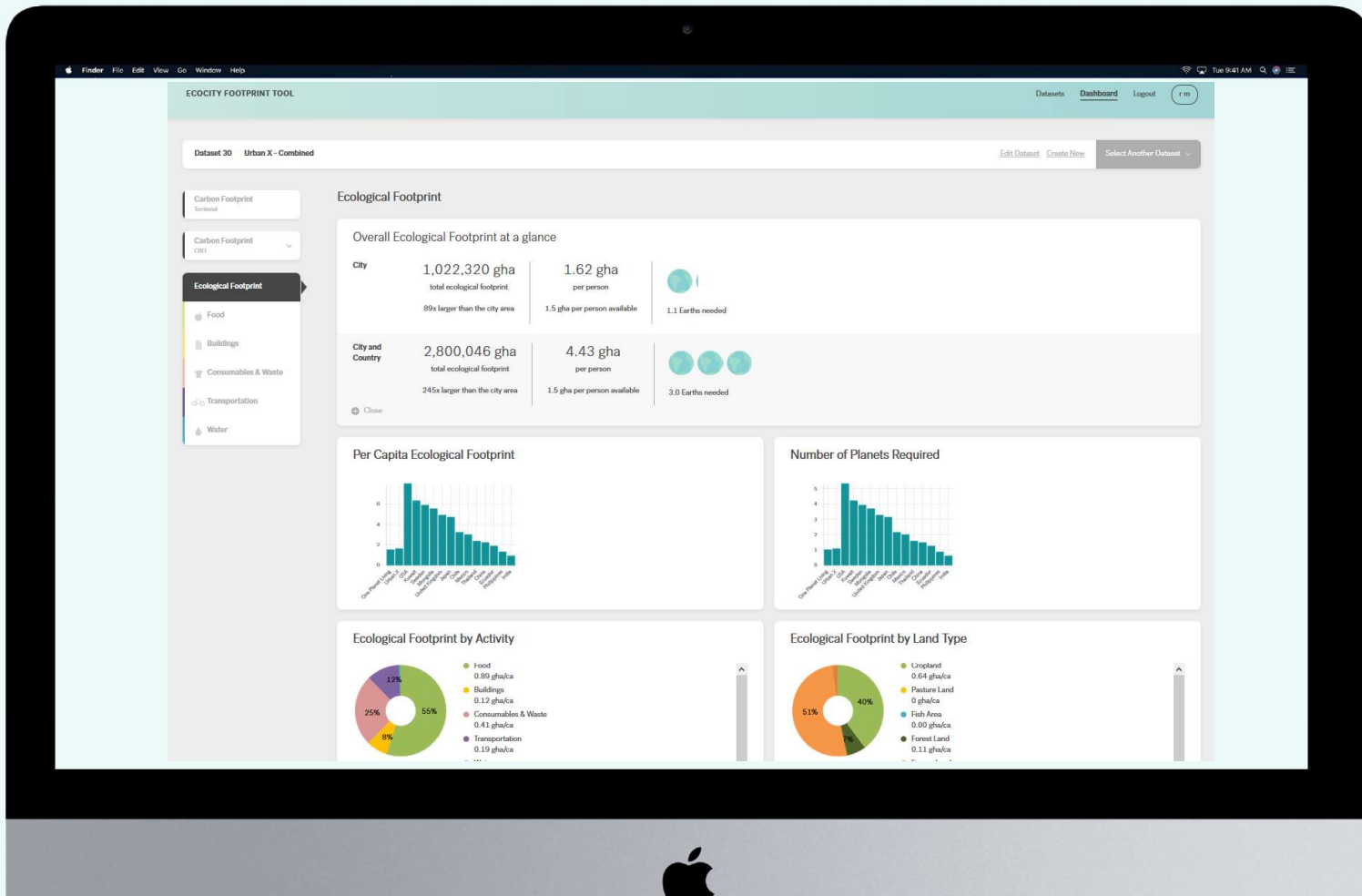
ecoCity Footprint Tool - Complementary Metrics



"In-Boundary" Impacts

"Consumption-based" Impacts"

ecoCity Footprint Tool Online Platform



Ecocity Pilot Communities



PLUS IOWA CITY!!

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Ecocity Pilots & Reps

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Powell River

Bo Ocampo /
Caroline Jackson
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Vancouver

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District of Saanich

Kate Letizia
City of Nelson

Katie Pearson
Capital Region District

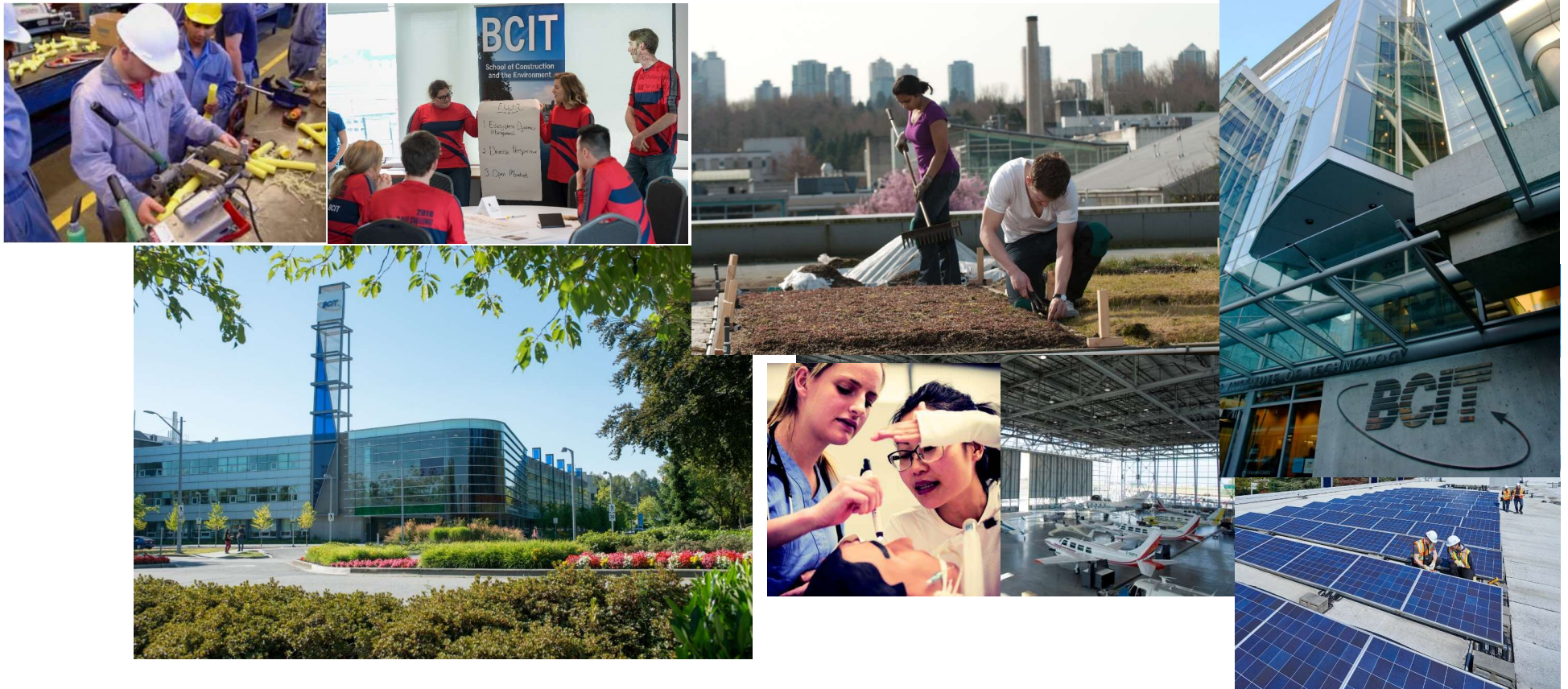
Kyle Aben
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Lloyd Lee
City of Vancouver

Maxwell Sykes
City of Surrey

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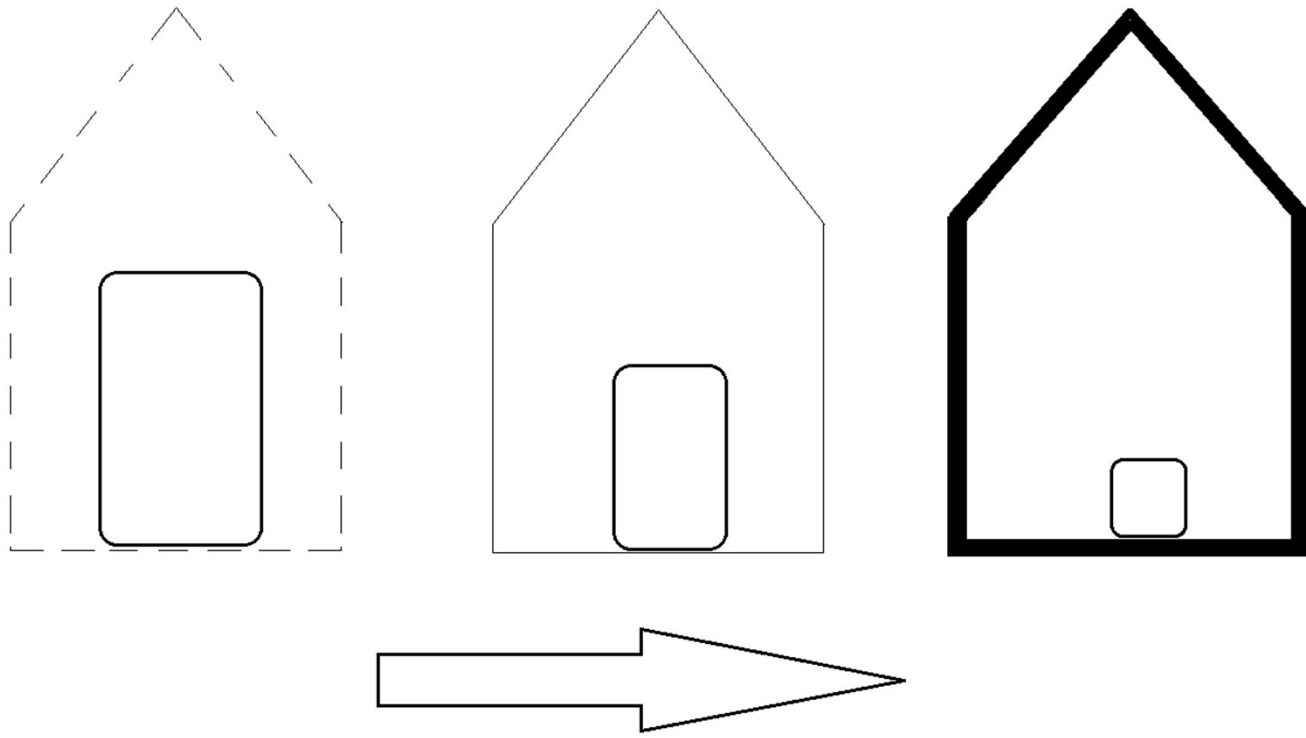


NET ZERO TRAINING FROM HOME.

Experience BCIT's renowned High Performance Building Lab from the comfort and safety of your own home. Learn the fundamentals of Net Zero Energy Buildings from live online demos taught by industry experts. Part-time courses start this September. Register now at bcit.ca/zeroenergybuildings

BCIT

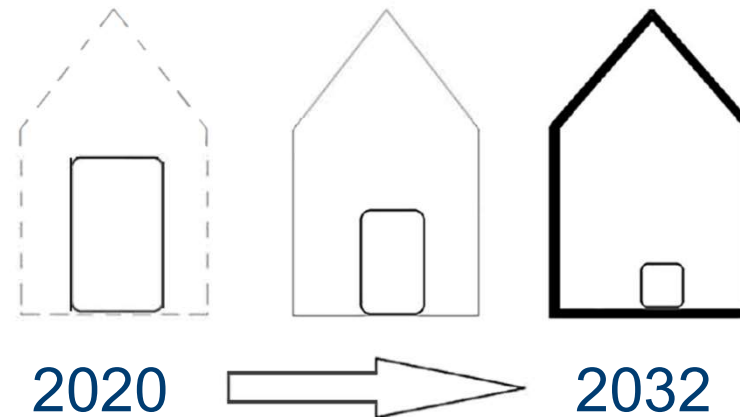
The laptop screen displays a live video stream of a man in a plaid shirt and cap working on a wooden structure. The interface includes a 'Participants (106)' list on the right, a 'Search' bar, and a 'Leave Meeting' button. The bottom of the screen shows a Windows taskbar with various application icons.



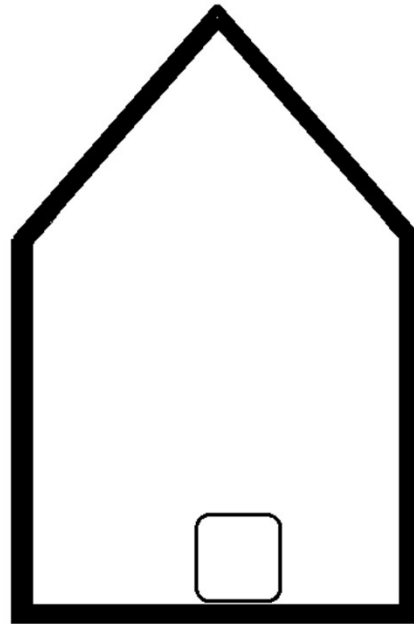
BC Energy Step Code Metrics

The 3 metrics for part 9 residential are:

- TEDI (how well insulated are my walls, my roof, ...)
- ACH (how airtight is my building envelope)
- MEUI (having a good envelope is great, now let's put good mechanical systems inside too)



So what about embodied carbon



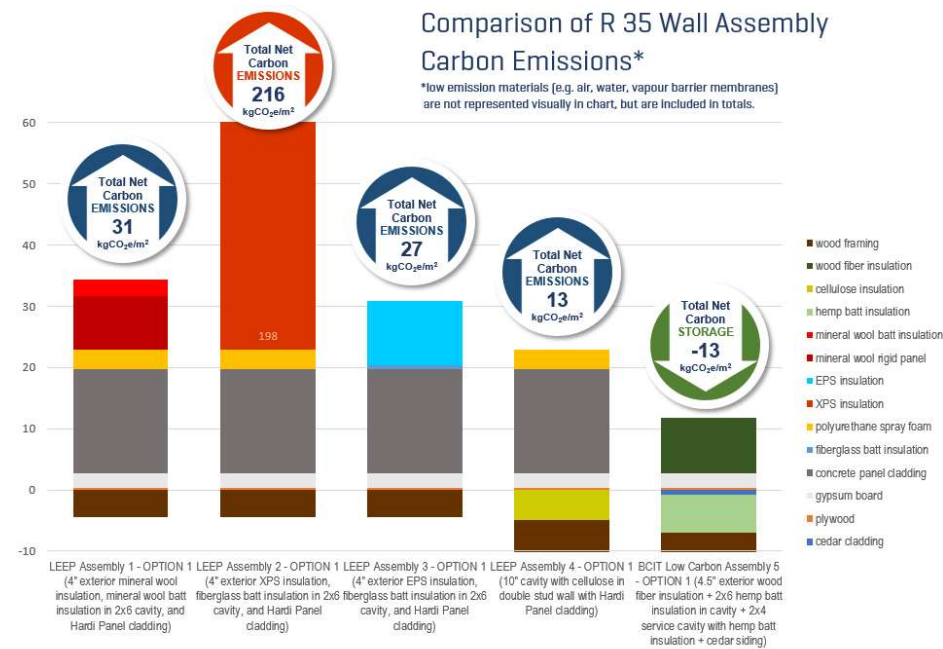
We built these 4 walls



We built these 4 walls



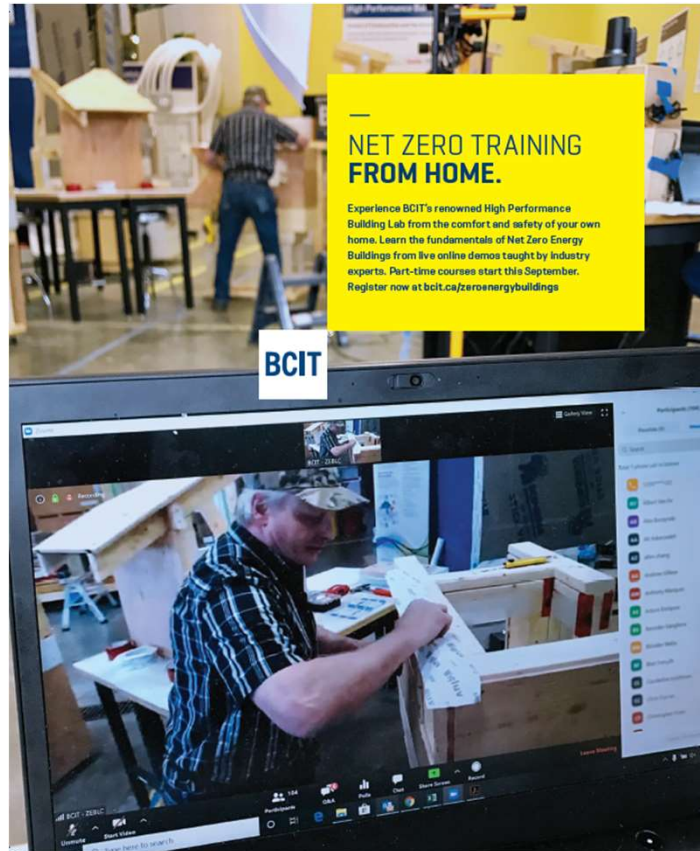
We did a carbon LCA



We built a 5th wall...



Hands-on course during COVID



Course trailer



FEATURED SPEAKERS

Ecocities Webinar Series: *Exploring Buildings' Embodied Emissions*



Patrick Enright
Senior Green Building Engineer
Sustainability Group
City of Vancouver's



BCIT EcoCities: City of Vancouver's Embodied Carbon Strategy

City of Vancouver
Planning, Urban Design & Sustainability
Patrick Enright, Sr. Green Building Engineer
February 23, 2021



AGENDA



- 1) Climate Emergency Action Plan
- 2) Embodied Carbon Strategy
- 3) Embodied Carbon Inventory & Baselines
- 4) Next Steps
- 5) Questions?



1) Climate Emergency Action Plan

Climate Emergency Action Plan



climate emergency 6 big moves



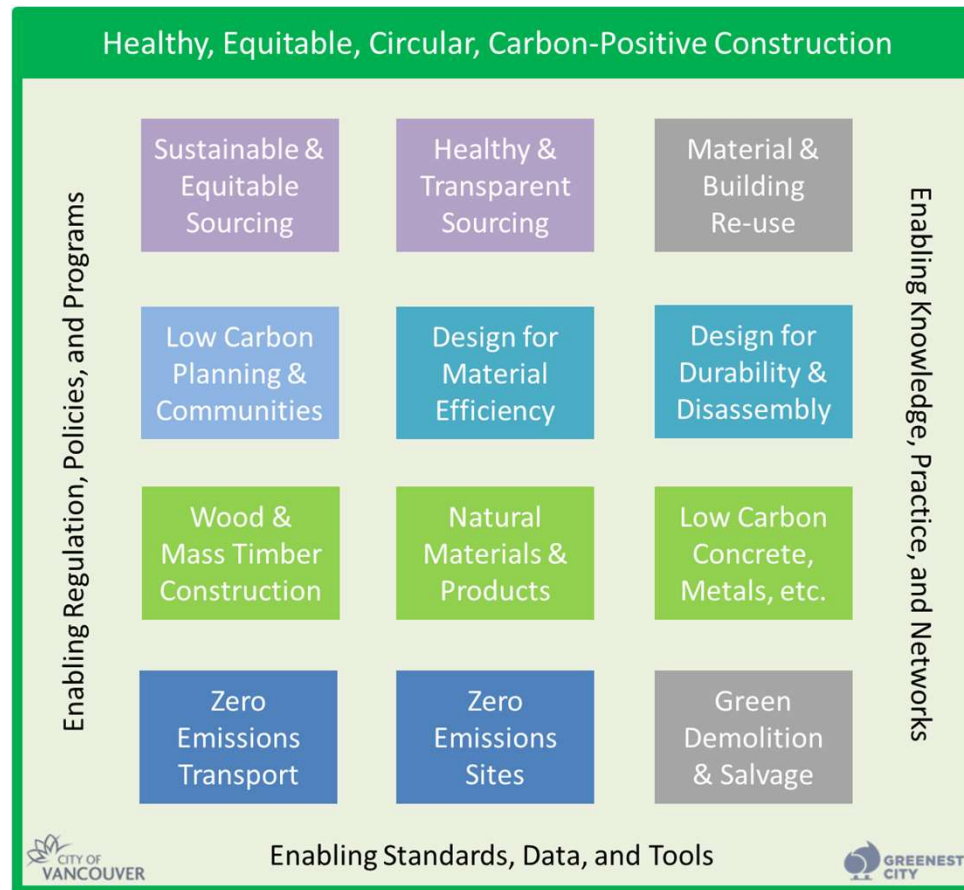
6 Big Moves, City of Vancouver



2) Embodied Carbon Strategy

Embodied Carbon Strategy

Our Vision:



Embodied Carbon Strategy



Our Goal: 40% by 2030

BIG MOVE

5

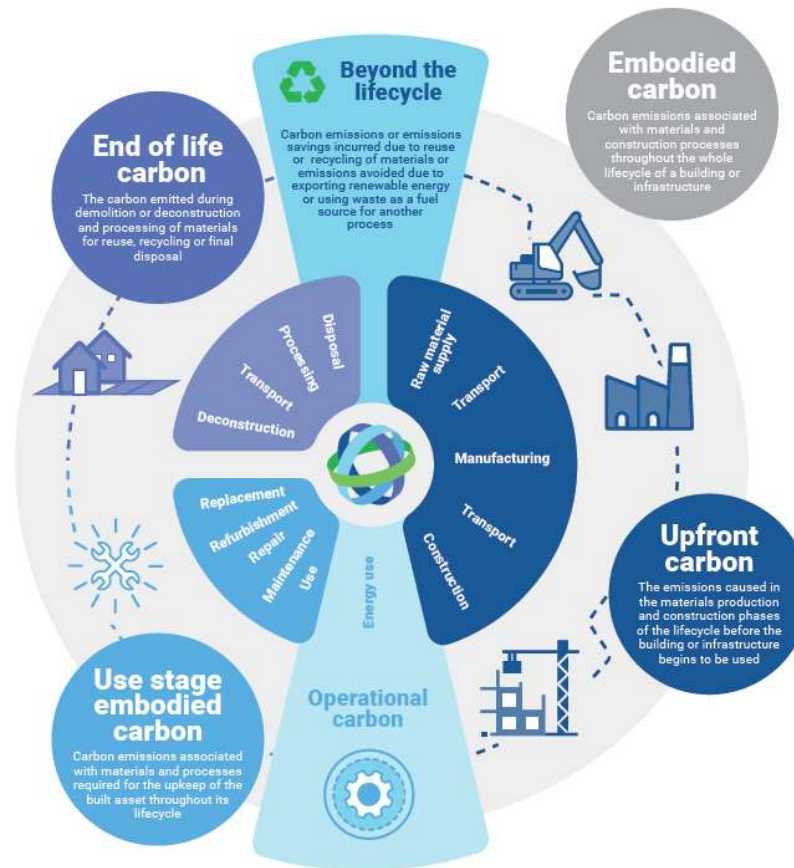


LOWER CARBON CONSTRUCTION MATERIALS AND DESIGNS

By 2030, the embodied emissions in new buildings and construction projects will be reduced by 40% compared to a 2018 baseline.

Embodied Carbon Strategy

The Basics:



The Principles:

- 1) Urgency
- 2) Neutrality of materials
- 3) Healthy materials and buildings
- 4) Circularity
- 5) Equity and responsibility
- 6) Affordability
- 7) Shared knowledge and vision

The Strategy:

- 1) Change the Rules (Policy and Regulation)
- 2) Change the Market (Remove Barriers and Provide Incentives)
- 3) Change the Culture (Capacity Building and Industry Transformation)
- 4) Change the Context (Complimentary Strategies and Actions)

1) Change the Rules (Policy and Regulation)

- Set the baseline
- Update the rezoning policy
 - performance % reduction requirement
 - possibly material and sourcing requirements (e.g. low carbon concrete, sust. wood)
- Update the Building By-law
- Leading targets for City-owned buildings

2) Change the Market (Remove Barriers and Provide Incentives)

- Remove barriers (e.g. height and building form allowances in zoning for MT)
- Incentivize deep carbon reductions (e.g. create incentives for detached homes for deep reductions)

3) Change the Culture (Capacity Building and Industry Transformation)

- Coordinate and share knowledge with other organizations and governments
- Support tools, guides, training, and knowledge sharing networks for industry

4) Change the Context (Complimentary Strategies and Actions)

- Plan for low-carbon neighbourhoods
- Optimize parking requirements
- Support zero emissions construction sites
- Support zero waste and deconstruction
- Support seismic resilience
- Support the green building economy



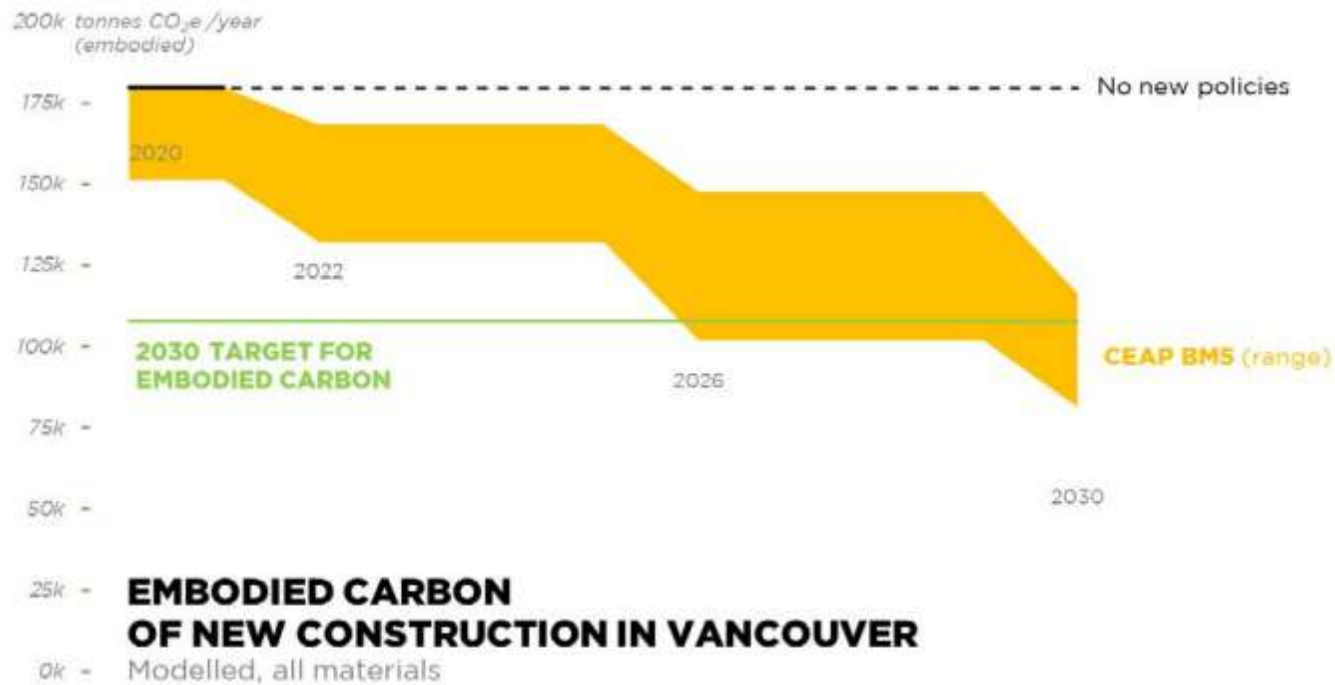
3) Embodied Carbon Baselines

Embodied Carbon Baselines

- 2020: *Embodied Carbon Strategy* includes modelling of city-wide embodied carbon
- Steps:
 - Estimate kgCO₂e/m² by building type
 - Set % reductions by year
 - Multiply by estimated annual build-out

	VBBL Requirements							
	Single Family	Residential < 7 storey wood	Residential 7-12 storey wood	Residential < 7 storey concrete	Residential ≥ 7 storey concrete	Office	Commercial	Industrial
BAU (kgCO ₂ e/m ²)	132	234	234	376	388	470	470	470
Reduction relative to BAU (2022-2025)	0%	0%	0%	0%	0%	0%	0%	0%
Reduction relative to BAU (2026-2029)	20%	20%	20%	20%	10%	10%	10%	10%
Reduction relative to BAU (2030+)	40%	40%	40%	40%	20%	20%	20%	20%

Embodied Carbon Baselines



- 2021/22: Policy to require whole-building % reductions in new developments
- Steps (current thinking):
 - Build off LEED experience
 - Set % reduction requirements in policy
 - Each project sets their own baseline
 - Create rules/guidelines to minimize ‘gaming’
 - Pick specific attributes for baselines, for projects to apply to their baseline
 - Example: high-rises to assume floors are 35MPa concrete with 0% SCM, using CRMCA national EPD

- Next Steps on Baselines:
 - Develop baseline rules/guidelines for projects
 - Consult with LCA experts and industry stakeholders, and coordinate with national standards and tools
 - Iterate and compare with city-wide modelling
- Advice:
 - Start with requiring reporting!
 - both WBLCA and EPD's
 - Whole-building or material specific?
 - Let's do both!



3) Next Steps

- CEAP Approved at Council: November
- Implementation:
 - Develop EC policy: Q1-Q2 2021
 - Update rezoning policy: 2021
 - Rezoning policy takes effect: 2022
 - More MT code updates: 2021
 - Create Part 9 incentives: 2021
 - Other actions: 2021-2025

Questions?



Stay informed!

vancouver.ca/
zeroemissions



Let's talk!

patrick.enright
@vancouver.ca

Embodied Carbon Strategy

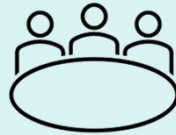
<https://council.vancouver.ca/20201103/documents/p1.pdf#page=213>



Polling Questions 2 & 3 (Interests & Using LCA info)

Questions?





Discussion/ chat question:

What do you see as the most significant barriers to addressing embodied emissions?



Polling Questions 4 (Courses)

Question

What topics would you like to see covered in future webinars?



Coming Soon from the Centre for Ecocities

- ❖ Launch online version of ecoCity Footprint Tool and Lighter Footprint App
- ❖ Continued support through the Peer Network
- ❖ Upcoming webinars
 - Engaging stakeholders
 - Release of research results from Knowledge Synthesis Grant

Thank You!

Contact:

Cora Hallsworth

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<https://commons.bcit.ca/ecocitycentre/>



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