WHOLE BUILDING LIFE CYCLE ASSESSMENT FOR THE B3 GUIDELINES

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Center for Sustainable Building Research

June 30, 2026

TODAY'S AGENDA

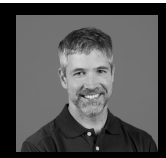
Morning Session (3 hours)

1. Overview of LCA
2. Whole Building LCA Tools
3. LCA Guidelines: M1A & M1B requirements
4. State of Minnesota Buy Clean program
5. How to achieve compliance (workflow and examples)

LUNCH BREAK (1 hour)

Afternoon Session (2 hours)

1. Athena Walkthrough (In-Depth)
2. In-class exercise



LOGISTICS & EDUCATION CREDITS

LEARNING OBJECTIVES – MORNING SESSION

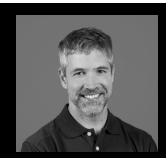
1. Understand the purpose and define the meaning and scope of whole building life cycle analysis.

2. Understand the relative importance of embodied impacts in a building's life cycle.

3. Describe how the results of an LCA are measured and compared across different buildings.

4. Identify the currently available software tools for completing a whole-building LCA.

5. Understand the submission requirements and various compliance paths of B3 Guideline M.1A.

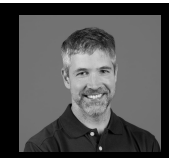


OVERVIEW OF LCA

WHAT IS LCA?

Life cycle assessment inventories all the flows between a product and nature, and then estimates the environmental impact of those flows.

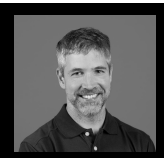
Slide courtesy of Athena Institute



WHAT IS LCA?

It looks at every stage (phase) of the product's life, for a comprehensive cradle-to-grave environmental footprint.

Slide courtesy of Athena Institute

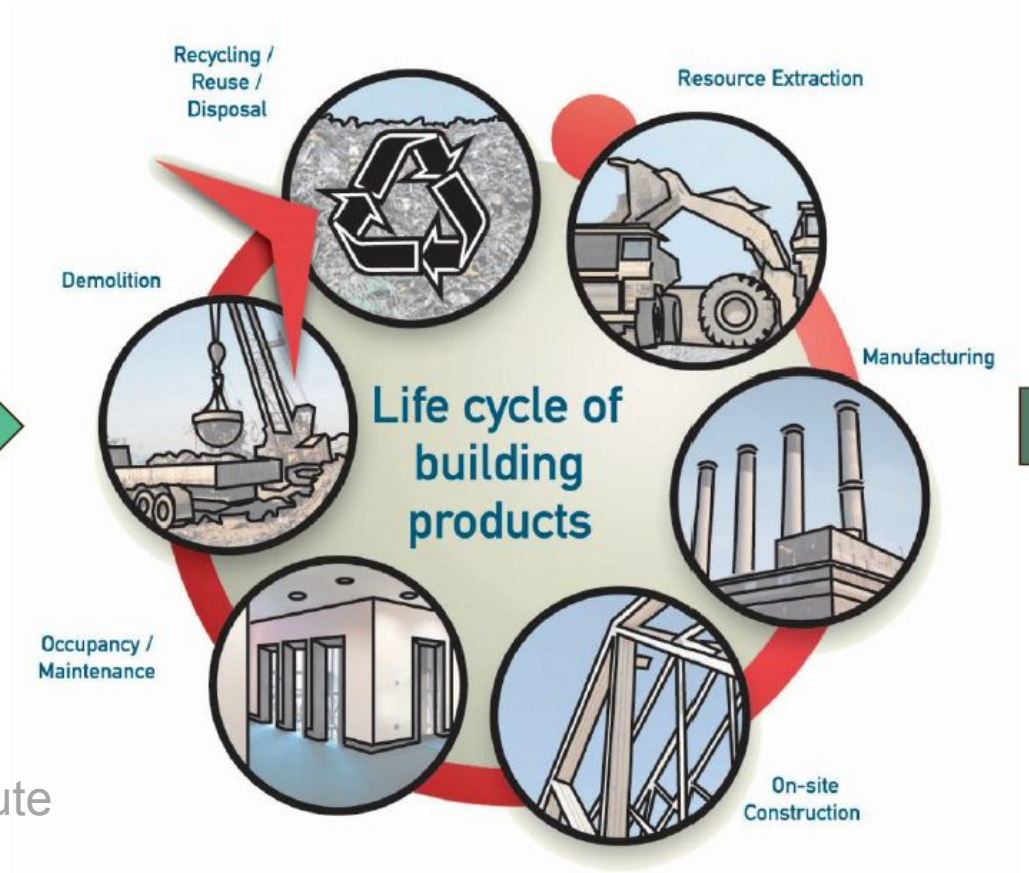


WHAT IS LCA?

Inputs and outputs are measured in each life phase – this results in an **environmental inventory.**

specific raw materials consumed: water, iron, sand, oil, limestone, electrical energy, etc…

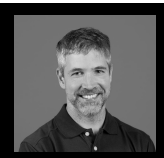
Resources in



Emissions out

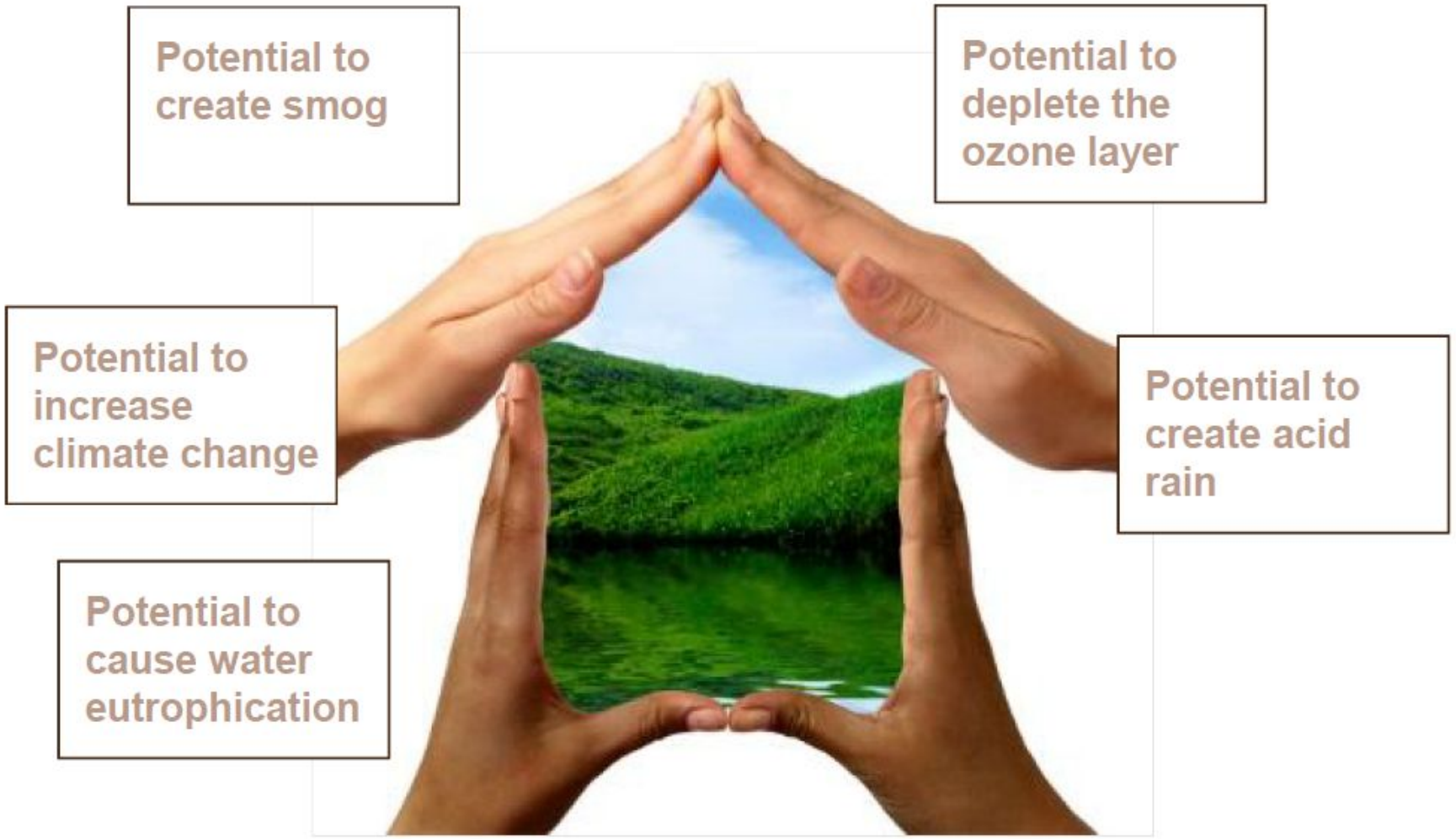
specific molecules released: CO2, CFCs, NOx, etc…

Slide courtesy of Athena Institute



WHAT IS LCA?

Next is **impact assessment**, where the inventory is projected to potential for environmental damage to air, land, and water.



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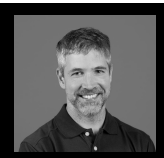
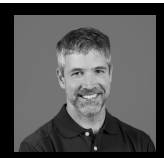


THE VALUE OF LCA

- Provides **real data** to inform choices
- Provides basis for **transparent disclosure** of environmental performance
- Addresses **embodied impacts** (which are often otherwise ignored)
- Identifies **hot spots** so we know where to look for improvements

Slide courtesy of Athena Institute



THE VALUE OF LCA

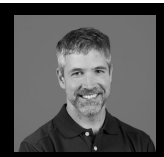
Slide courtesy of Athena Institute

- Provides **real data** to inform choices

55% recycled content!

Local product!

(Sounds good, but what's the environmental benefit?)



THE VALUE OF LCA

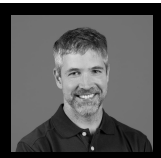
- Provides basis for **transparent disclosure** of environmental performance

Slide courtesy of Athena Institute

Environmental Facts

One square meter of carpet
Life cycle impact from cradle to one year of usage

Energy Consumption	
Total nonrenewable primary energy	209.12 MJ
Total renewable primary energy	4.02 MJ
Total primary energy	213.14 MJ
Resource Consumption	
Nonrenewable resources	15.40 kg
Water	0.5338 m^3
Waste Produced	
Non-hazardous waste	15.52 kg
Hazardous waste	0.0706 kg
Impact Measures	
Acidification potential	2.06 mol H+ Equiv.
Eutrophication potential	0.0044 kg N-Equiv.
Global warming potential	10.61 kg CO_2-Equiv.
Ozone depletion potential	9.34E-07 kg CFC 11-Equiv.
Smog potential	0.50 kg NOx-Equiv.



THE VALUE OF LCA

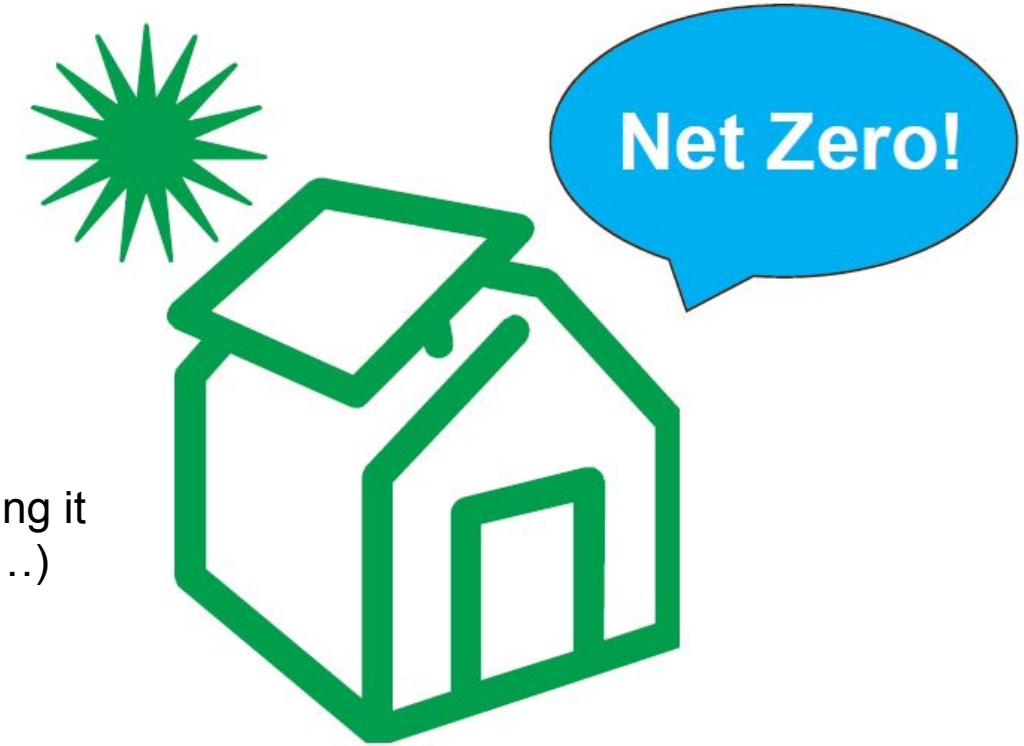
- Provides basis for **transparent disclosure** of environmental performance – Environmental Product Declarations (EPDs)

Slide courtesy of Athena Institute

THE VALUE OF LCA

- Addresses **embodied impacts** (which are often otherwise ignored). We don't have to wait X years for the benefits to accrue. Benefits are available starting today.

(If we don't count everything it took to make the building…)



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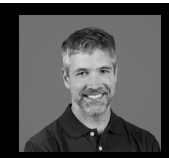

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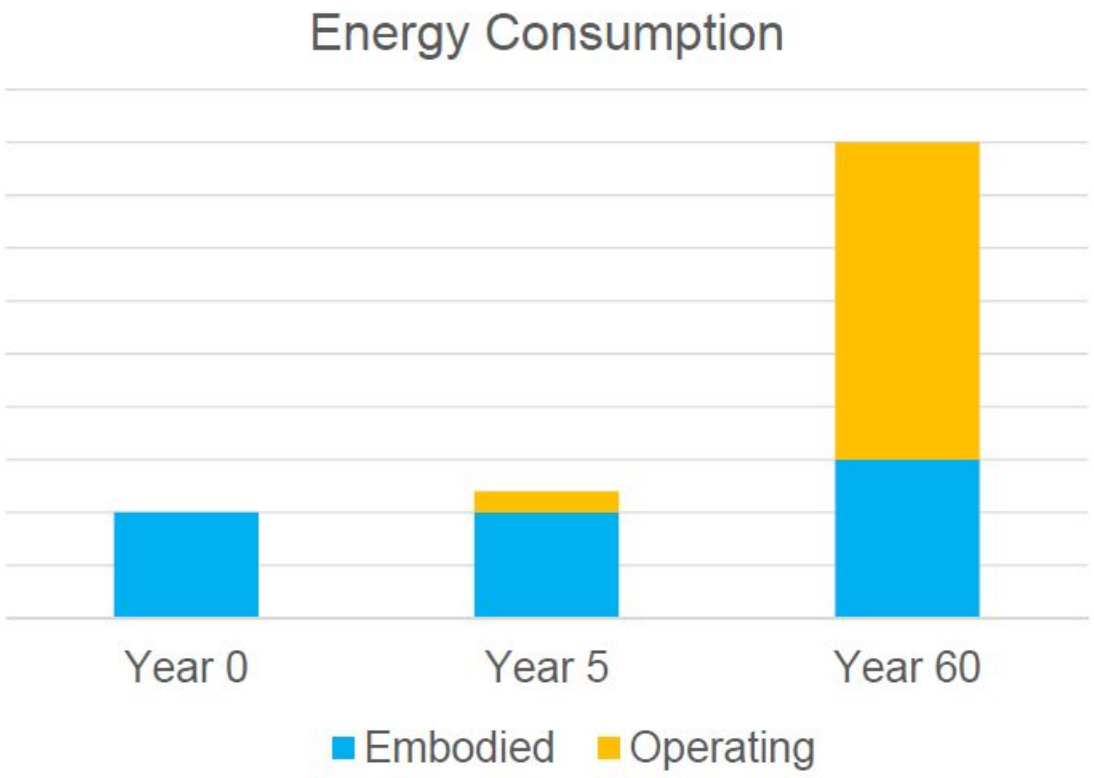
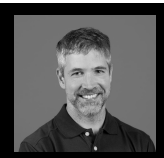


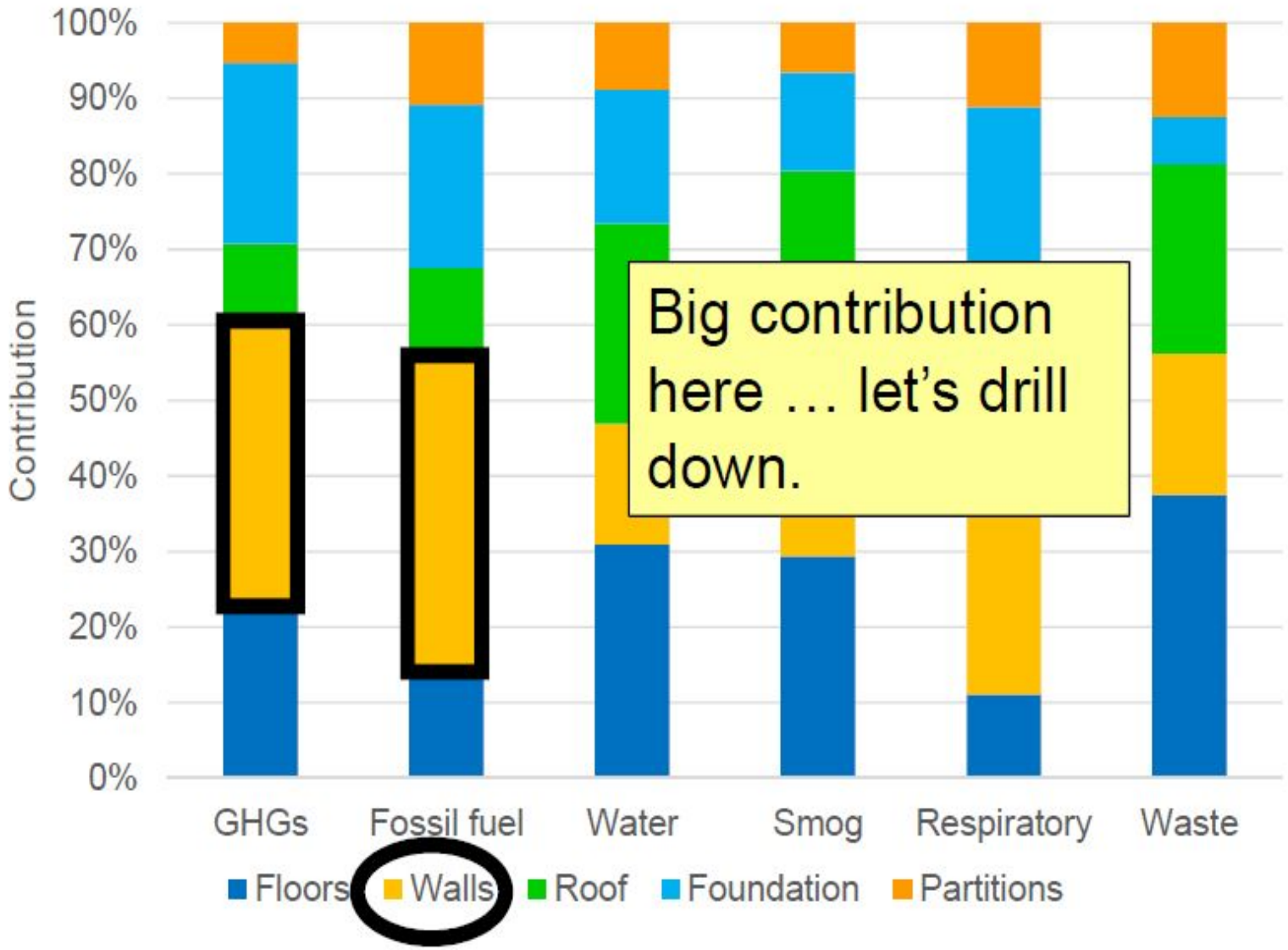
The more efficient buildings become, the greater role embodied energy plays in a building's lifetime energy consumption.

Slide courtesy of Athena Institute



THE VALUE OF LCA

- Identifies **hot spots** so we know where to look for improvements.



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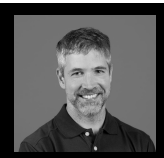
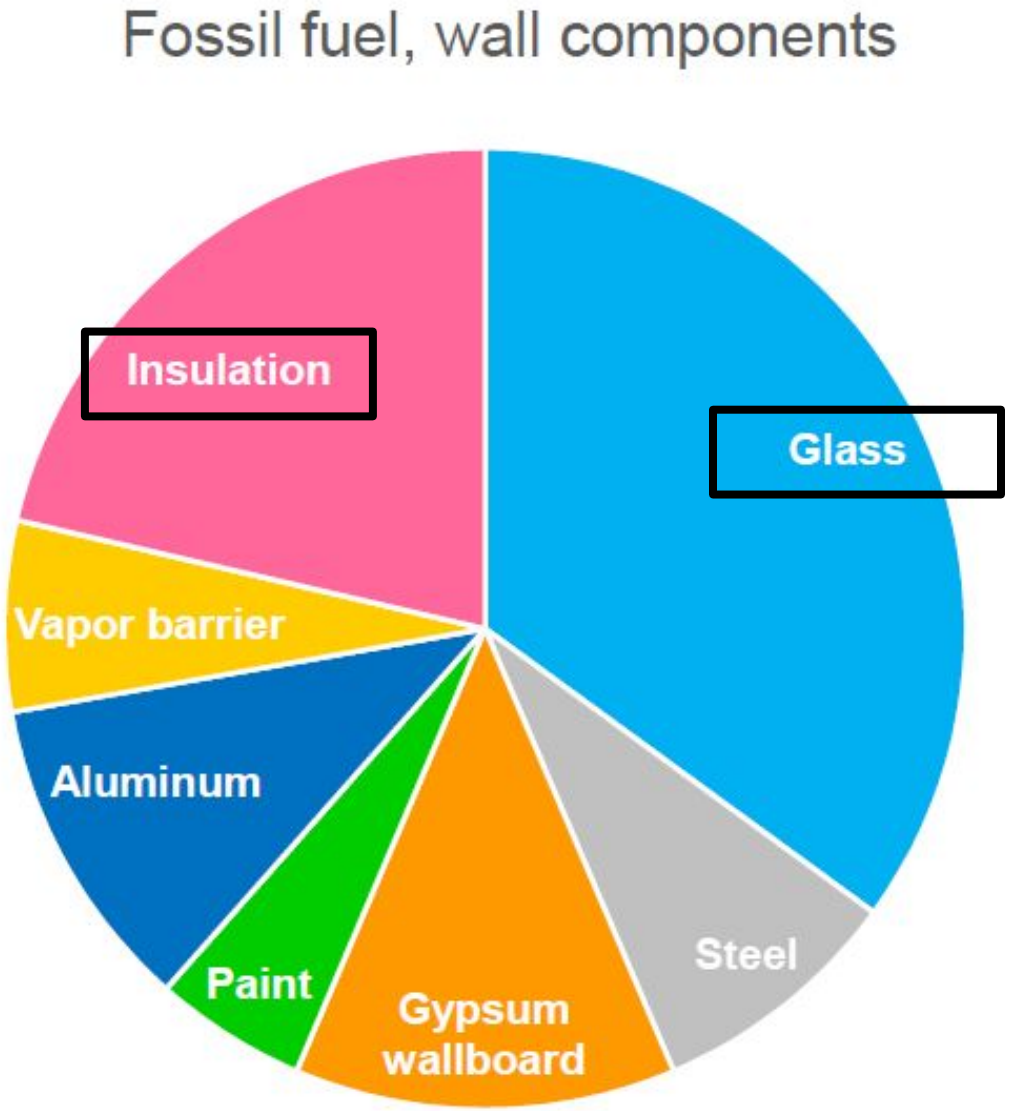


THE VALUE OF LCA

- In this example, we could choose to change insulation type or reduce glass surface area.



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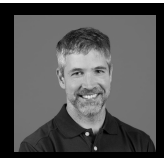
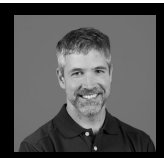


LCA LIMITATIONS

- LCA is just one tool in the sustainability toolkit.
- It addresses only some of the environmental impacts we may be concerned about.
- We still need other tools for different impacts – for example, certifications for sustainable harvesting (FSC, SFI, etc) including site specific impacts like biodiversity
- LCA is an **estimating science** not an exact science (there is a large margin of error)

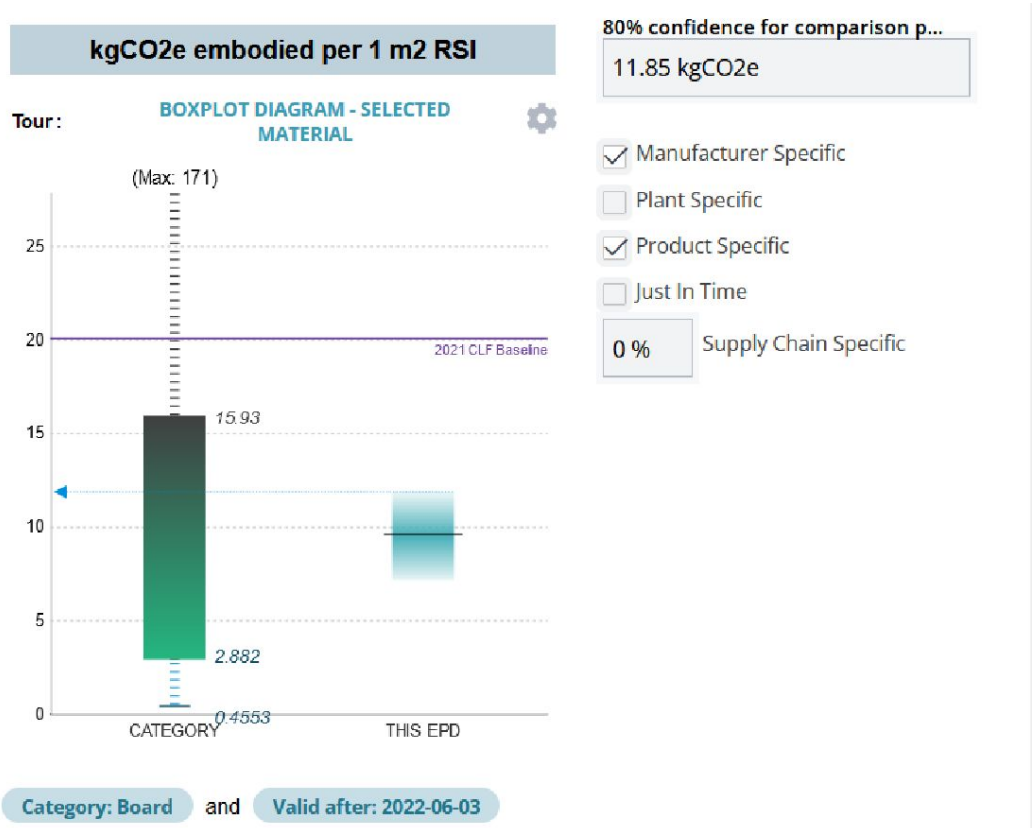
Slide courtesy of Athena Institute

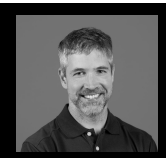


LCA LIMITATIONS

LCA may be most useful for *relative* impacts – for making decisions and comparing alternatives, ie – is option X better than option Y and by how much?

Less useful for determining *absolute* values. Whole building LCA practitioners have difficulty developing hard targets and benchmarks for building types. That's why a reference building of the same design is typically used for comparison.

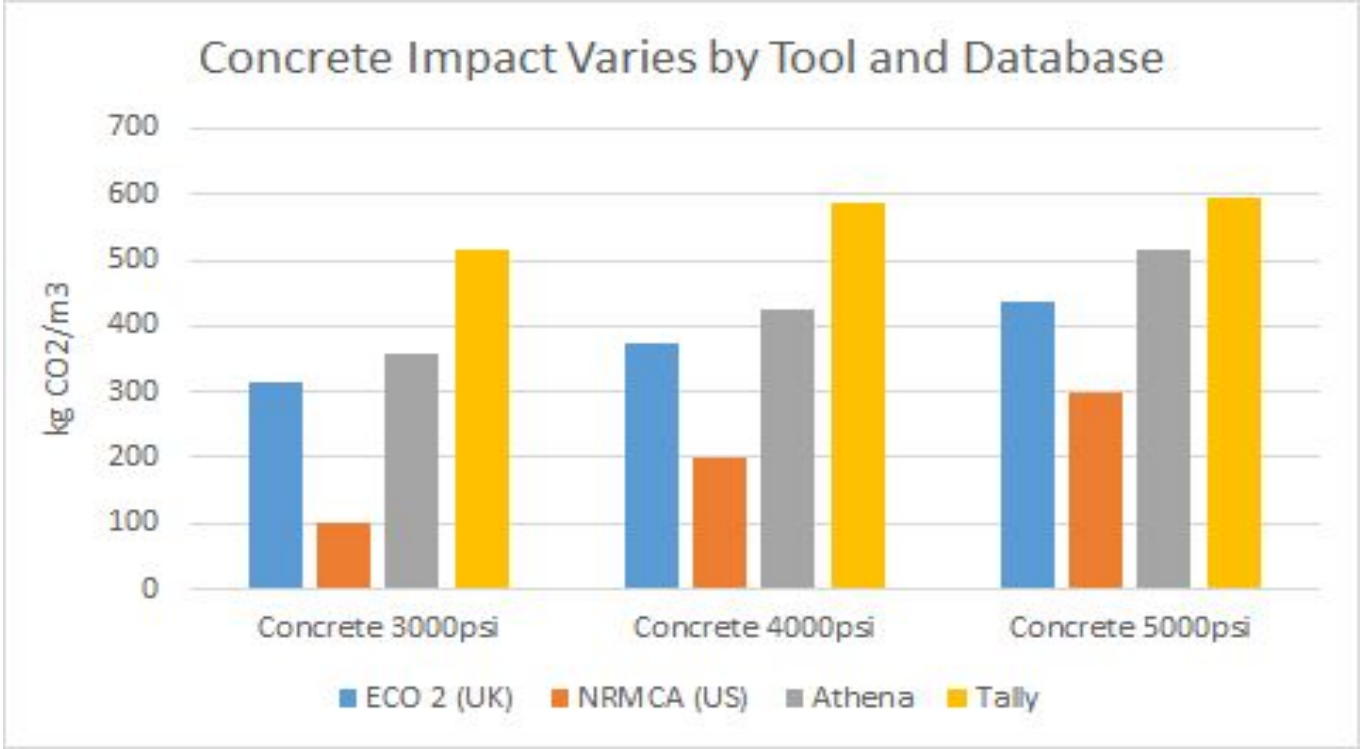


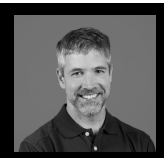


LCA LIMITATIONS

Environmental impacts vary significantly from tool to tool and compared to standard benchmarks. This is due to variations in the material data sets – geographically where the data is coming from and how it is being calculated.

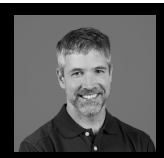
Comparison or tracking of results using two different tools or data sets is not valid in most cases.





LCA LIMITATIONS

WHY DO IMPACTS VARY SO MUCH?



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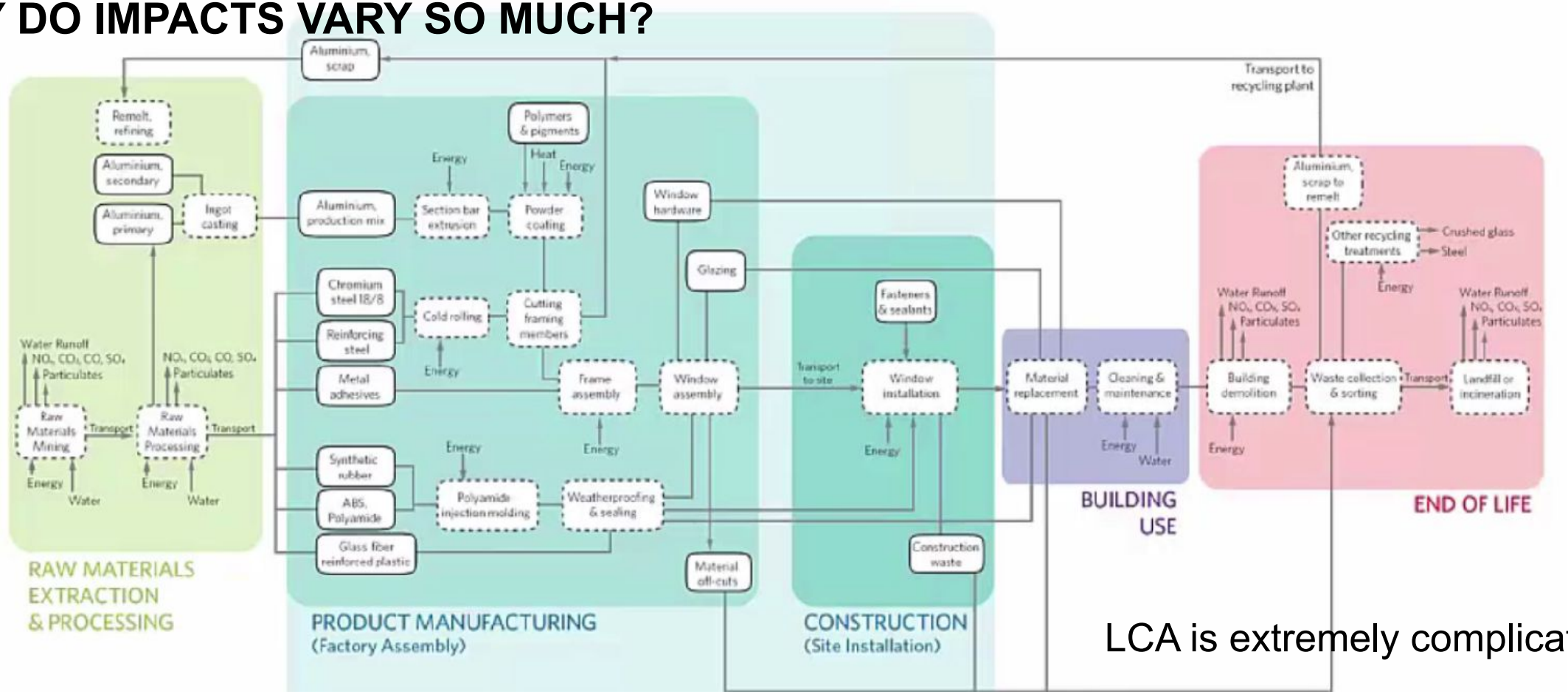
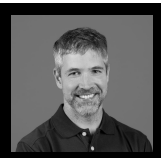


LCA is extremely complicated



PROTOCOLS

HOW IS AN LCA DONE CONSISTENTLY?

ISO 14040 SERIES | Defines the mandatory elements of an LCA. How to...

- Set scope/boundaries
- Identify impact categories to be used
- Classify LCI results into impact categories
- Translate LCI results into environmental impact results

TRACI 2.2 | Methodology developed by EPA to translate LCI results into indicators & environmental impacts

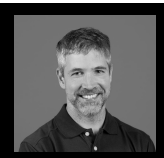

INTERNATIONAL STANDARD

ISO

ISO 14040:2006/Amd 1:2020

Environmental management — Life cycle assessment — Principles and framework — Amendment 1

ISO

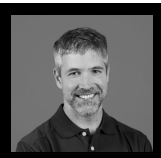


LCI VS. LCA

Life Cycle Inventory (LCI) - Identifies and quantifies all the *specific* chemicals or molecules (such as CFCs or SF6) that are emitted during the relevant processes, as well as the raw material and energy inputs for these processes. This forms the data collection portion of the larger LCA process

Life Cycle Analysis (LCA) - Groups these emissions into categories and calculates environmental or human health impacts using a set of representative “indicator” molecules (CO2 for global warming, SO2 for acidification, O3 for smog, etc)

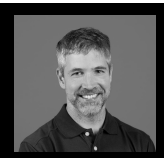
Example - How many molecules of CO2 is one molecule of SF6 worth?



LCA RESULTS – “INDICATORS”

LCA results are categorized by impact “indicators”. Taken together, the indicators are supposed to represent a comprehensive measure of impacts on the environment. Below, “e” stands for “equivalent”. Example indicator set (there are more):

- Global warming potential (kg of CO2e)
- Acidification potential (kg SO2e)
- Human Health (particulates) (kg PM2.5e)
- Eutrophication potential (kg N-e)
- Ozone Depletion potential (kg CFC-11-e)
- Smog potential (kg O3e)
- Total primary energy



LCA RESULTS – “INDICATORS”

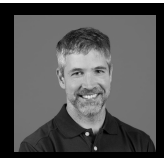
BENEFITS:

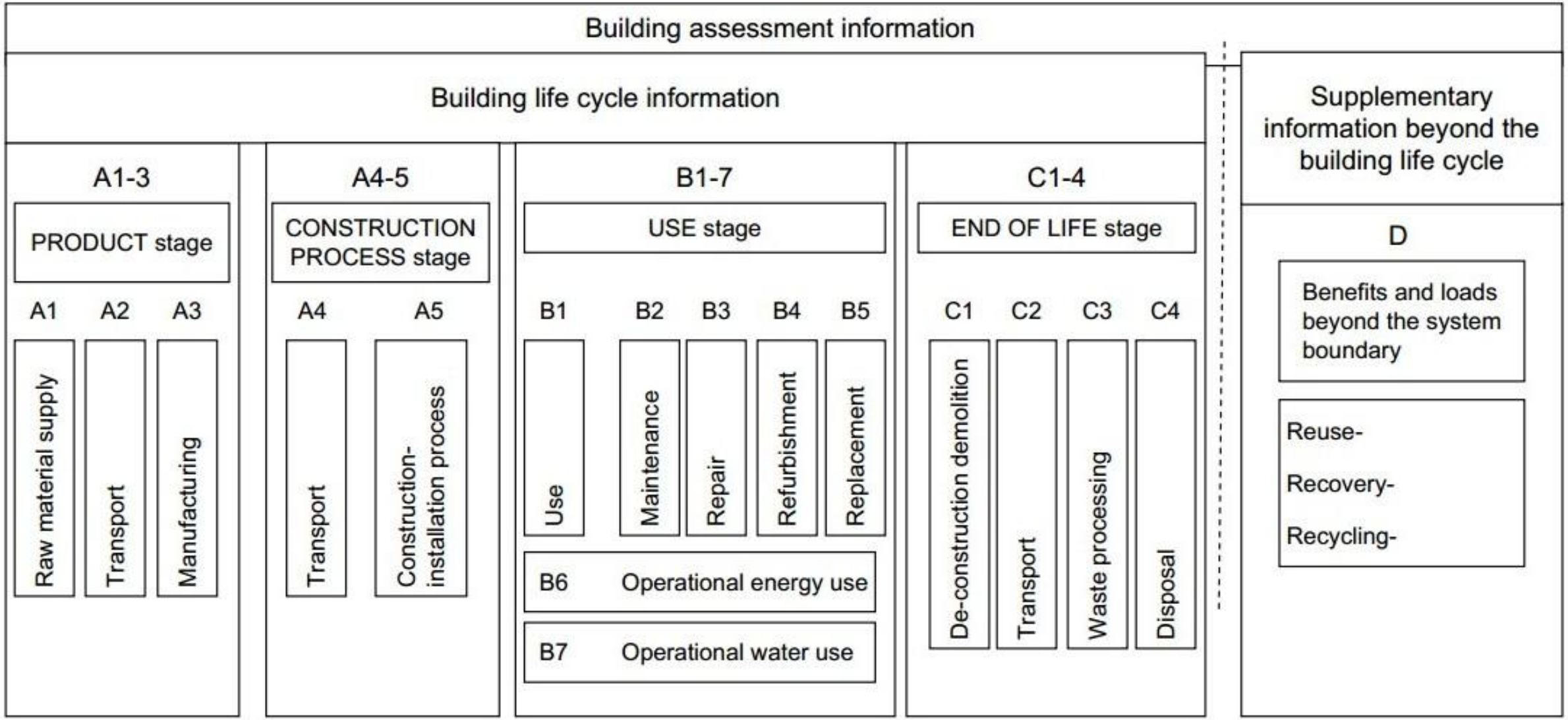
Use of indicators allows comparison of two products/materials that might result in the use or emission of very different sets of chemicals. You must have a common unit of measurement - which is the indicator molecule - to compare effects. However...

DRAWBACKS:

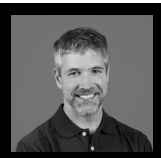
Indicators are just that. They “indicate” potential effects -- It is nearly impossible to definitively correlate emissions of specific chemicals to negative impacts on the environment or human health.

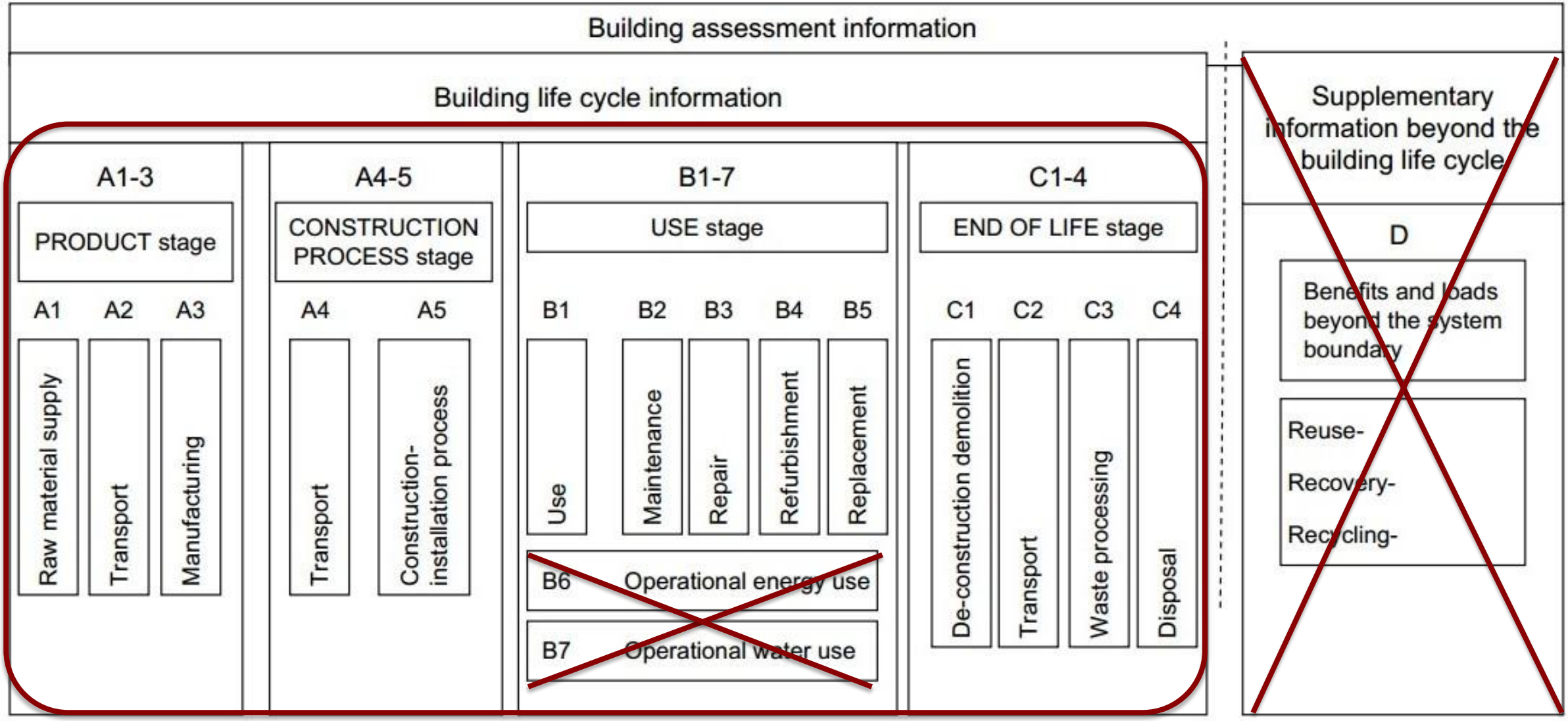
Typically, LCA falls especially short on human health impacts and habitat/biodiversity impacts.





From EN 15978 - diagram from Construction sector views on low carbon building Materials, Jannik Giesekam, John R. Barrett & Peter Taylor





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A NOTE ON BUILDING LIFE SPAN

Lifespan plays an important role in the results. Some materials look better than others considering different lifespans. However, the lifespan of a building can only be estimated.

Image credit – Ski Safari

EXAMPLE

Retail/commercial structures are often built of steel and concrete – more “durable” materials, but are also some of the shortest-lived. Houses and churches are often maintained to last for long periods of time, despite being made of wood.

Image credit – Montreal Gazette

A NOTE ON BUILDING LIFE SPAN

Lifespan plays an important role in the results. Some materials look better than others considering different lifespans. However, the lifespan of a building can only be estimated. **We must use a consistent standard. M1a is aligned with LEED: 60 years**

Image credit – Ski Safari

EXAMPLE

Retail/commercial structures are often built of steel and concrete – more “durable” materials, but are also some of the shortest-lived. Houses and churches are often maintained to last for long periods of time, despite being made of wood.

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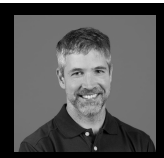


WHOLE BUILDING LCA TOOLS

TOOLS FOR LCA

SimaPRO, GaBi, OpenLCA	• For LCA specialists and practitioners (analyzing a specific product) • Requires knowledge of industrial processes. Specialists are hired by a company to perform a full LCA analysis on a particular product/material (such as a Huber OSB).
EcoConcept, EC3	• For consumers and designers (working at the product selection level) • Streamlined product-based LCA tools useful for comparing and analyzing specific products and alternatives. Theoretically, results can be built up to evaluate whole assemblies.
Tally, One Click LCA, Athena, C.Scale, BEAM Estimator, Revit Carbon Insights	• For architects and designers (working at the whole building scale) • First 4 tools cover complete life cycle for whole building LCA analysis. • Other tools listed only cover A1-A3 scope, or other limited life cycle scope

WHOLE-BUILDING LCA

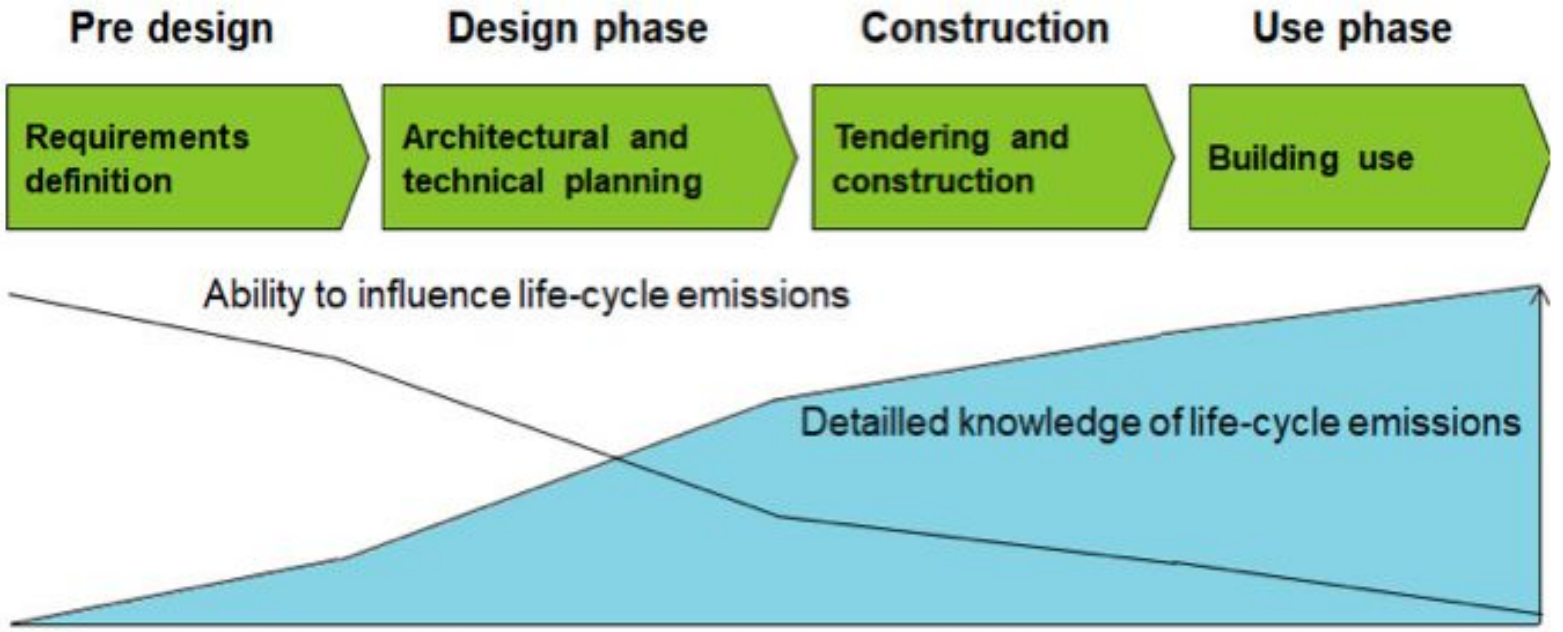
- Attempts to quantify embodied impacts from the materials and process used to construct, maintain, and demolish the building.
- Typically, whole-building LCA includes: structure, enclosure, foundation, floors, maybe interior walls and maybe finishes
- Typically does not include: fixtures, furnishings, and equipment (plumbing, HVAC equipment, furniture, lighting, etc)
- May also include operational impacts (such energy use and associated emissions)

Image credit - ids-center.com

LCA - IMPACTS IN EARLY DESIGN

How can we make good decisions earlier?

- We know we need to model earlier in design



Overview of Whole Building Life-Cycle Assessment for Green Building Certification and Ecodesign through Industry Surveys and Interviews. Tytti Bruce-Hyrkäs, Panu Pasanen and Rodrigo Castro. 25th CIRP Life Cycle Engineering (LCE) Conference, 30 April 2 May 2018, Copenhagen, Denmark

WHOLE BUILDING LCA TOOLS

Currently approved tools to meet B3 requirements

Athena Impact Estimator for Buildings

One Click LCA

tally 2.0

Other tools for future exploration

c.scale™

CARE Tool

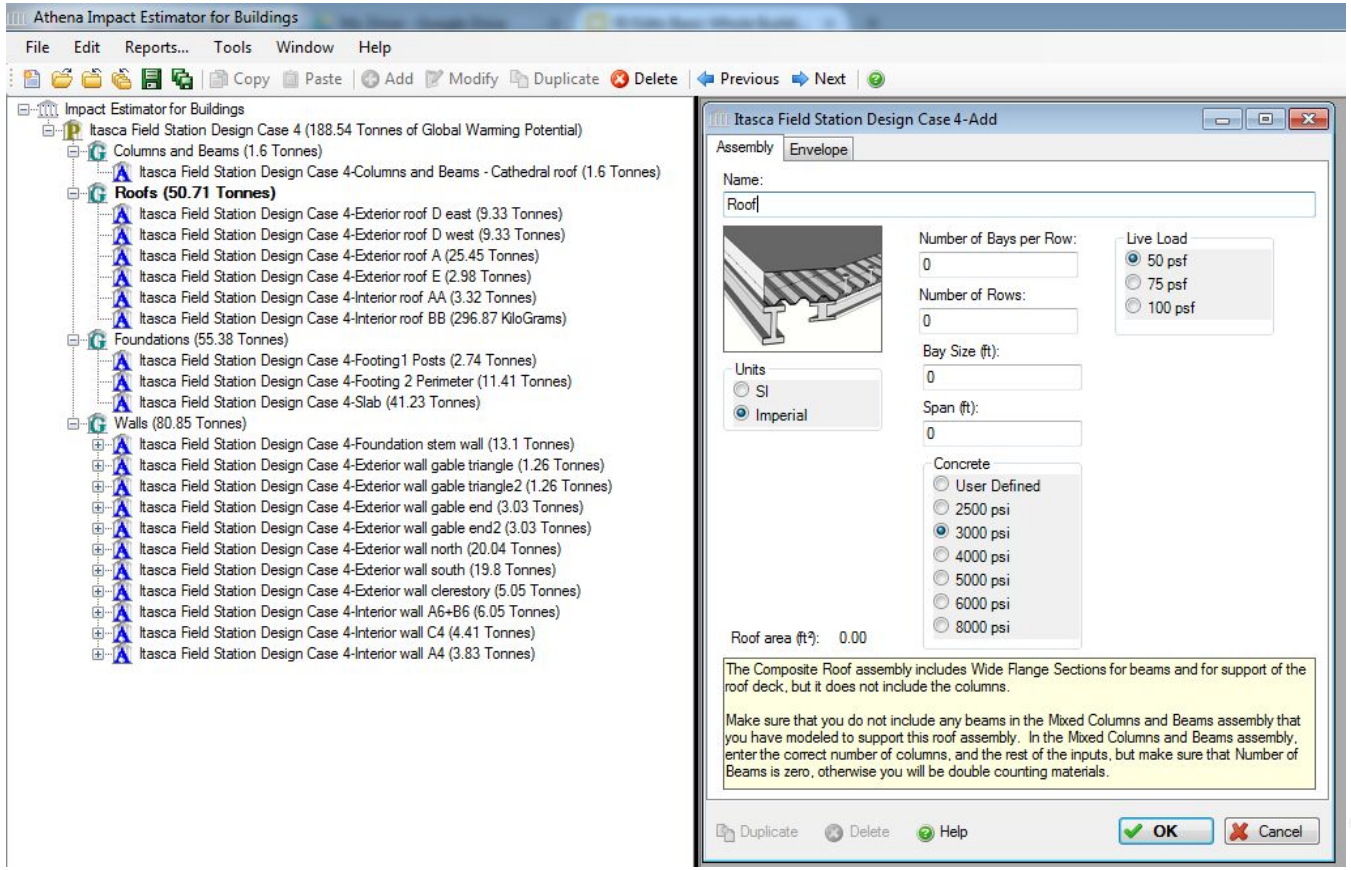
BEAM — Building Emissions Accounting for Materials (BEAM) software

Beacon

Embodied Carbon Order of Magnitude Estimator (ECOM)
https://se2050.org/ecom-tool/

ATHENA IMPACT ESTIMATOR (IE)

- Developed by Athena Institute
- Tree-based data structure based on area take-offs for building systems, no visual models
- Material impacts taken from USLCI Database - NREL database plus proprietary information developed by the Athena Institute with Morrison Hershfield



ONE CLICK LCA

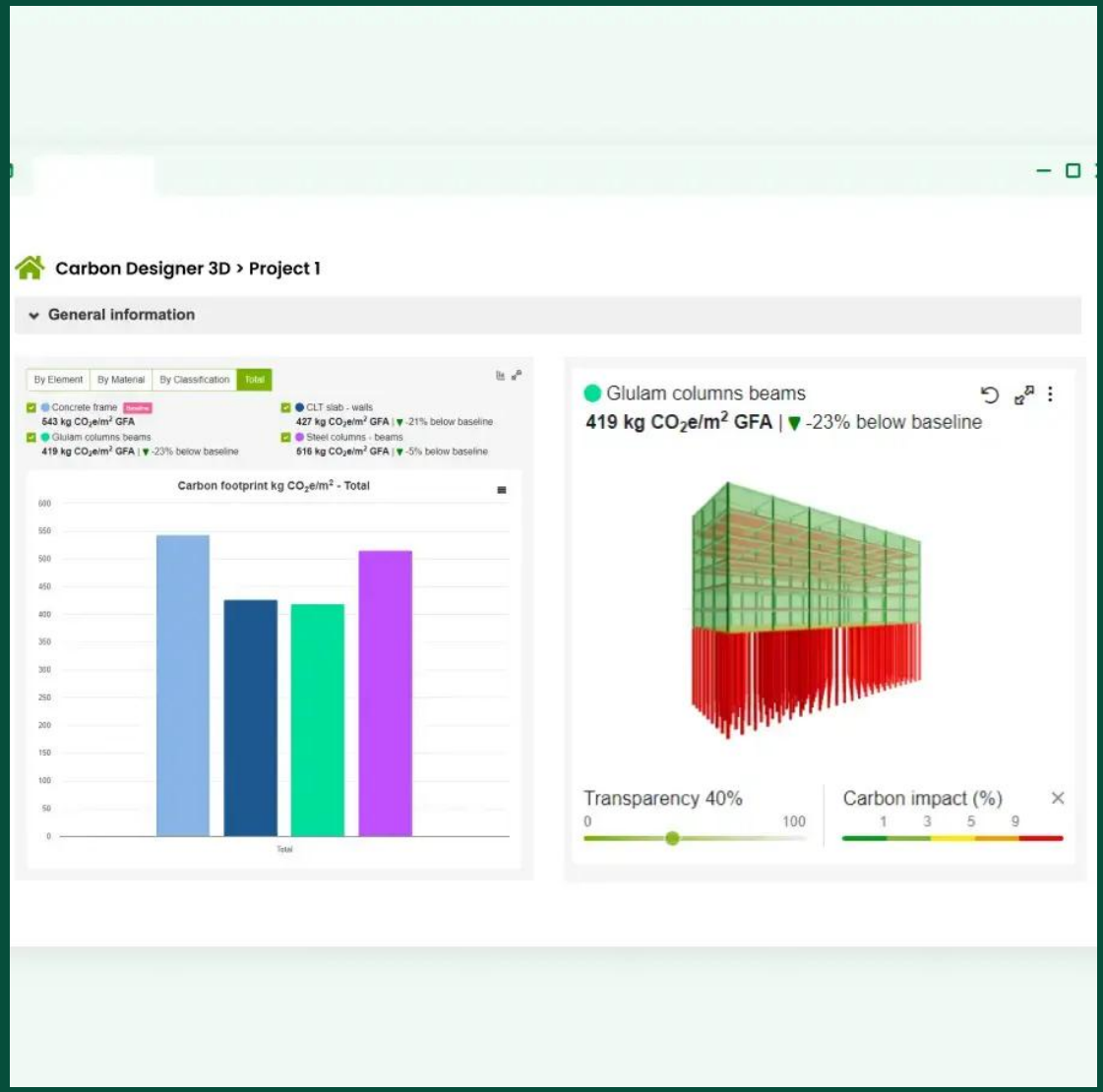
Spencer Jarrett
Building & Infrastructure LCA, EPD solutions
spencer.jarrett@oneclicklca.com

One Click LCA for Minnesota B3

From early design carbon decisions to B3 documentation

15-minute software workflow | B3 M.1A

Spencer Jarrett
Senior LCA & EPD Consultant, One Click LCA

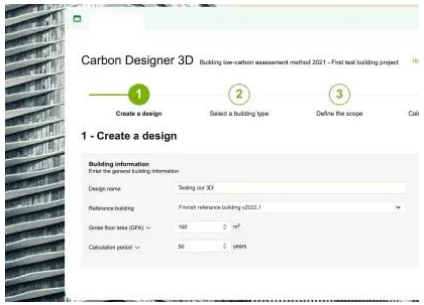


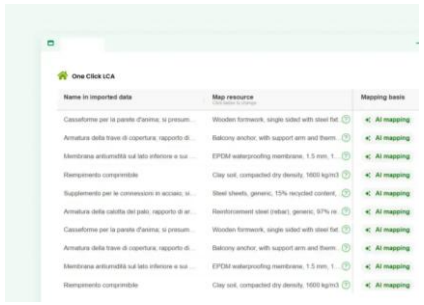
Where One Click LCA fits in the project workflow

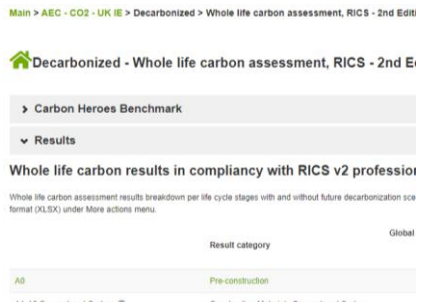
Use the software as a design feedback loop before it becomes a final report.

The same model can evolve: assumptions → project quantities → mapped materials → reduction evidence.

Early massing	Design options	Quantity import	Material mapping	Hotspot analysis	B3 outputs
Predesign / concept	SD scenario testing	DD / CD data	EPDs + datasets	Compare + reduce	Reports + Tracking Tool







Key point: final reporting is the output — design decisions are the value.

Sources: One Click LCA Carbon Designer 3D, integrations, AI mapping, and results documentation

Carbon Designer 3D: early design before the model is detailed

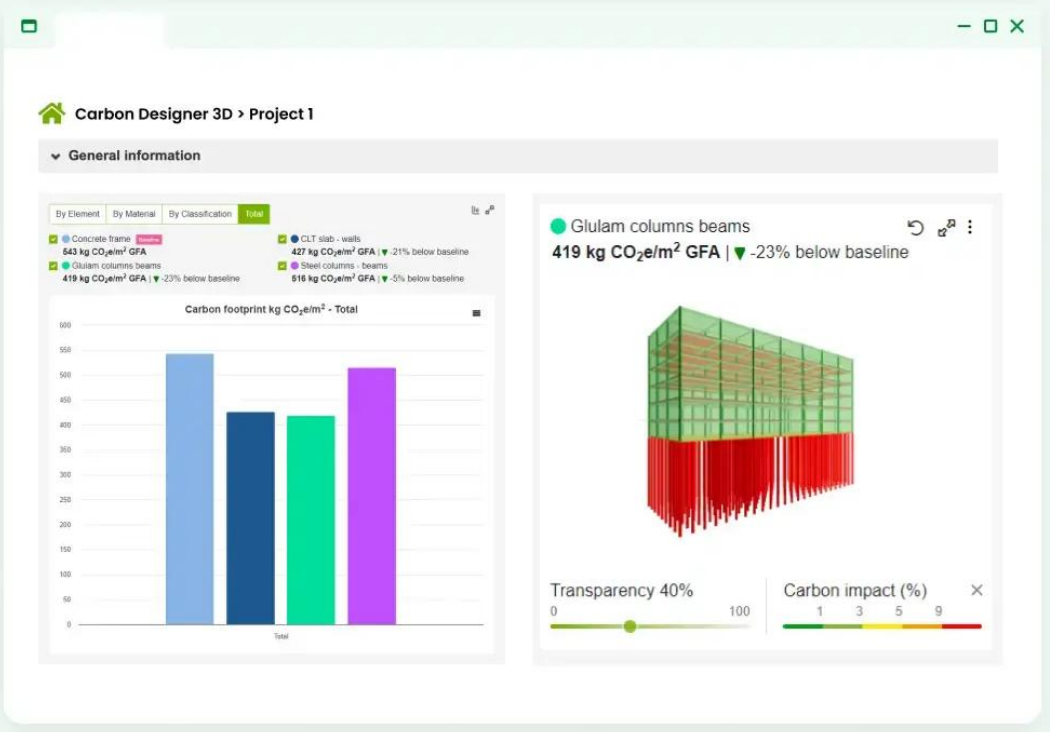
Estimate, compare, and optimize embodied carbon while the team still has room to change the design.

What the interface helps teams test

01 Building type and size assumptions
02 Reference buildings and design options
03 Structural and envelope assumptions
04 Early carbon hotspots and reductions
05 Fast comparisons before BIM quantities exist

B3 relevance
Use early results to test massing, shape, layout, surface area, assembly choices, and material substitutions before the Reference Building and selected design are fixed.

Design tool first. Reporting tool later.

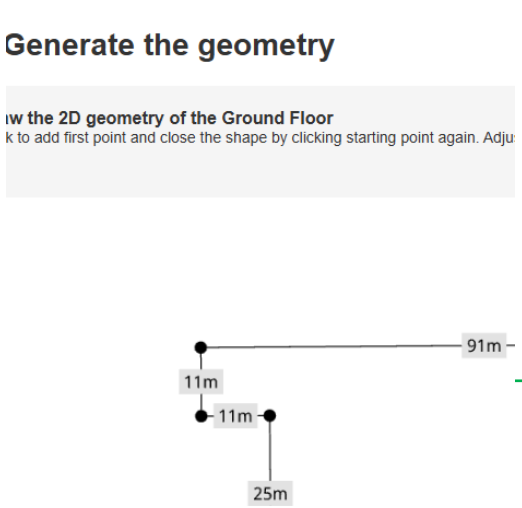


ONE CLICK LCA SCREENSHOT

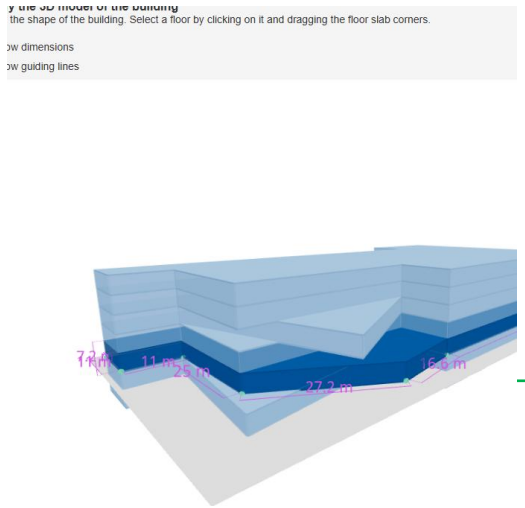
Sources: One Click LCA Carbon Designer 3D help article and early design decarbonization page

New feature spotlight: Free Drawing + AI-generated shapes

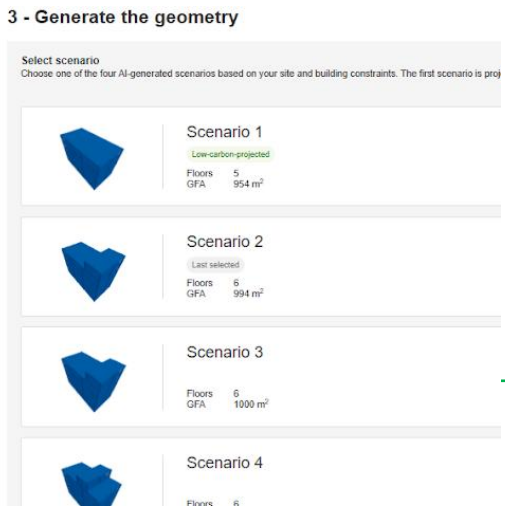
Faster early design exploration: from sketch or constraints to testable massing options.



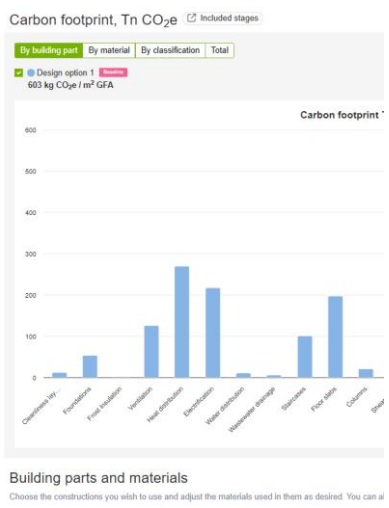
1 Draw or select shape



2 Generate 3D model



3 Compare AI options



4 Test carbon impact

Free Drawing creates a 3D building model from a manually drawn 2D floor plan.

Generate Shapes with AI creates multiple compliant massing options from site and design parameters.

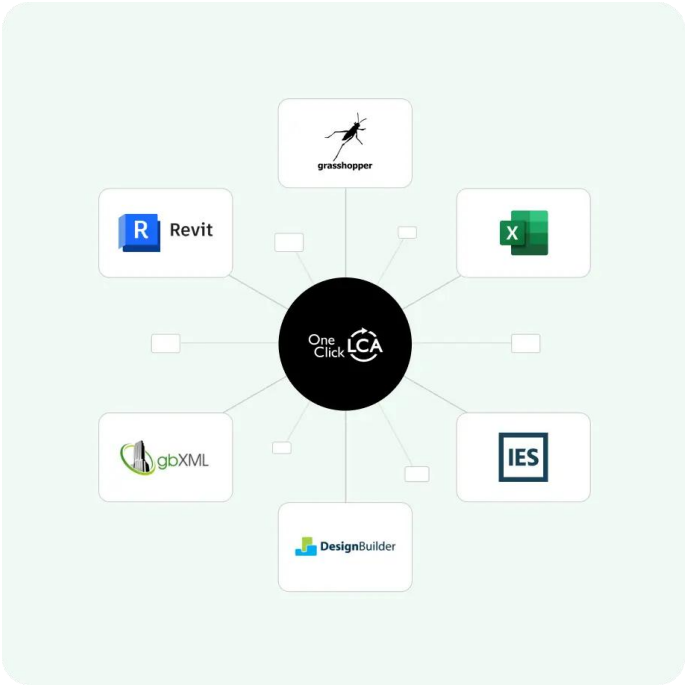
Use the outputs for team discussion, not automatic compliance decisions.

B3 Path 1 fit: massing, layout, surface area, assembly choices, material substitutions

Sources: One Click LCA Free Drawing and Generate building shapes with AI help articles

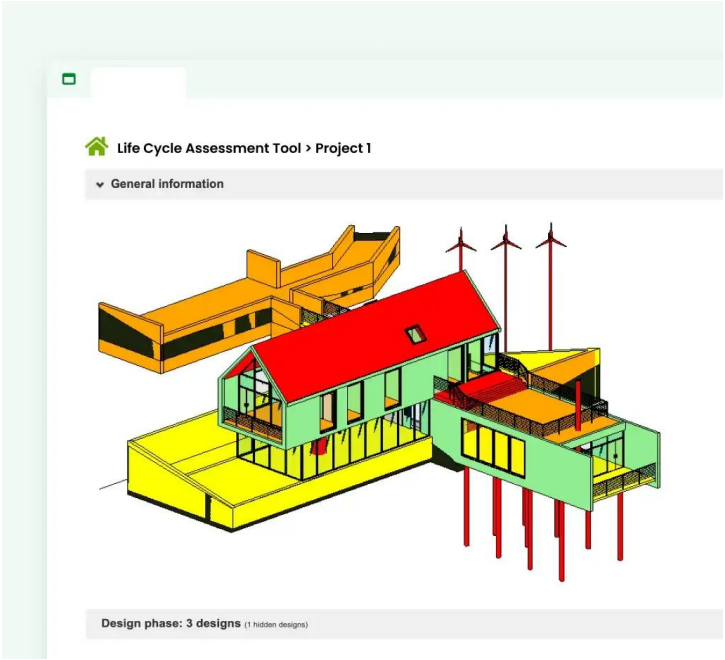
Getting data into One Click LCA as design matures

As the project advances, the workflow shifts from assumptions to project-specific quantities.



BIM
Excel / CSV
IFC
Manual entry

→ **Import review** → **Quantities ready for mapping**



Revit | **IFC** | **Excel / CSV**

Rhino / Grasshopper | **IES-VE** | **Procore**

Manual

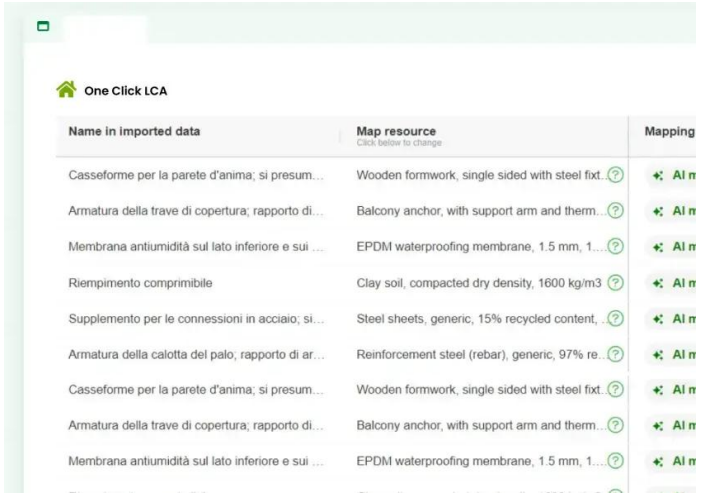
Quality check
Automation helps with quantity flow, but the project team still validates scope, units, modeled vs. omitted items, and assembly representation.

Quantity quality drives LCA quality.

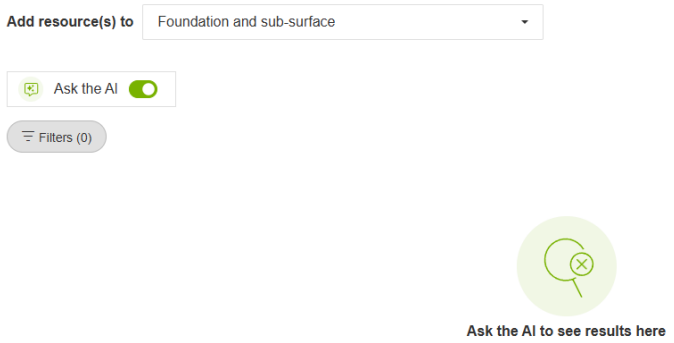
Sources: One Click LCA integrations, Revit integration, updated import process, and IFC Viewer guidance

Material mapping, AI assistance, and finding the right LCA data

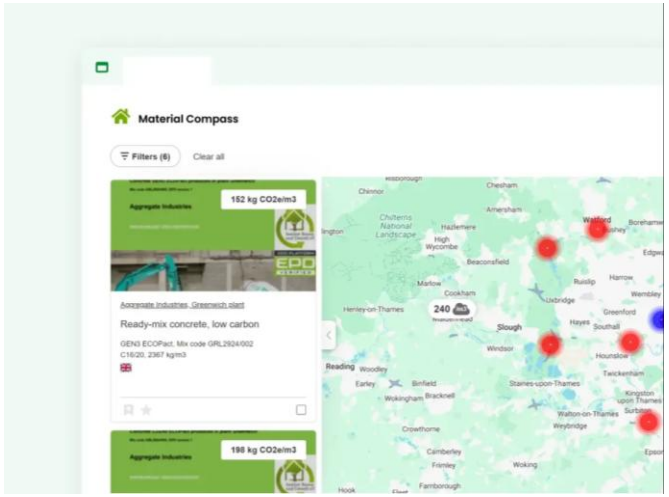
Imported rows become useful only after they are mapped to appropriate environmental profiles.



AI mapping



Ask the AI



Materials Compass

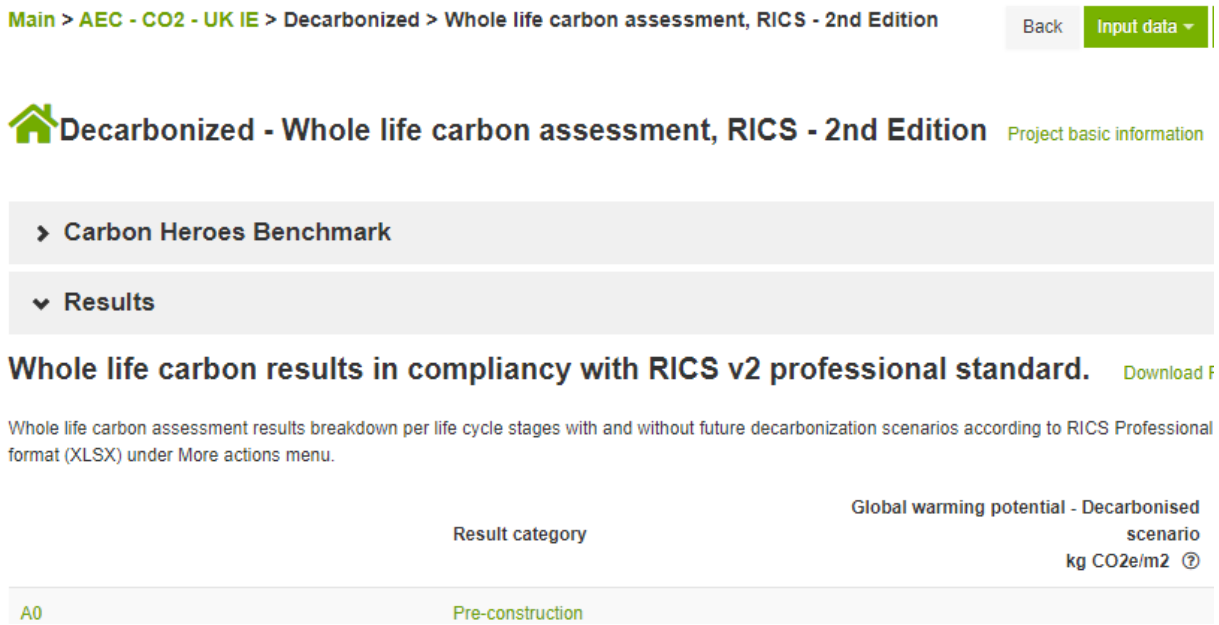
Unmapped material row → AI / search assistance → Selected profile → Practitioner review → Defensible mapping

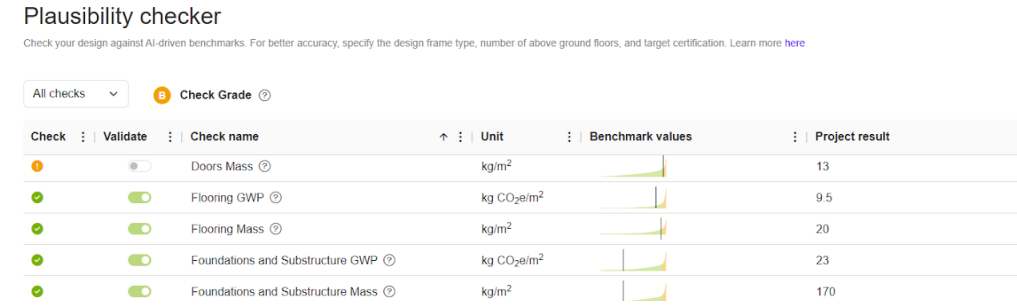
Review: product specificity • geography • units • scope • EPD validity • assumptions

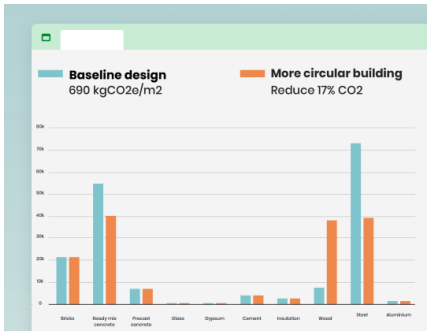
Sources: One Click LCA Powered by AI, Ask the AI, Materials Compass, and import guidance

Results, hotspots, comparison, and B3-ready outputs

Turn the model into design feedback and documentation evidence.







Illustrative B3 comparison
Reference Building: 100%
Selected Design: 88%
GWP reduction: 12%

What to pull from the results

01 GWP by life-cycle stage and assembly
02 Top contributors and hotspots
03 Reference Building vs. selected/current design
04 Plausibility / QA checks before submittal

B3-relevant outputs

01 Excel detailReport for Reference Building and current/selected design
02 Building Materials tab PDF showing materials and mapping if Revit was used
03 Model files, reports, and Tracking Tool entries per selected path

Goal: defensible reporting, not just a presentation-ready chart.

Sources: One Click LCA results page and AI Plausibility Checker; B3 Guidelines v3.2r02 M.1A

B3 documentation playbook: turn the workflow into evidence

Assign ownership early so the final submittal is a byproduct of design decisions, not a scramble.

Predesign / SD
Set B3 version + path
Create early reference logic
Test massing strategies

→

Design development
Import better quantities
Review scope and units
Map major assemblies

→

CD / procurement
Update selected design
Request EPDs
Confirm material alternates

→

Final design / submit
Run QA checks
Export detailReports
Compile Tracking Tool evidence

Who owns the data?

Architect	massing, envelope, finishes, product categories
Structural engineer	structure, grid, frame, concrete/steel/timber quantities
LCA lead	model setup, mapping review, hotspots, reports
Spec writer	EPDs, product documentation, procurement language
GC / CM	as-built quantities, alternates, construction records

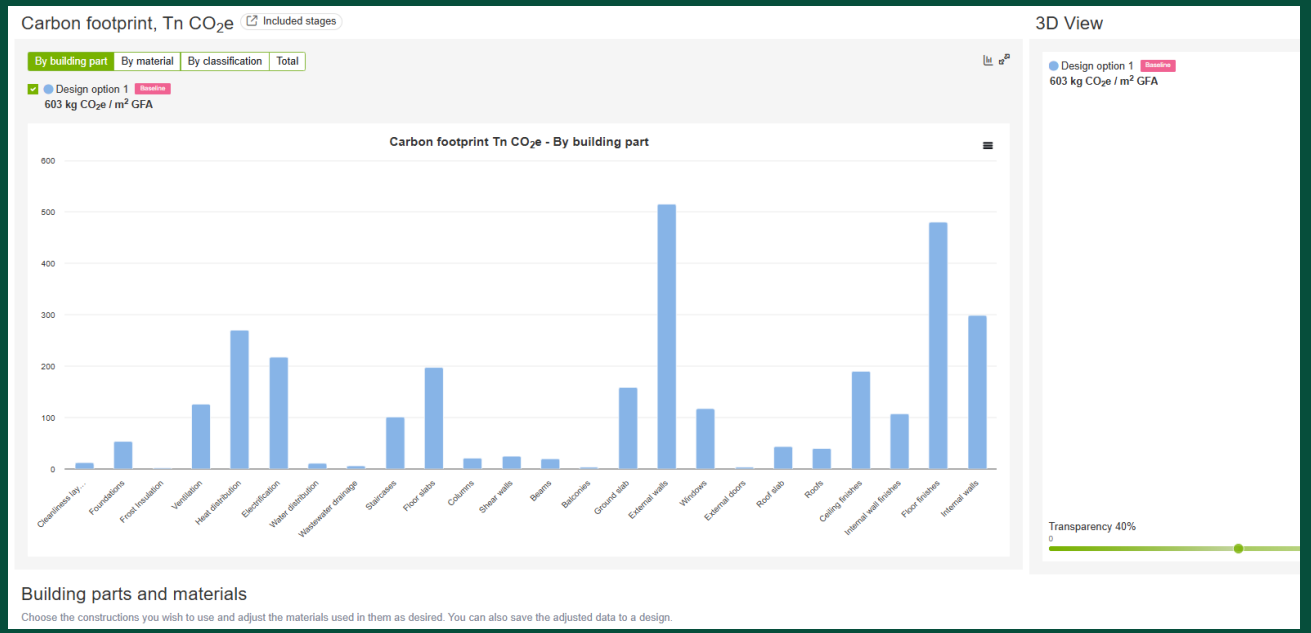
B3 submittal package mindset
Reference Building model + selected/current design model
Reports showing GWP impact by A–C life-cycle phases and assembly type
Excel detailReport exports and mapping evidence
Tracking Tool entries consistent with selected path

Most common risk: starting the LCA after key structural and envelope decisions are already fixed.

Sources: B3 Guidelines v3.2r02 M.1A submittal requirements; One Click LCA workflow guidance

Practical takeaways for project teams

1. Start early with Carbon Designer 3D — before major design decisions are locked.
2. Use Free Drawing and AI-generated shapes to test massing and layout quickly.
3. Bring in better quantities as the design matures; validate scope and units.
4. Treat mapping as QA-critical; AI assists, but human review makes it defensible.
5. Use results, hotspots, and detailReport exports to support B3 documentation.
6. Confirm the applicable B3 version, path, scope, Tracking Tool, and submittals.



Questions? Spencer Jarrett | Senior LCA & EPD Consultant | One Click LCA | oneclicklca.com

One Click LCA does not replace team judgment — it makes carbon tradeoffs visible early enough to act on them.

C.SCALE & TALLY 2.0

Jack Rusk
CEO and Co-founder of C.Scale
jack@cscale.io

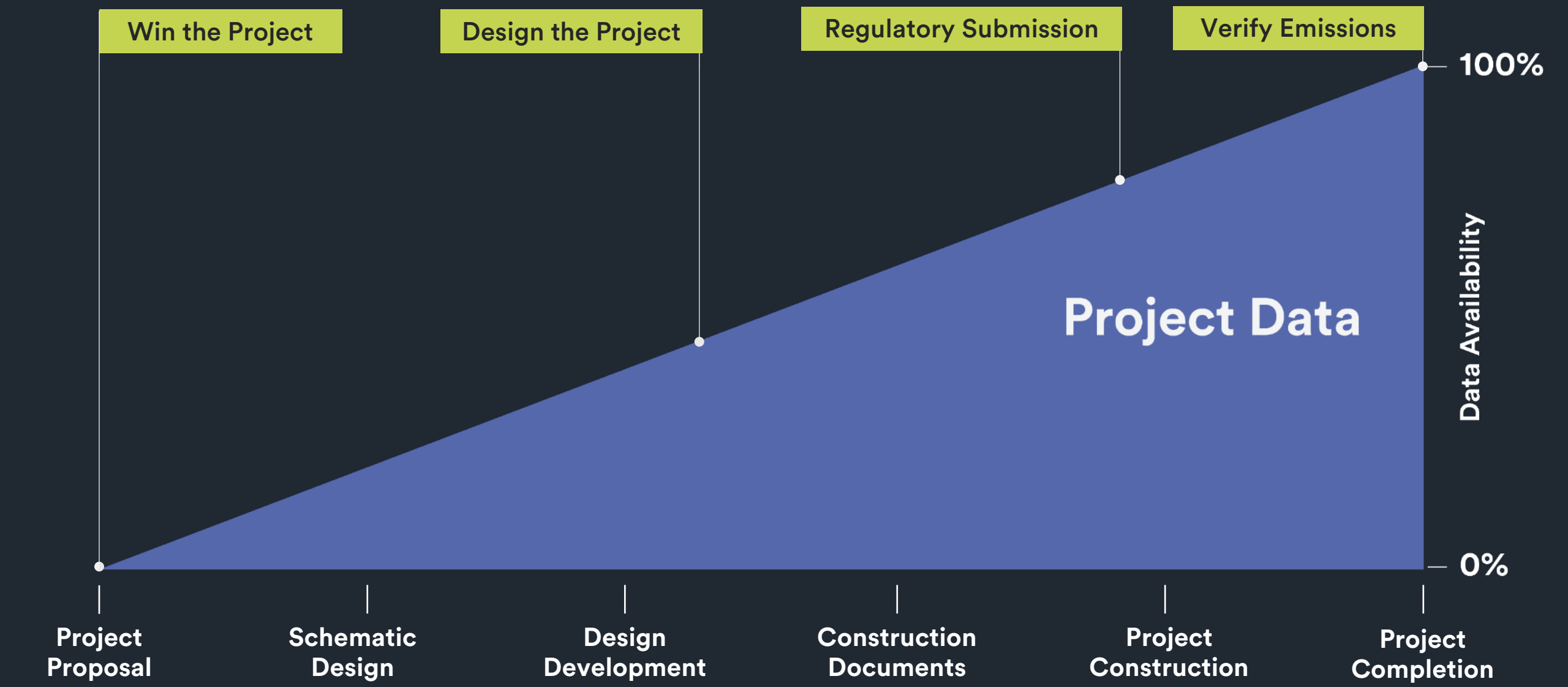
c.scale™

Data-Driven Decarbonization

jack@cscale.io

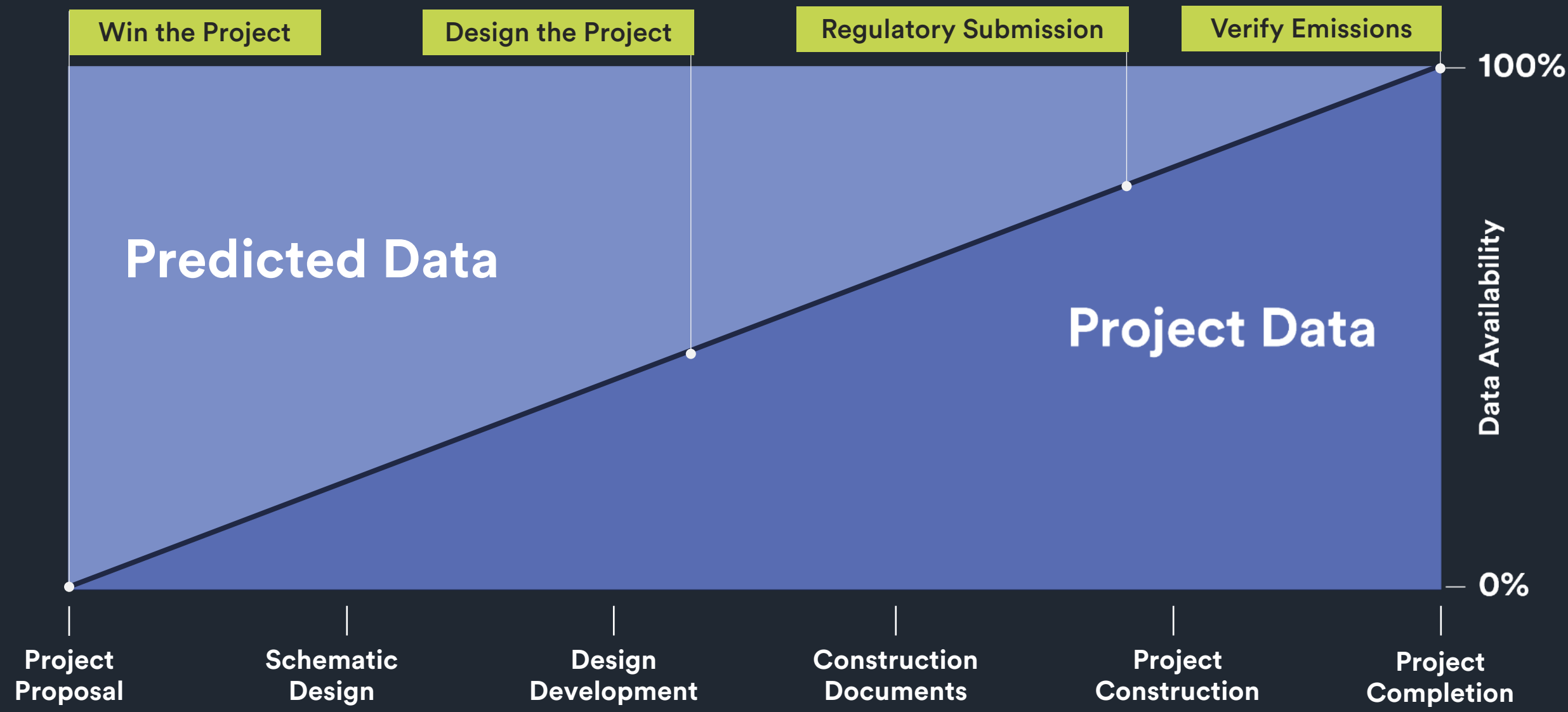

The right data at the right time
to support the right decision
c.scale

Project specific data comes too late for action



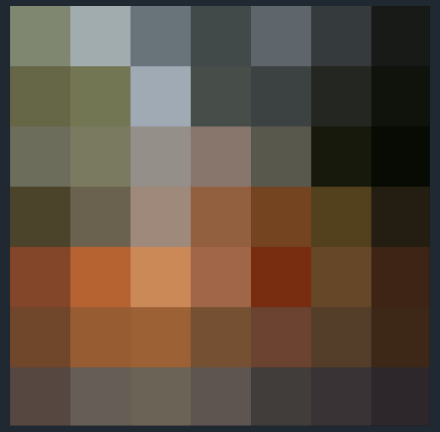
c.scale

C.Scale fills in gaps to enable impactful decisions



c.scale

Carbon clarity from concept to construction

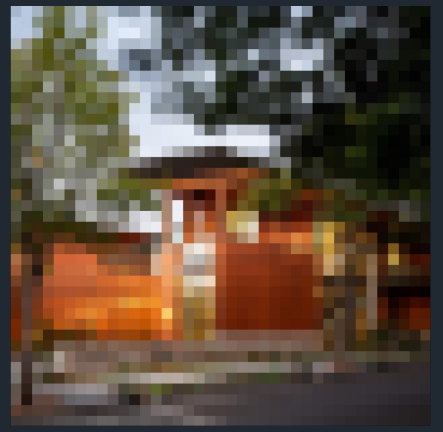


Planning and Concept

Get started by entering basic project details and C.Scale fills in the rest.

Schematic Development

Identify key systems and assemblies that meet your climate impact goals.



Detailed Design

Build an AI-assisted LCA, or import one and C.Scale will fill in around it.

Procurement and Approvals

Inform specs and streamline LEED and regulatory compliance.

Construction and As Built

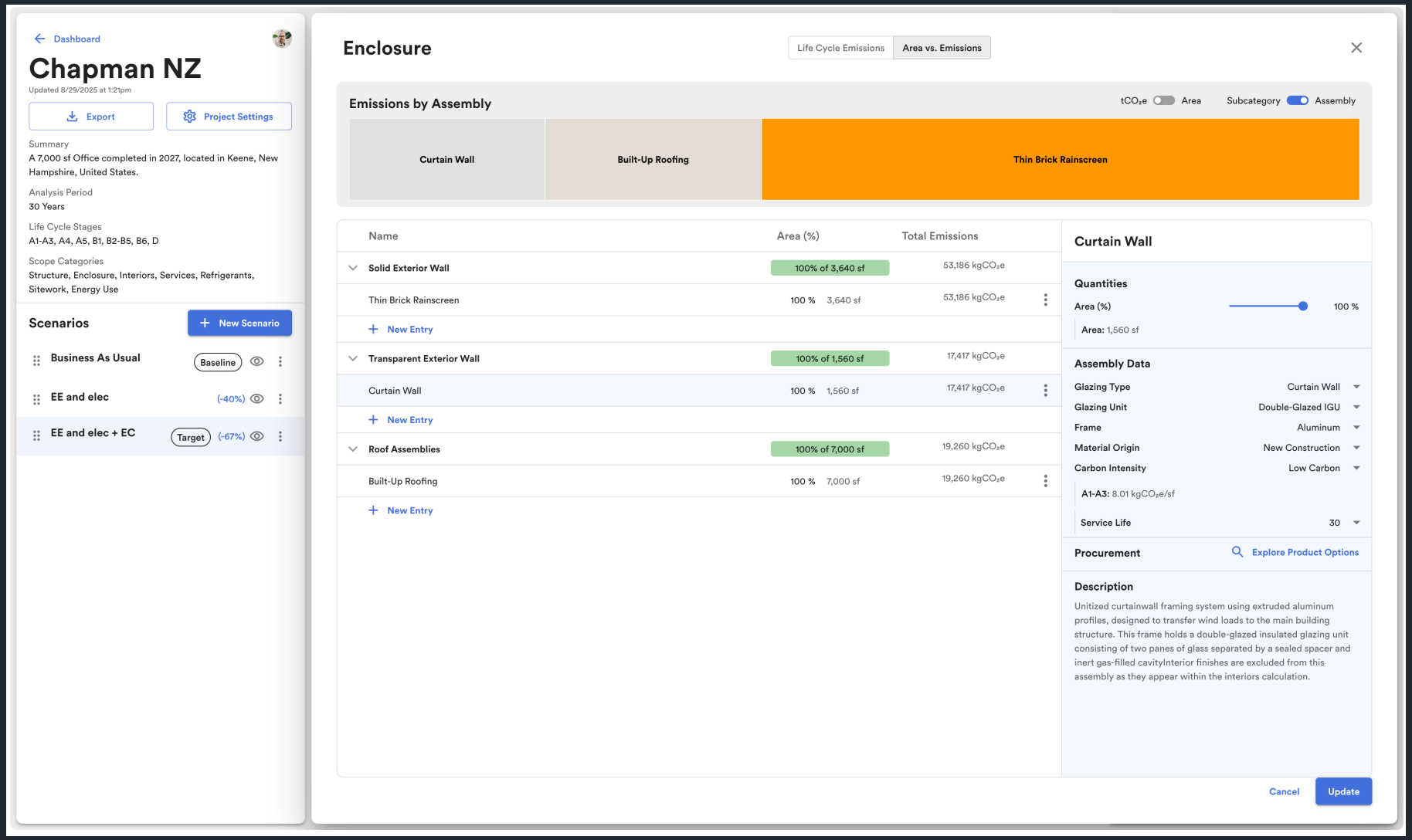
Complete the picture with as-built data collaboratively with the full project team.

c.scale™

Set whole building strategy

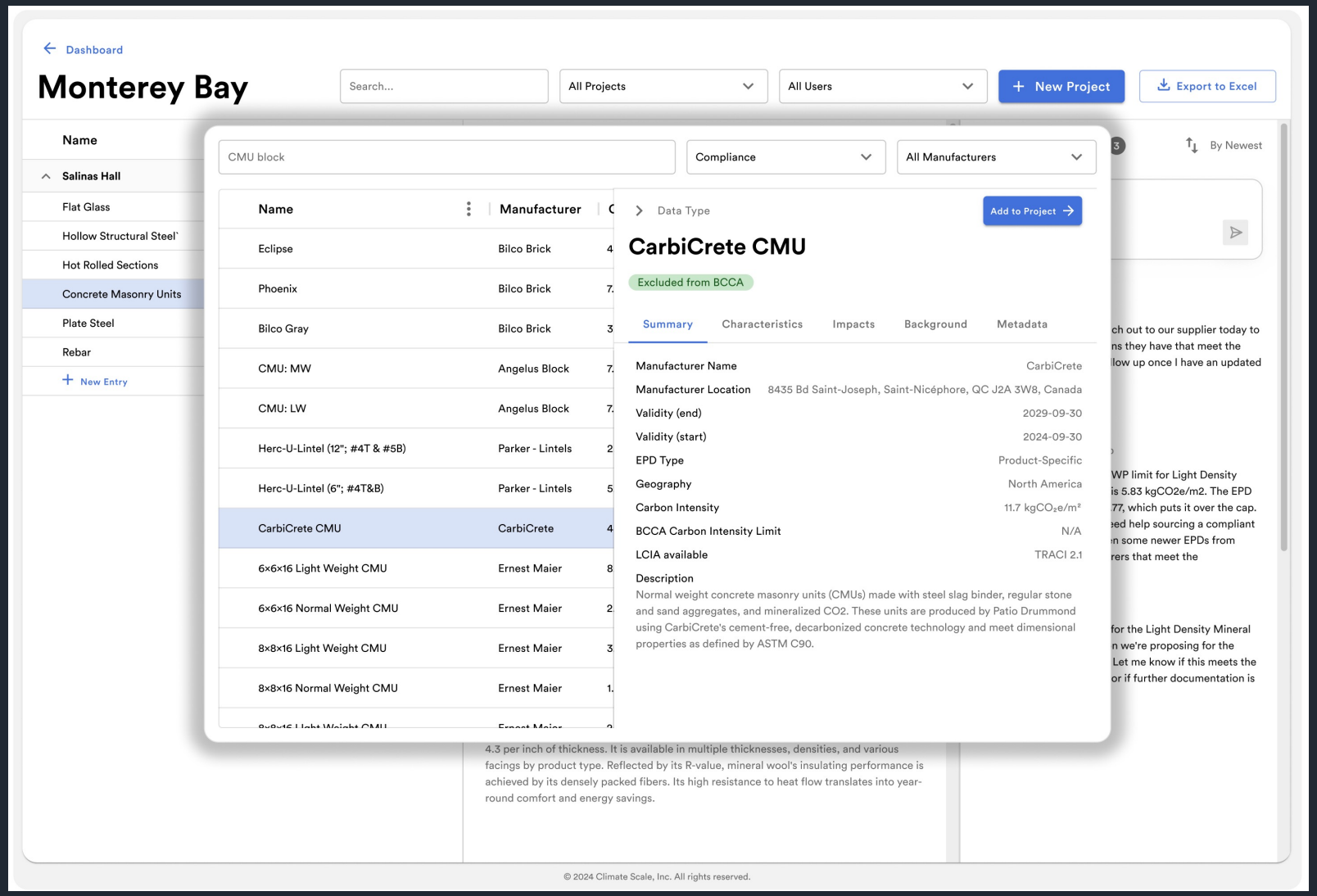
c.scale

Configure assemblies



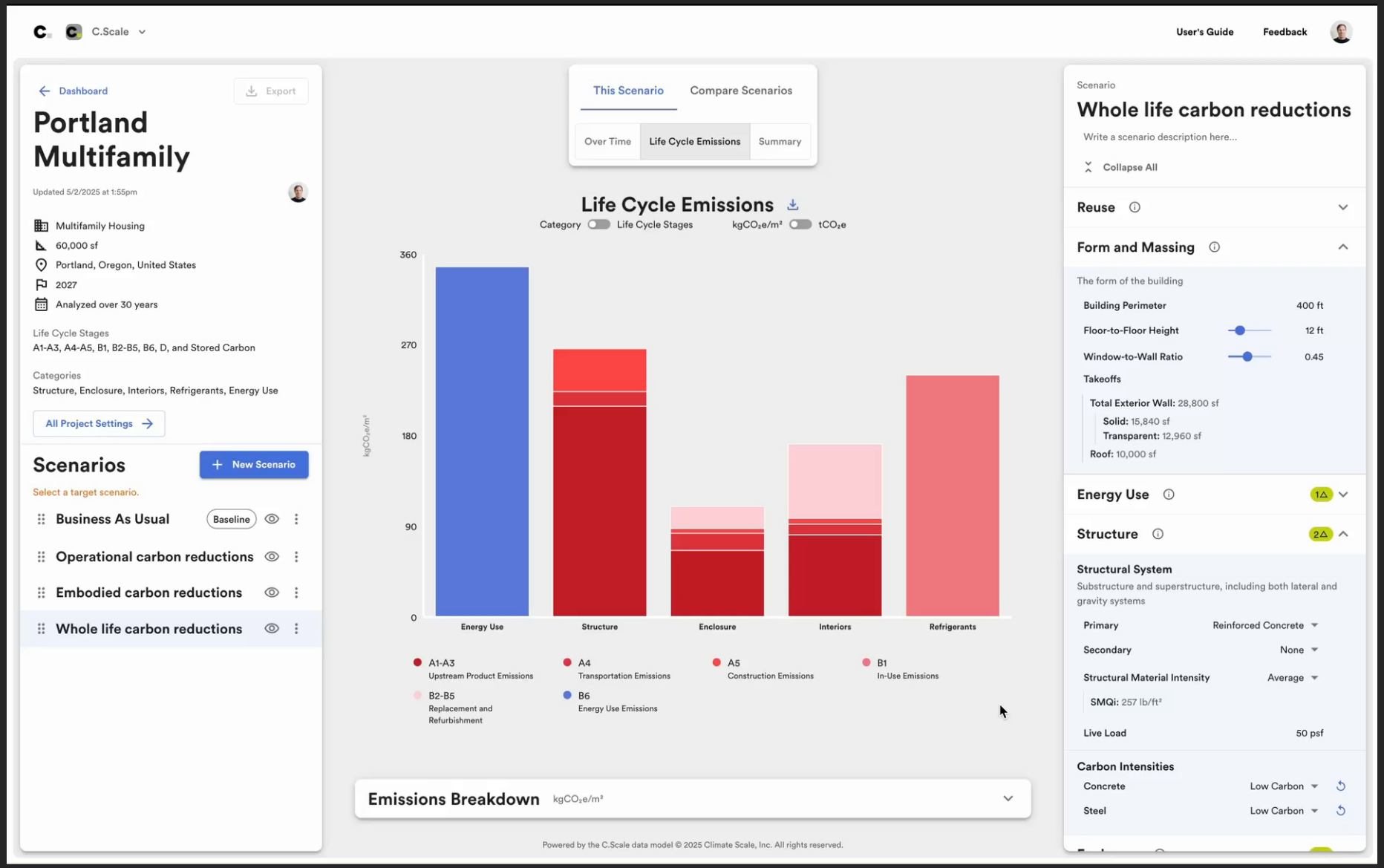
c.scale™

Material selection and detailed design



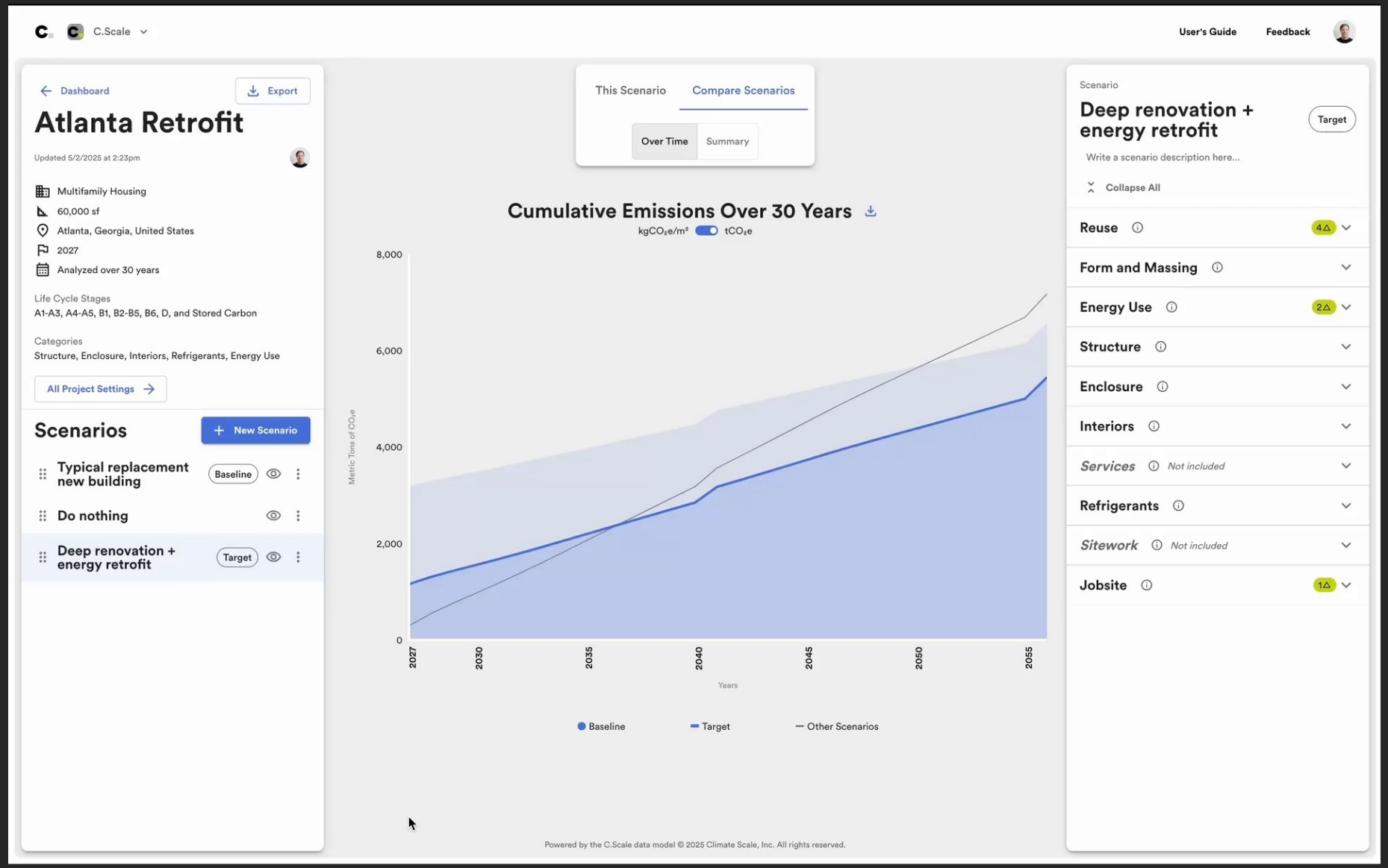
c.scale

Iteratively address hot spots



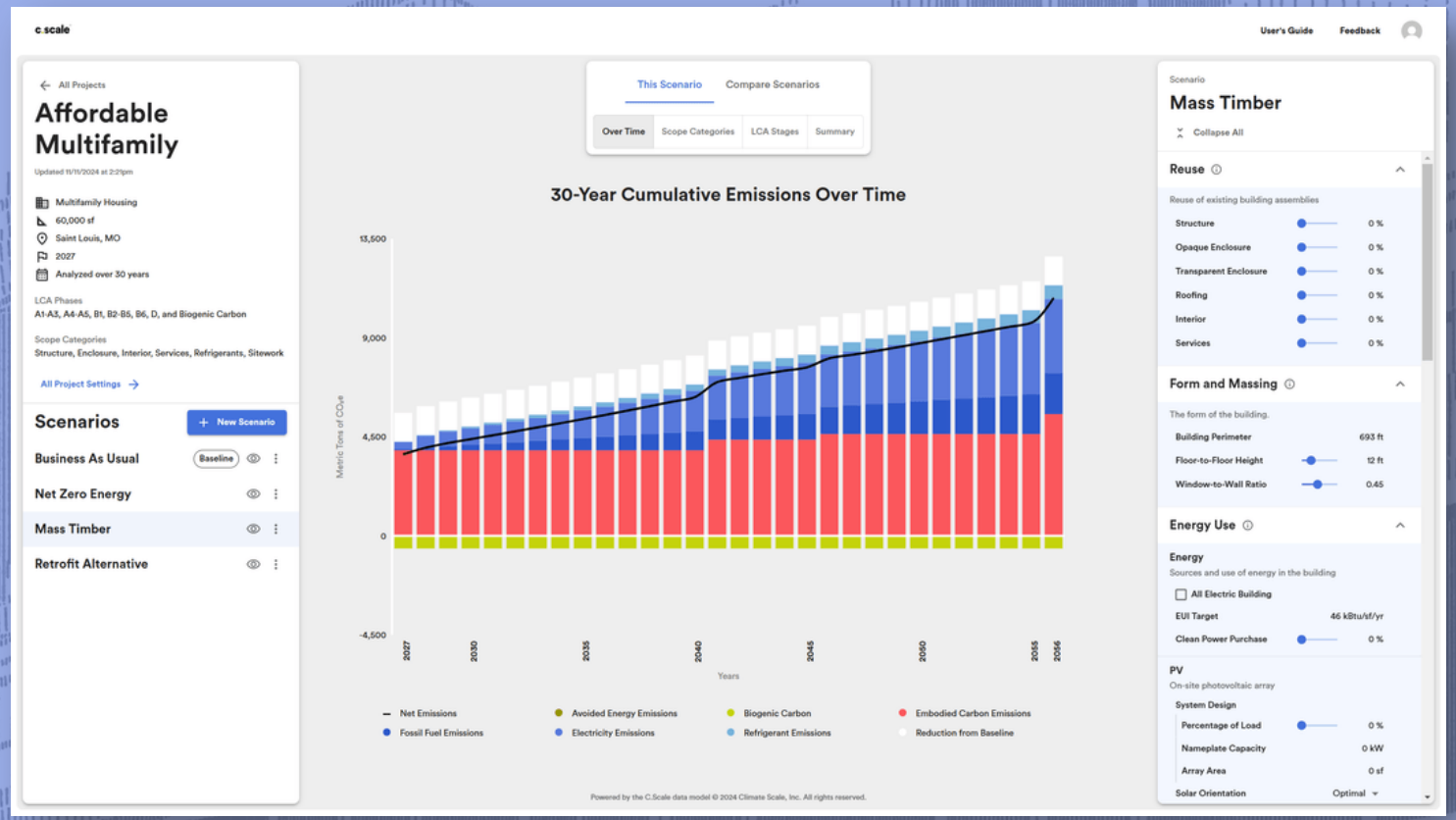
c.scale

Consider the time value of carbon



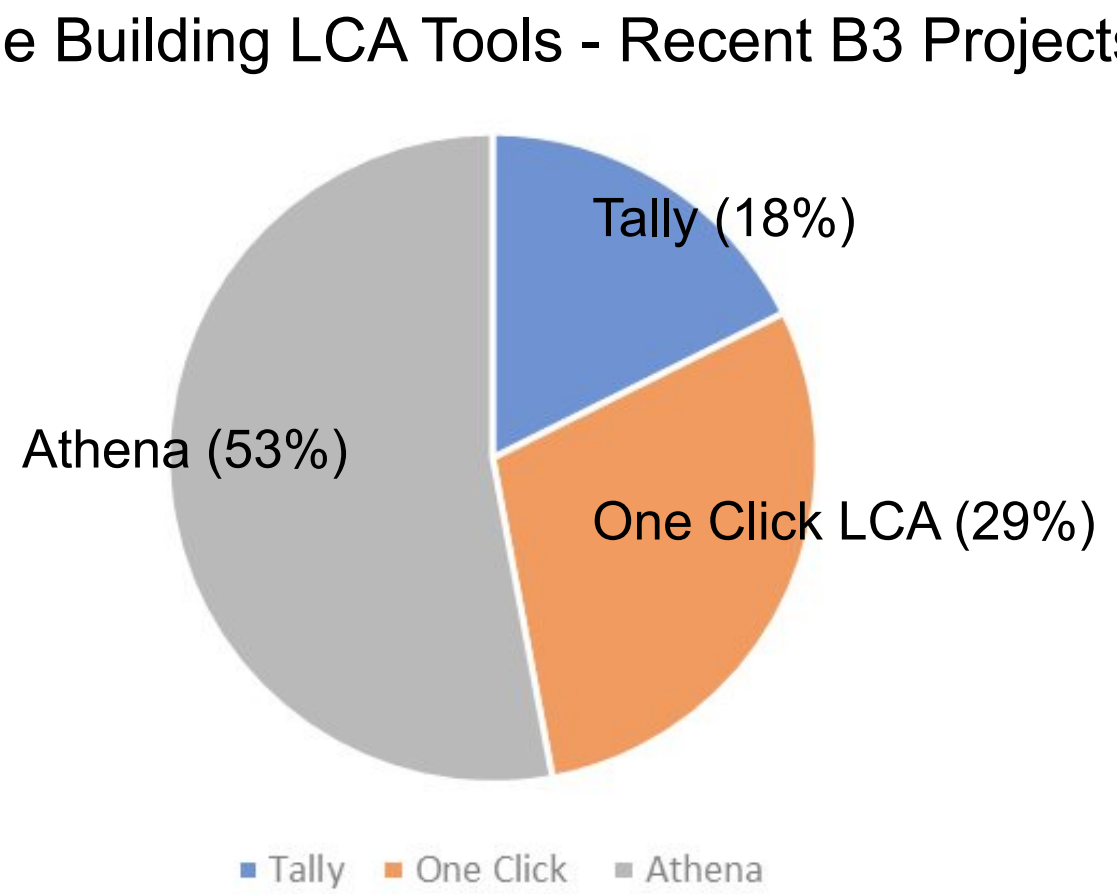
c.scale

C.Scale is free to use



app.cscale.io

RECENT B3 LCA TOOL USAGE



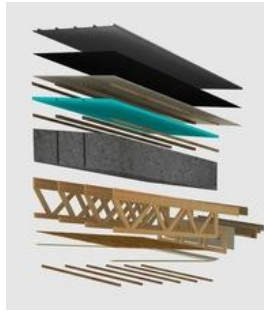
M1A REQUIREMENTS

CREDIT M1A

PATH 1: WHOLE-BUILDING LEVEL

Most complex to model. But now we can compare buildings that are functional equivalents. Allows for investigations of building shape and surface area, and tradeoffs between different types of structural systems.

PATH 2: ASSEMBLY LEVEL



PATH 3: PRODUCT/MATERIAL LEVEL

CREDIT M1A

GUIDELINE REQUIREMENTS | PATH 1 – WHOLE BUILDING LCA APPROACH

Closely follows *LEED v4 BD+C MR Credit - Building Life Cycle Impact Reduction*

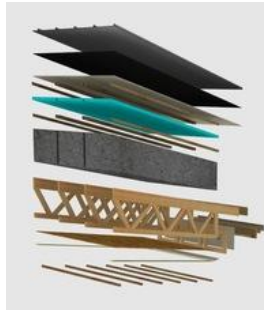
Document at least a 10% reduction in whole building global warming potential as compared to a Reference Building through life cycle assessment using approved software. Compare the Selected Design (the design of the building at the end of the FD phase) to the Reference Building, developed by the end of the D phase.

CREDIT M1A

PATH 1: WHOLE-BUILDING LEVEL

PATH 2: ASSEMBLY LEVEL

Easier to model than a whole building. But can only compare assemblies that are functionally equivalent. Not fair to compare R48 roof vs R60 roof, for example.



PATH 3: PRODUCT/MATERIAL LEVEL

CREDIT M1A

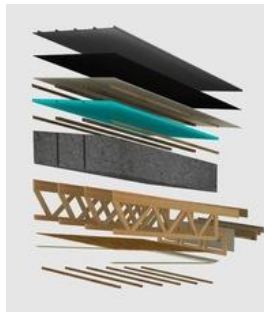
GUIDELINE REQUIREMENTS | PATH 2 – ASSEMBLY LEVEL LCA APPROACH (STRUCTURAL BAYS)

Document at least a 10% reduction in global warming potential as compared to a Reference Case structural bay model (or similar functional unit) using approved software. Compare the Selected Design Case (representing the design of the building at the end of the FD phase) to the Reference Case, developed by the end of the D phase.

CREDIT M1A

PATH 1: WHOLE-BUILDING LEVEL

PATH 2: ASSEMBLY LEVEL



PATH 3: PRODUCT/MATERIAL LEVEL

Simplest, quickest approach. But limited. Can only compare materials that are functionally equivalent, for example – OSB vs. plywood sheathing. Not fair to compare ccSPF vs. fiberglass batts.

CREDIT M1A

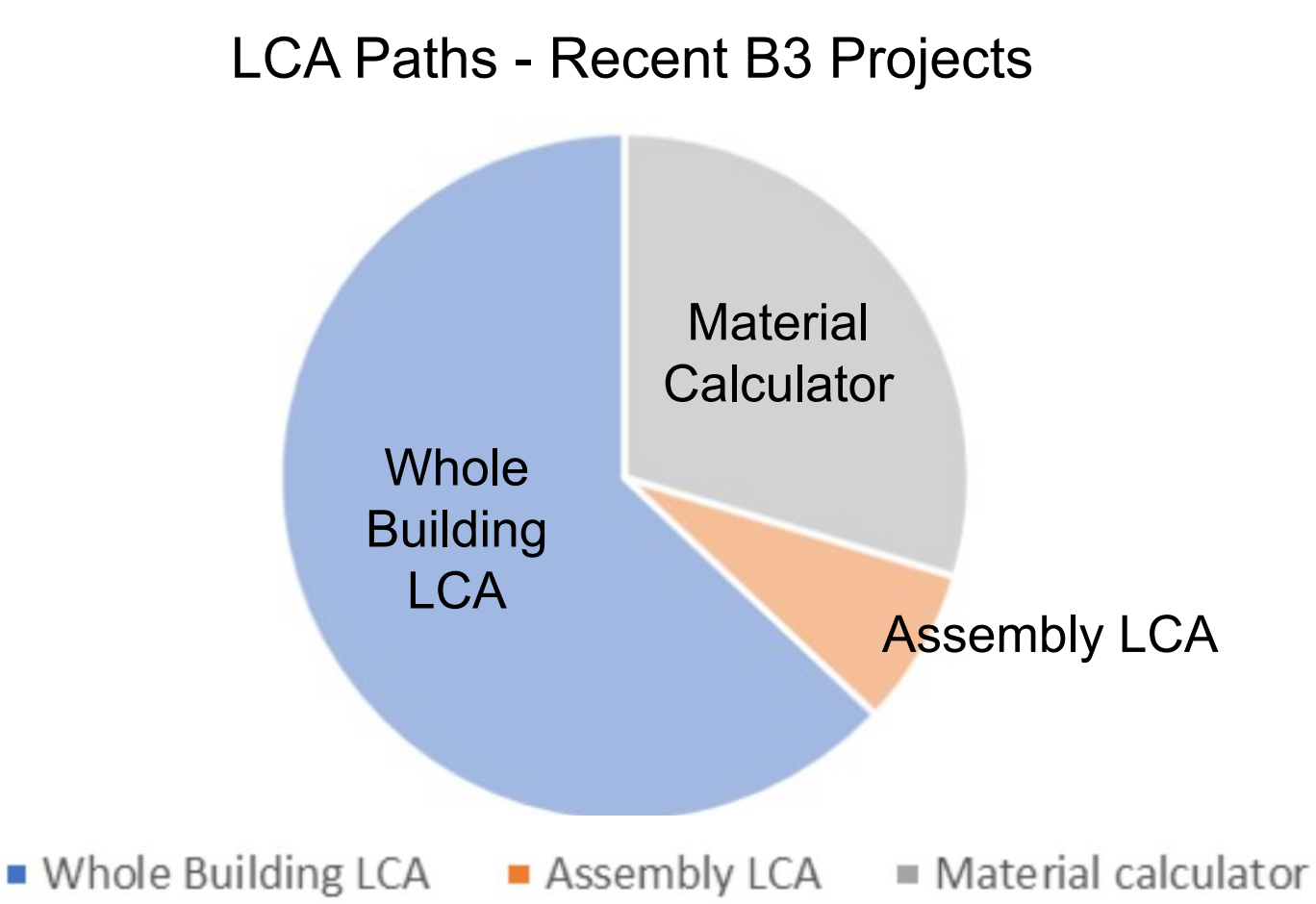
GUIDELINE REQUIREMENTS | PATH 3 – MATERIAL LEVEL LCA APPROACH

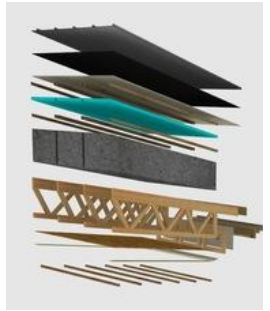
Achieve GWP savings by substituting lower GWP materials for higher GWP materials. Document savings by using the B3 LCA Material Selection Calculator and achieving an Impact Score of < 1.65 (or < 1.75 for B3 Small Buildings)

This compliance path is limited to building projects that utilize one dominant structural and enclosure type, which must make up at least 60% of the building's structural volume and exterior surface area respectively. In addition, the project's assemblies and materials must be well-approximated by those contained in the Material Selection Calculator.

Image credits
- ids-center.com
- greenbuildingassembly.com
- myhuberwood.com

B3 LCA PATHS





CREDIT M1B

CURRENT GUIDELINE REQUIREMENTS

v3.2r02

Product Life-Cycle Assessments: Use at least 5 different permanently installed products sourced from at least five different manufacturers that meet one of the disclosure criteria below:

1. **Product-specific declaration:** Products with a publicly available, critically reviewed LCA conforming to ISO 14044 that report impacts from at least cradle to gate.
2. **Environmental Product Declarations (EPDs)** which conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle-to-gate scope.
   a. Industry-wide (generic) EPD – Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator are valued as one-half (½) of a product for purposes of compliance.
   b. Product-specific Type III EPD – Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as the participant by the program operator are valued as one whole product for purposes of compliance.

CREDIT M1B

FORTHCOMING UPDATED REQUIREMENTS

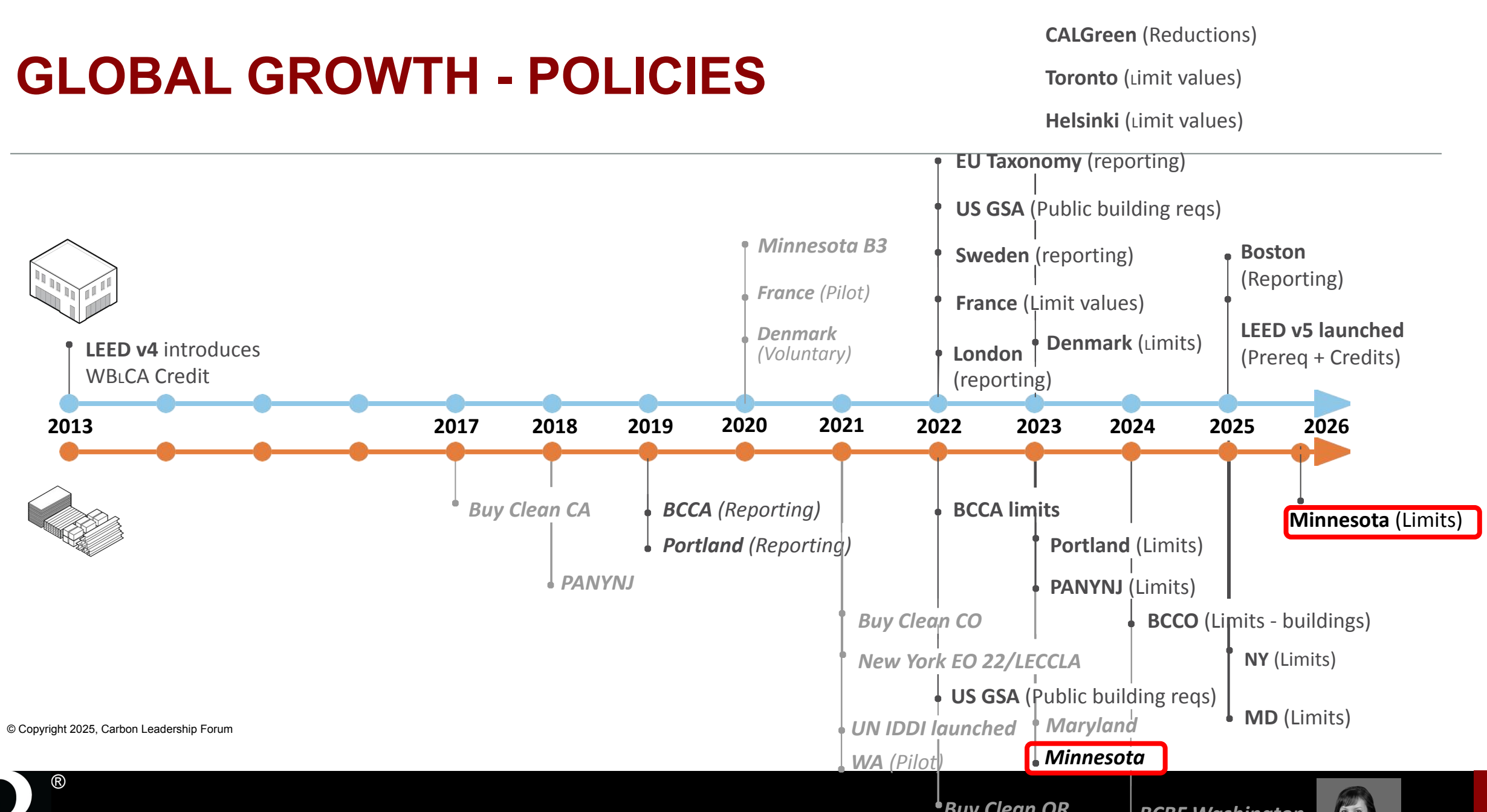
v3.2r03

Environmental Product Declarations (EPDs), Type III, conform to ISO 14025

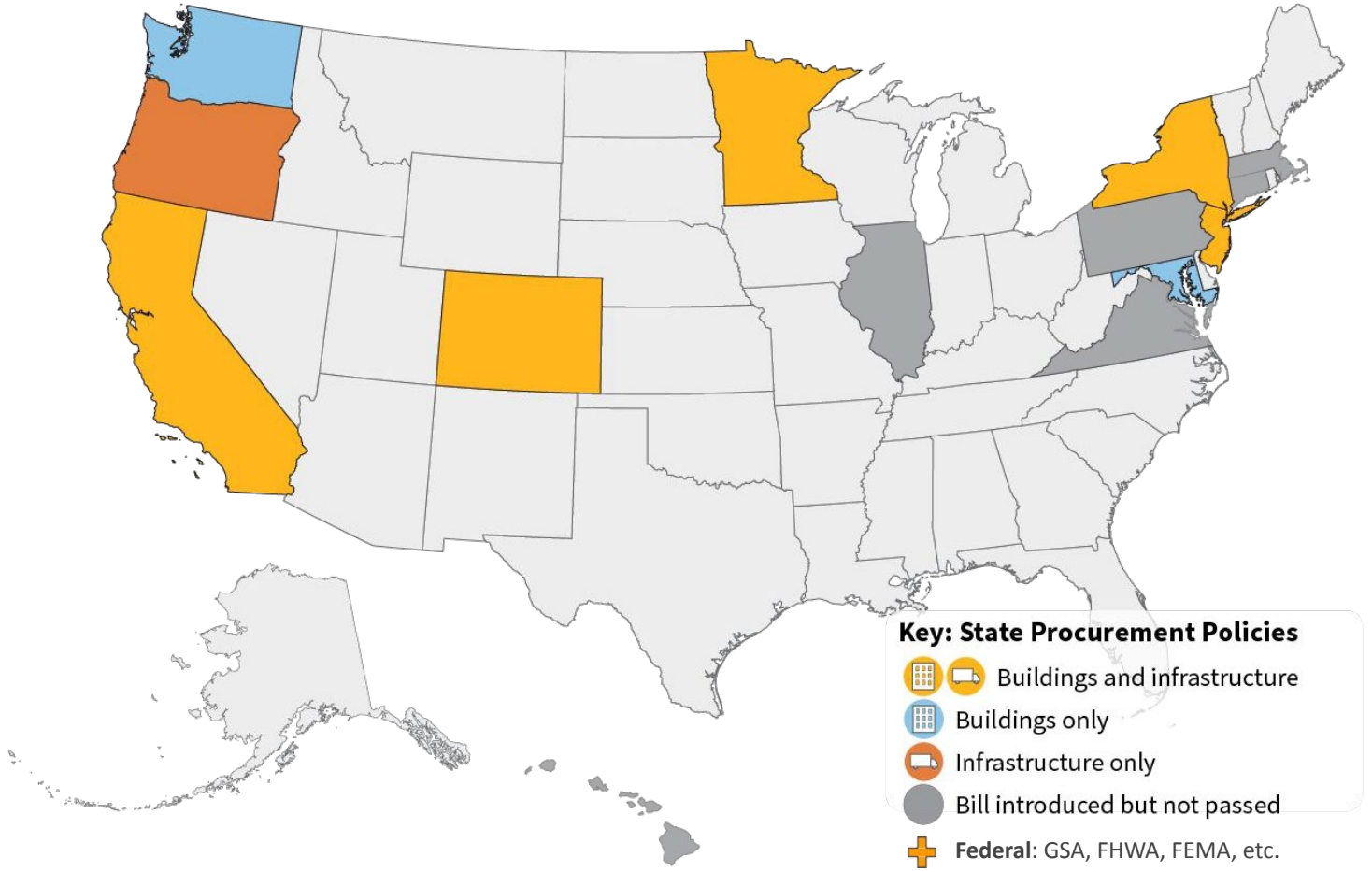
- **Expanded list of materials** required to submit EPDs
- Embedded table format in the Tracking Tool → Excel spreadsheet EPD reporting template
- Working on integrating requirements to **align with Buy Clean**

MN BUY CLEAN PROGRAM

GLOBAL GROWTH - POLICIES



CURRENT 2025 BUY CLEAN PROCUREMENT POLICIES



MINNESOTA BUY CLEAN POLICY

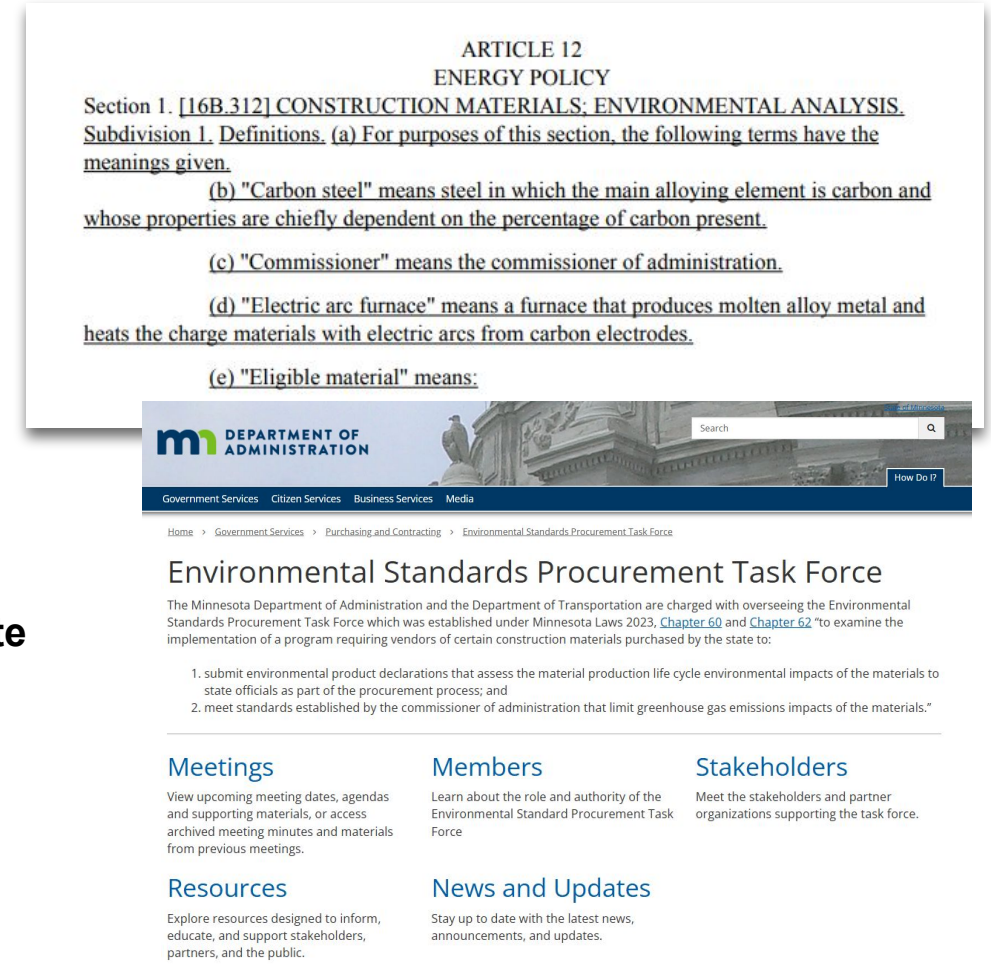
2023 LEGISLATION - Minnesota Statute 16B.312

In 2023, Minnesota passed the **Buy Clean Buy Fair Act**, a procurement policy aimed at reducing environmental impacts of construction materials used on state-funded projects.

The **Environmental Standards Procurement Task Force**, mandated by Minnesota Statute 16B.312, was formed in October 2023.

The Task Force is examining requirements of a program that **will require Environmental Product Declarations (EPDs) to demonstrate compliance** with future Global Warming Potential (GWP) limits that will be established for concrete, rebar, structural steel, asphalt, and other construction materials purchased by the state.

https://mn.gov/admin/government/purchasing-contracting/buy-clean/



ARTICLE 12
ENERGY POLICY

Section 1. [16B.312] CONSTRUCTION MATERIALS; ENVIRONMENTAL ANALYSIS.

Subdivision 1. Definitions. (a) For purposes of this section, the following terms have the meanings given.

(b) "Carbon steel" means steel in which the main alloying element is carbon and whose properties are chiefly dependent on the percentage of carbon present.

(c) "Commissioner" means the commissioner of administration.

(d) "Electric arc furnace" means a furnace that produces molten alloy metal and heats the charge materials with electric arcs from carbon electrodes.

(e) "Eligible material" means:

DEPARTMENT OF ADMINISTRATION

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Environmental Standards Procurement Task Force

The Minnesota Department of Administration and the Department of Transportation are charged with overseeing the Environmental Standards Procurement Task Force which was established under Minnesota Laws 2023, Chapter 60 and Chapter 62 "to examine the implementation of a program requiring vendors of certain construction materials purchased by the state to:

1. submit environmental product declarations that assess the material production life cycle environmental impacts of the materials to state officials as part of the procurement process; and
2. meet standards established by the commissioner of administration that limit greenhouse gas emissions impacts of the materials."

Meetings

View upcoming meeting dates, agendas and supporting materials, or access archived meeting minutes and materials from previous meetings.

Members

Learn about the role and authority of the Environmental Standard Procurement Task Force

Stakeholders

Meet the stakeholders and partner organizations supporting the task force.

Resources

Explore resources designed to inform, educate, and support stakeholders, partners, and the public.

News and Updates

Stay up to date with the latest news, announcements, and updates.

MINNESOTA BUY CLEAN - TASK FORCE MEMBER GROUPS

Task Force Members

ESPTF Member Representation	Organization and (Role)	Name*
(1a) Minnesota Department of Administration	Minnesota Department of Administration (Co-chair)	Betsy Hayes
	Staff	Julie Bayerl
(1b) Minnesota Department of Transportation	Minnesota Department of Transportation (Co-chair)	Curt Turgeon
	Staff	Emil Bautista
	Staff	Joseph Nietfeld
(2) Center for Sustainable Building Research, CSBR (Facilitation)	CSBR	Richard Graves
	Staff	Natalie Georgieff
(3) University of Washington, Civil & Environmental Engineering	Staff	
(4) the Aggregate and Ready- Mix Association of Minnesota	AVR Concrete	
	Cemstone	
(5) the Concrete Paving Association of Minnesota (CPAM)	CPAM	
	CPAM	
(6) the Minnesota Asphalt Pavement Association (MAPA)	MAPA	
	Duininck Companies	
(7) the Minnesota Board of Architecture, Engineering, Land Surveying, Landscape Architecture, Geoscience and Interior Design	MSR Design	
	ESG	
	HGA	
	University of Minnesota	
(8) a representative of the Minnesota iron mining industry	Cleveland Cliffs	
(8a) building construction firms	Kraus Anderson	
	AGC	
(8b) transportation construction firms	Kraemer North America	
	Mathy Construction	
(9a) the American Institute of Steel Construction;	AISC	
	AISC	
(9b) the Concrete Reinforcing Steel Institute;	CRSI	
(10) the Institute of Scrap Metal Recycling Industries (ISRI);	ISRI	
(11) suppliers of eligible materials	Aggregate Industries	
	Cargill	
	Gerdau	
(12) organized labor in the construction trades	LIUNA MN	
	LIUNA MN	
(13) organized labor in the manufacturing or industrial sectors	United Steel Workers	
(14) environmental advocacy organizations	Blue Green Alliance	
	Fresh Energy	
	Fresh Energy	
(15) environmental justice organizations	100% Campaign	
	Clean Water Action	

Stakeholders & Working Group Contributors

Organization
ARM of Minnesota
Blue Green Alliance
Cemstone
County Materials
Ewald Consulting
Fresh Energy
Ingevity
ISRI Board Chair
Koch Industries
Midwest Building Decarbonization Coalition
Nucor
Old Castle Infrastructure
PCI Midwest
Rinker Pipe
StanTec
Steel Manufacturers Association
Taft Advisors
Winthrop

MINNESOTA BUY CLEAN - TASK FORCE TIMELINE

2023
October 1 - Task Force established

2024
- February 22 - EC Context: Concrete and Asphalt
- March 14 - EC Context: Steel, Rebar and Other Materials
- April 25 and May 23 - Bidding and Procurement
- July 1 - Pilot Program begins
- Summer/Fall - Material-specific and Pilot Working Groups
- Oct 23 - ESPTF Mtg#6: Concrete and Asphalt WG
- Nov 20 - ESPTF Mtg#7: Steel and Rebar WG
- Dec 18 - ESPTF Mtg#8: Pilot Program and Other Materials

2025
- March 19, 2025 - Mtg#9: Task Force Recommendations
- May 8, 2025 - Draft Report sent to Task Force for comment
- Spring - Draft Report, Select Awardees & Distribute Funds
- Summer/Fall - Draft Report Staff Reviews and Revisions
- Oct 8 - Mtg#10: TF Recommendations & Legislative Report
- **December 1 - Report to the Legislature**

2026
- **January 15 - GWP limits** established for concrete and rebar
- April 22 - ESPTF Mtg#11 (Virtual)
- June 17 - ESPTF Mtg#12 (In Person) - Maplewood, MN
- **July 15 - Implementation date** of GWP limits/EPD disclosure requirements (projects letting on or after this date)
- **August 19 - BuiltCold Database Training** (In Person, TBD)
- **September 16 - ESPTF Mtg#13** (TBD)
- **October 14 - ESPTF Mtg#14** (TBD)
- **December 1 - Report** to the Legislature

2027
- December 1 - Report to the Legislature

2028
- January 15 - Establish a maximum GWP for structural steel and, after conferring with the commissioner of transportation, for asphalt paving mixtures and concrete pavement
- December 1 - Report to the Legislature

2029
- January 1 - Task Force ends

MINNESOTA BUY CLEAN - ELIGIBILITY

"**Eligible project**" means: (16B.312 Subd. 1.f)

(1) new construction of a state building larger than 50,000 gross square feet of occupied or conditioned space;

(2) renovation of more than 50,000 gross square feet of occupied or conditioned space in a state building whose renovation cost exceeds 50 percent of the building's assessed value; or

(3) new construction or reconstruction of two or more lane-miles of a trunk highway.

"Eligible material" means: (16B.312 Subd. 1.f)

(1) carbon steel rebar;

(2) structural steel;

(3) concrete; or

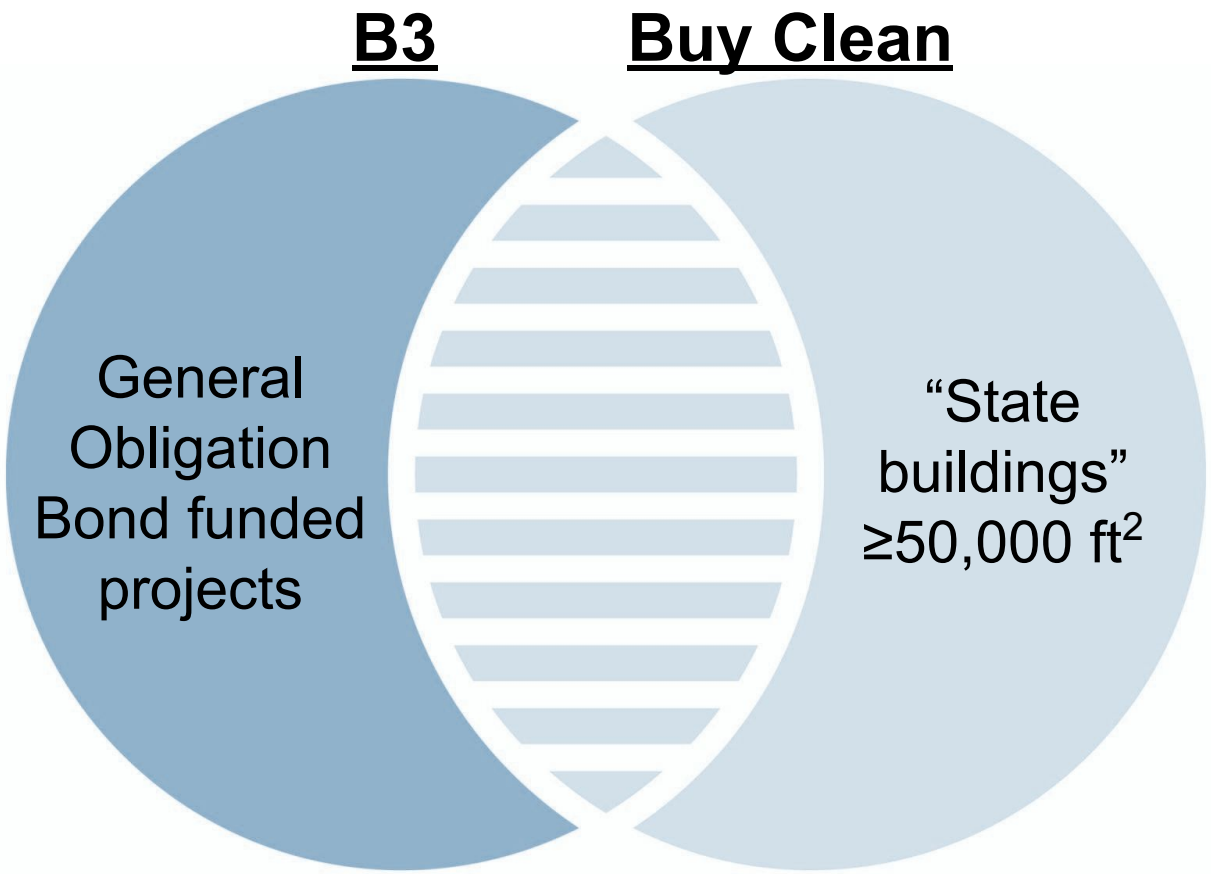
(4) asphalt paving mixtures.

(5…) other materials…

State Building means a building owned by the state of Minnesota or a Minnesota state agency (16B.312.1).

B3 + BUY CLEAN

- Intersection of B3 + Buy Clean
- B3 will integrate Buy Clean requirements; if you meet one, you will meet the other automatically



State Building means a building owned by the state of Minnesota or a Minnesota state agency (16B.312.1).

BUY CLEAN POLICY IMPLEMENTATION

July 15, 2026 - Implementation date of GWP limits/EPD disclosure requirements (projects letting on or after this date)

Product Category	Implementation	Implementation Details
Concrete (used in buildings)	**GWP Limits Set (for Ready Mix)**	**GWP Limits Set Jan. 15, 2026:** Ready Mix Concrete limits based on the National Ready-Mix Concrete Association's (NRMCA) North Central regional benchmarks published in the Industry-Wide EPD. **Implementation of GWP limits July 15, 2026.** **EPD Mandatory Disclosure Starting 2026:** Concrete Masonry Units (CMU) and Precast.
Steel Rebar (used in buildings)	**GWP Limits Set**	**GWP Limits Set Jan. 15, 2026:** Based on Concrete Reinforcing Steel Institute's (CRSI) Industry-Wide EPD. (legislation: **GWP limits no later than Jan. 15, 2028**). Limits implemented
Structural Steel	EPD Disclosure	**EPD Disclosure - Starting 2026: Collect EPDs** to identify subcategories and establish benchmarks. (legislation: **GWP limits no later than Jan. 15, 2028**). Hot-Rolled Steel, HSS tubes, Plate, Decking, Open-Web Steel Joists, & Cf Framing.
Concrete Pavement	EPD Disclosure	**EPD Disclosure - Starting 2026: Collect EPDs** to identify subcategories and establish benchmarks. (legislation: **GWP limits no later than Jan. 15, 2028**)
Asphalt Pavement	EPD Disclosure	**EPD Mandatory Disclosure - Starting 2026: Collect EPDs** to identify subcategories and establish benchmarks. (legislation: **GWP limits no later than Jan. 15, 2028**)

BUY CLEAN GWP LIMITS & EPD DISCLOSURE

https://mn.gov/admin/assets/2026-MNBuyCleanGWPLimits_2026-01-15_tcm36-724796.pdf

CONCRETE

Table 1: GWP Limits for Concrete Materials

Material Category[1]			Maximum Allowable GWP Limit
Ready-Mix Concrete[2] Used in Buildings ($kgCO_2e/m^3$) based on concrete compressive strength	Normal-Weight concrete (NW)	≤2500 psi	241 $kgCO_2e/m^3$
		3000 psi	264 $kgCO_2e/m^3$
		4000 psi	312 $kgCO_2e/m^3$
		5000 psi	372 $kgCO_2e/m^3$
		6000 psi	394 $kgCO_2e/m^3$
		8000 psi	460 $kgCO_2e/m^3$
	Lightweight concrete (LW)	3000 psi	487 $kgCO_2e/m^3$
		4000 psi	537 $kgCO_2e/m^3$
		5000 psi	591 $kgCO_2e/m^3$
	Add 30% to these GWP limits where high early strength[3] concrete mixes are required for technical reasons.		
Concrete Masonry Units (CMU)			TBD[4]
Precast/Prestressed Concrete			TBD[4]

1. Only permanently installed materials must be considered.
2. (a) GWP values shown are categorized by 28-day concrete compressive strengths (psi) and are based on NRMCA's North Central Regional Baseline values published in NRMCA's National and Regional LCA Benchmark Report v3.2 (2022).
   (b) Limits shown do not apply to concrete pavement mix designs and mix designs for abutting concrete elements for roadway applications such as curbs, sidewalks, aprons, barriers, and retaining walls. GWP limits specific to concrete pavement and abutting concrete element applications will be developed at a later date, taking into account other factors, aside from concrete compressive strength, including but not limited to permeability, workability, smoothness, and functional application which may warrant creation of additional concrete subclassifications unique to pavement.
   (c) Portable/mobile batch plants need not meet the GWP limits shown, but required material EPD data shall be submitted as recommended in NSF PCR for Concrete v2.3 – 2025 Extension (NSF 1112-19 with 2024 deviation and 2025 Extension).
   (d) Requirements apply to concrete utilized on the project site including but not limited to: building elements (walls, beams, columns, slabs, foundations, etc.), hardscape, curbs, site retaining walls, sidewalks, aprons, barriers, and other cast-in-place concrete elements on building sites.
3. "High early strength" is concrete that, through the use of additional cement, high-early-strength cement, or admixtures, has accelerated early-age strength development. High early strength concrete produced using additional cement should be avoided where possible, due to its higher embodied carbon. An affected project delivery team must submit documentation from the Structural Engineer of Record (SEOR) on whether high early strength concrete is necessary for technical reasons, and obtain written approval from the Department of Administration or Department of Transportation prior to procurement. This 30% allowance reflects input from building sustainability experts, general contractors, engineers, and ready-mix or cement producers.
4. Lack of data at this time. It is anticipated that limits will be set for these materials once data availability and accuracy improve. Please note: Items (mixtures, materials, products) for which GWP limits are not set per this table require mandatory EPD disclosure, though they are not bound by GWP limits at this time.

BUY CLEAN GWP LIMITS & EPD DISCLOSURE

https://mn.gov/admin/assets/2026-MNBuyCleanGWPLimits_2026-01-15_tcm36-724796.pdf

STEEL REBAR

Table 2: GWP Limits for Steel Reinforcing Bar (Rebar) Used in Buildings

Steel Product Category	Maximum GWP[1] Limit at Mill or Manufacturer Gate	Equivalent GWP[1] Limit Converted for use with Fabricated[2] Product EPD
Steel Reinforcing Bar (Rebar)[3]	0.755	0.854

1. GWP limits shown are in dimensionless standard units (ton CO2e / ton steel or kg CO2e / kg steel). GWP limits are based on a 100-year lifetime impact (GWP-100) in accordance with the Product Category Rule (PCR) for Designated Steel Construction Products. The GWP value shown for fabricated reinforcing steel is based on the Industry Wide EPD: *Environmental Product Declaration: Fabricated Steel Reinforcement, Concrete Reinforcing Steel Institute (CRSI), 2022*. The unfabricated value is back-calculated from the report.
2. GWP Limits are based on cradle-to-mill-gate or cradle-to-manufacturer-gate LCA scopes, as appropriate for the particular steel product. When interpreting individual steel product EPDs, care should be taken to identify the GWP value that corresponds to the correct LCA scope. When multiple scope values are present in an EPD, preference shall be given to the cradle-to-mill-gate or cradle-to-manufacturer-gate LCA scopes when evaluating compliance with the above table.

   When the cradle-to-mill-gate or cradle-to-manufacturer-gate LCA scopes are not listed explicitly in individual steel product EPDs, this is likely due to the values being reported as cradle-to-fabricator-gate LCA scopes. In that case, one may use the values listed in the column, Equivalent GWP Limit Converted for use with Fabricated Product. The values in this column include the effects of scrap rates, transportation to fabrication, and fabrication. Impacts from reinforcing bars are from the CRSI industry-wide EPD (2022) and indicate a scrap rate of 3.0% (A1 multiplier), transportation (A2) of 0.0490 tons/ton, and fabrication (A3) of 0.0270 tons/ton.
3. The Reinforcing Steel Bar product category includes all rebar grade ASTM A615(M) and ASTM A706(M).

BUY CLEAN GWP LIMITS & EPD DISCLOSURE

https://mn.gov/admin/assets/2026-MNBuyCleanGWPLimits_2026-01-15_tcm36-724796.pdf

STEEL EPD DISCLOSURE

Table 3: Steel Products for EPD Disclosure Only – GWP Limits to be Implemented in 2028

Steel Product Category[1]	
Structural Steel	Hot-Rolled Sections (W-, S-, C-, MC-, M- shapes, angles, tees)
	HSS (Hollow Structural Sections)[2]
	Plate
Open Web Steel Joists (OWSJ)	
Steel Deck	
Cold-Formed Steel Framing[3]	

1. According to the 2022 Code of Standard Practice for Steel Buildings and Bridges (ANSI/AISC 303-22) and the requirements of the Minnesota Buy Clean statute as interpreted, the steel products in this table are covered when used as elements of the structural frame that are shown/noted in the structural documents.
2. HSS (Hollow Structural Sections) consisting of carbon or low-alloy steel that is cold-formed and welded (ASTM A500, A847 or A1085) in round, square and rectangular configurations.
3. Cold-formed steel framing, also called cold-formed metal framing, includes stud, track, U-channel, furring channel, L-headers, and built-up sections using one or more of these shapes.

BUY CLEAN & B3: SUBMITTAL PROCESS (preliminary)

B3 Phase Names	Buy Clean Submittal Requirements	Agency Review
Predesign	• **Written acknowledgement** that they are aware of Buy Clean requirements • **Apply for waiver** only for Emergency Order construction, if applicable	Dept of Admin **RECS reviews**
Design	• **Identify preliminary materials** and which materials are eligible **(draft EPD Submittal Form)** • **Apply for waivers** and/or exemptions (if applicable) - **Waiver Form** • **Submit draft specification** language outlining EPD submittal requirements for eligible materials	Dept of Admin **RECS designer reviews**
Final Design	• **Finalize material selection to meet GWP limits** and EPD disclosure requirements. • **Submit specification language** outlining contractor submittal requirements, including a schedule of EPDs required to be submitted by the contractor. • **Submit draft EPDs (if available)** and draft material data **(EPD Submittal Form)**	Dept of Admin RECS designer reviews
Closeout/ Construction	• Project team and Contractor/ Subcontractor submit final product data and EPDs **(EPD Submittal Form).** Team to verify that product data and EPDs provided in the submittals match the as-built condition and comply with Buy Clean requirements.	Dept of Admin RECS designer reviews; OSP reviews and approves final pay-app once all contractual requirements are fulfilled

BUY CLEAN WAIVERS AND EXEMPTIONS

Waiver Justifications

1. Technically Infeasible
2. Significant Increase in Project Cost
3. Significant Delay
4. Results in Sole-Source of Material
5. Emergency or Director's Order
6. Geographic Impracticability

Exception Pathway

- Carbon Budget exception pathway
  - can only be used within a single material product category (i.e. ready-mix concrete)
  - Product weighted average/budget calculation

EPD REPORTING: Industry-aligned template

HOW TO TRACK & REPORT EC ON PROJECTS

- NEW reporting template (Excel)
- Industry aligned data fields
- Material disclosure to align with MN Buy Clean
- Draft at Design Phase, Final version at Construction/Closeout

83

	A	B	C	D	E	F	G
1	**Appendix M-1b: EPD Reporting Template**						
2	**B3 Guidelines - Version 3.2r03**						
3	**Copyright - Regents of the University of Minnesota**						
4							
5	**Purpose:**						
6		The purpose of this spreadsheet is to collect adequate product data in order to track and report material impacts, and verify compliance of EPDs submitted for materials on the project.					
7		The Material Categories tab lists the Standard Declared Units to be used for reporting GWP values from EPDs for specific materials/products.					
8		Please refer to the guidelines for information on mandatory and voluntary reporting for specific materials. Material disclosure and EPD reporting requirements will be updated					
9		to align with any/all requirements of the State of Minnesota's Buy Clean policy.					
10		If a valid EPD is not available for a material/product, please include material data and quantity information below and provide a separate written statement detailing the reasoning					
11		and the steps that the project team has taken in an effort to obtain an EPD.					
12	**Key:**						
13		Blue highlighted areas show constants or outputs calculated by the spreadsheet					
14		Yellow highlighted areas show required inputs					
15							

EPD REPORTING: Industry-aligned template

Material/Product Data

	Material Category	Material Subcategory	CSI Specification Section or Bid Item No.	Manufacturer Name	Manufacturing Facility/Plant/Mill Location*	Product Name & Description
Ex.	*Concrete*	*CIP ReadyMix Concrete*	*03 30 00*	*ABC Cem Inc.*	*123 Main Street, Minneapolis, MN 55411*	*4000 PSI, 3/4, FLY, 4% AIR, VMA*
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

	Application/ Usage	Product Quantity (in Declared Units**)	Declared Units**	Product Category Rule (PCR) listed on EPD	EPD Expiration Date	Reported GWP-100 (kgCO2e per Declared Unit*)
Ex.	*FOOTINGS*	*1203*	*m3 (cubic meter)*	*NSF IntlPCR for Conc v2.3, 2023-11-01*	*8/9/2029*	*255.00*
1						
2						
3						
4						
5						
6						
7						
8						

BUY CLEAN DATABASE DEVELOPMENT

BUILTCOLD
www.builtcold.com

+

MINNESOTA

- Federal Buy Clean Initiative
- Buy Clean Colorado Act
- Washington State Buy Clean Buy Fair

Building Transparency EC3 https://www.buildingtransparency.org/

hpdc https://www.hpd-collaborative.org/

BUY CLEAN PROGRAM - NEXT STEPS

- July 15, 2026
  - GWP/EPD disclosure requirements implemented
  - Database launch
- 2026 and beyond…
    - Track PCR updates and industry updates
    - Re-evaluate EPD data and limit-setting for
        - **Tier 1 Materials:** Asphalt Paving, Concrete Paving, Structural Steel, Precast Concrete, CMU, CFMF
        - **Tier 2 Materials:** Glass, Insulation, Aluminum
- 2028, January 15 - Establish a maximum Global Warming Potential (GWP) for structural steel, asphalt paving mixtures, and concrete pavement

LOOKING AHEAD - B3 UPDATES

MINNESOTA B3 GUIDELINES®

| v3.2r02 | v3.1 | v3.0 | v2.2 |

v3.2r03 current version revisions in process

- **EPD Reporting** Template & Updated Material Requirements
- **WBLCA** - clarifying submittal requirements (documents to upload)
- **C&D Waste** Guidelines

v4.0 + forthcoming new version changes (TBD)

- **WBLCA** Tools, Methodology, Guidance
- **Material Circularity** - Systems Thinking
- **Health** and other material impact categories

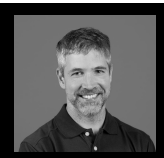
HOW TO ACHIEVE COMPLIANCE

CREDIT M1A

HOW TO ACHIEVE COMPLIANCE | PATH 1 – WHOLE BUILDING LCA APPROACH

Modeling requirements:

1. Approved software: Tally, Athena Impact Estimator, One Click LCA **(evaluating C.Scale)**
2. Building service life: 60 years
3. Assessment scope: A-C (cradle to grave), omit D (beyond building life)
4. The Reference Building and the Selected Design must be functionally equivalent. They must both meet the Owner's Project Requirements, as established in P1. They must have the same function and floor area. They must both meet the minimum performance requirements of the B3/SB2030 program (such as energy use).

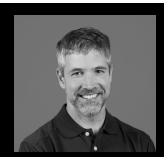


CREDIT M1A

HOW TO ACHIEVE COMPLIANCE | PATH 1 – WHOLE BUILDING LCA APPROACH

What to include in the model:

1. Complete building enclosure including glazing *from the interior finish to the exterior cladding*
2. Structural elements (posts, beams, bearing walls)
3. Foundation, basement, roof, and all intermediate floors
4. Attached or unattached parking structures on site

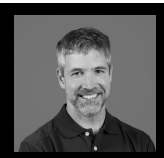


CREDIT M1A

HOW TO ACHIEVE COMPLIANCE | PATH 1 – WHOLE BUILDING LCA APPROACH

What to omit:

1. All non-load bearing interior walls and assemblies
2. All interior finishes with the exception of the exterior wall assemblies
3. All furnishings and equipment
4. All building electrical and mechanical equipment
5. All site improvements (landscaping, parking lots) with the exception of parking ramps

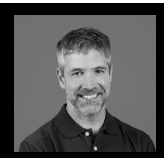


CREDIT M1A

HOW TO ACHIEVE COMPLIANCE | PATH 1 – WHOLE BUILDING LCA APPROACH

Key Differences from *LEED v4 BD+C MR Credit - Building Life Cycle Impact Reduction*:

1. A 10% impact reduction is required for GWP only
2. LEED Options 1, 2, and 3 (building and material reuse) will not be considered as a compliance path for this credit (though they may help meet other B3 reqs.)

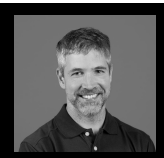


CREDIT M1A

HOW TO ACHIEVE COMPLIANCE | PATH 1 – WHOLE BUILDING LCA APPROACH

Allowable impact reduction strategies:

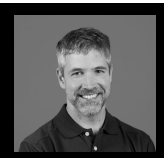
	Path 1	Path 2	Path 3
Impact Reduction Strategies	Whole Building	Assembly Level	Material Level
Building Size (floor area)	no	no	no
Building Service Life	no	no	no
Building shape (layout, surface area)	yes	no	no
Building structural spacing (grid layout)	yes	no	no
Assembly substitutions (swap types)	yes	yes	no
Assembly design changes (thicknesses and layers of materials)	yes	yes	no
Window-to-wall area ratio changes	yes	yes	no
Floor to Floor height changes	yes	yes	no
Structure design changes (type and sizing of beams + columns)	yes	yes	no
Material substitutions	yes	yes	yes



WHOLE BUILDING LCA MODELS

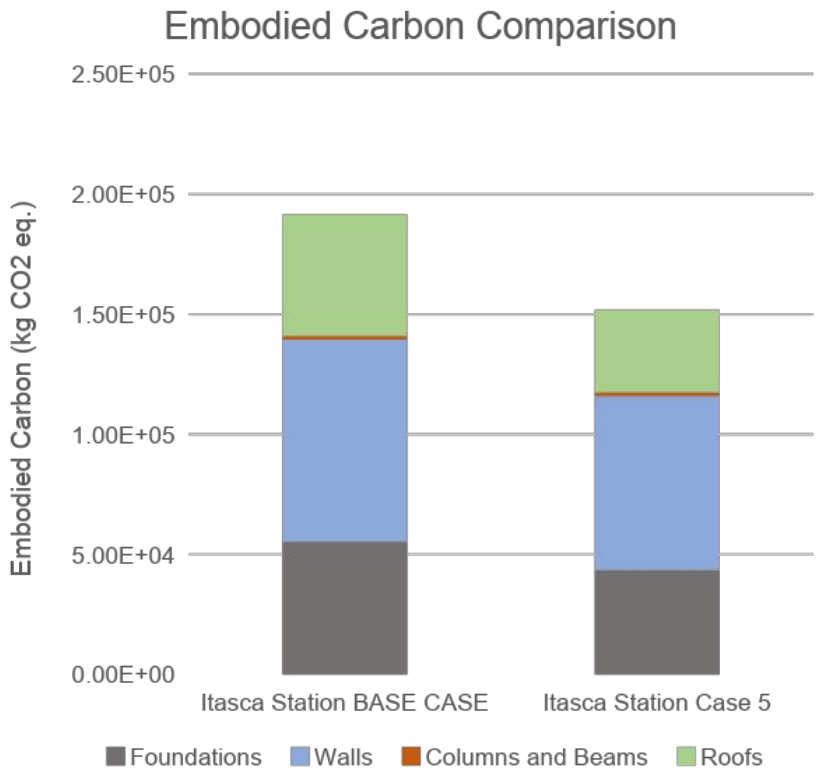
ITASCA BIOLOGICAL STATION – wood frame, super-insulated, single story, slab on grade

Image credit - MSR



WHOLE BUILDING LCA MODELS

ITASCA BIOLOGICAL STATION – wood frame, super-insulated, single story, slab on grade



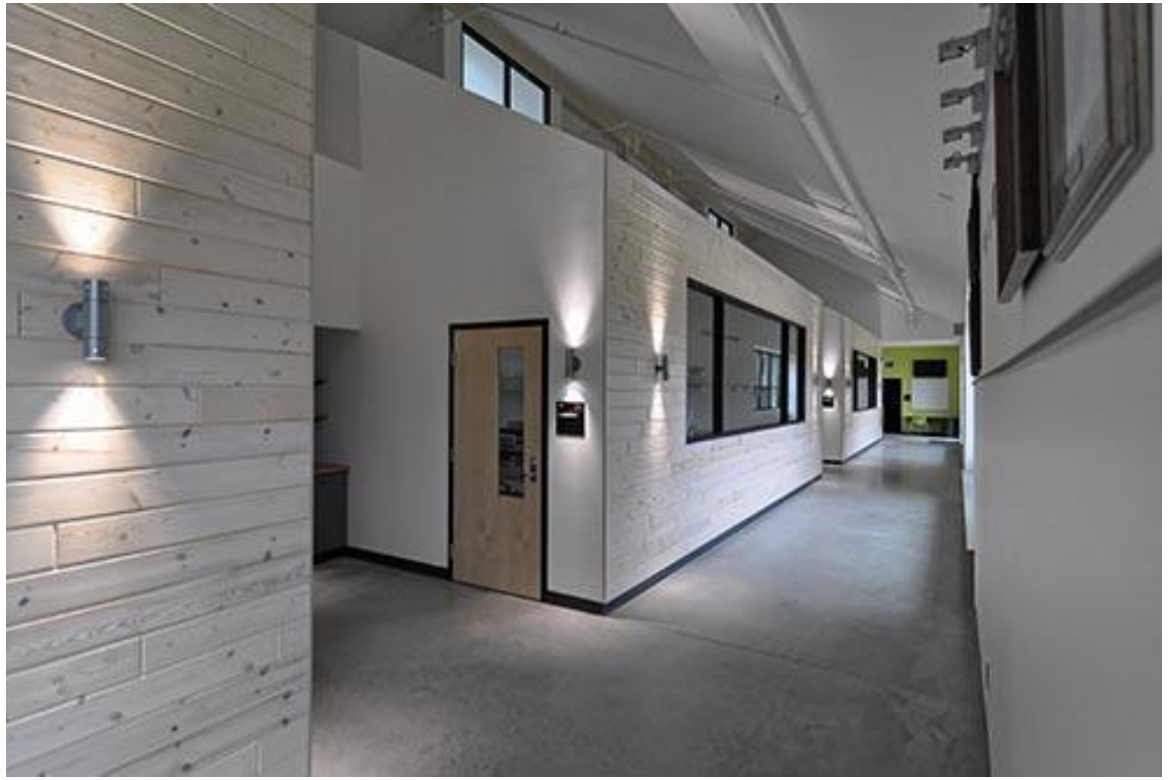
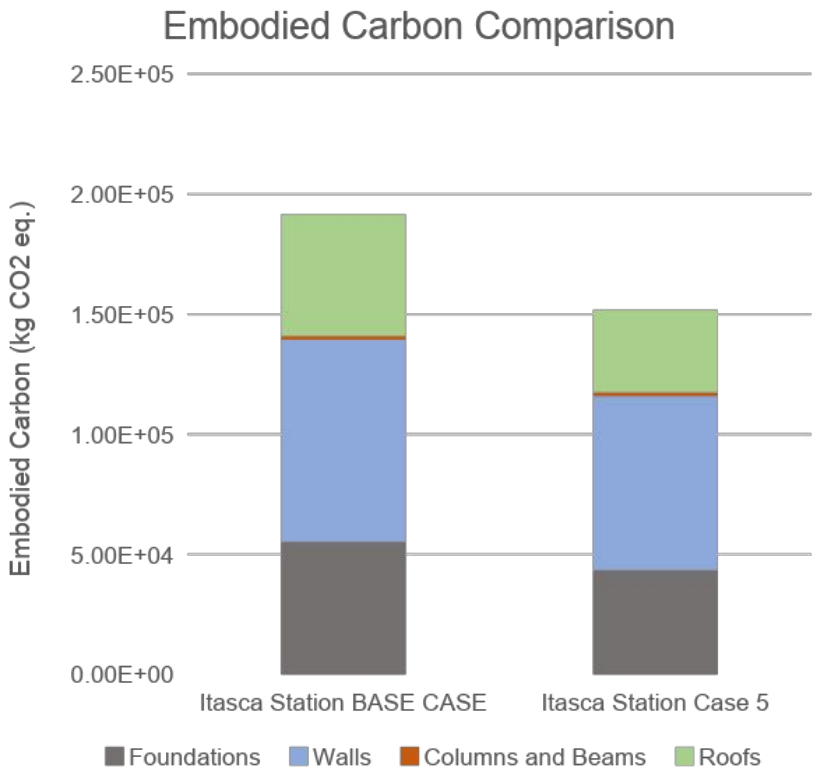


Image credit - MSR

WHOLE BUILDING LCA MODELS

ITASCA BIOLOGICAL STATION – wood frame, super-insulated, single story, slab on grade



Base case foundation - perimeter and post footings, 5" concrete floor slab w 2" XPS

Base case walls - foundation stem wall w 2" XPS, 2x8 stud wall w ccSPF + mineral wool in cavities, and 3" EPS exterior foam

Base case C+Bs - glulam columns and LVL beams for cathedral roof

Base case roofs - wood truss roof w 20" blown cellulose, peel & stick membrane, glass felt shingles

Case 5 foundation - 4" concrete slab replacing 5", EPS foam replacing XPS below grade

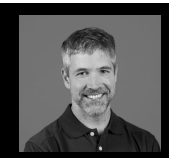
Case 5 walls - cedar bevel siding replacing fiber cement, cellulose + air barrier replacing closed cell spray foam

Case 5 C+B's - same as base case

Case 5 roofs - roofing felt (2 layers) replacing peel & stick membrane

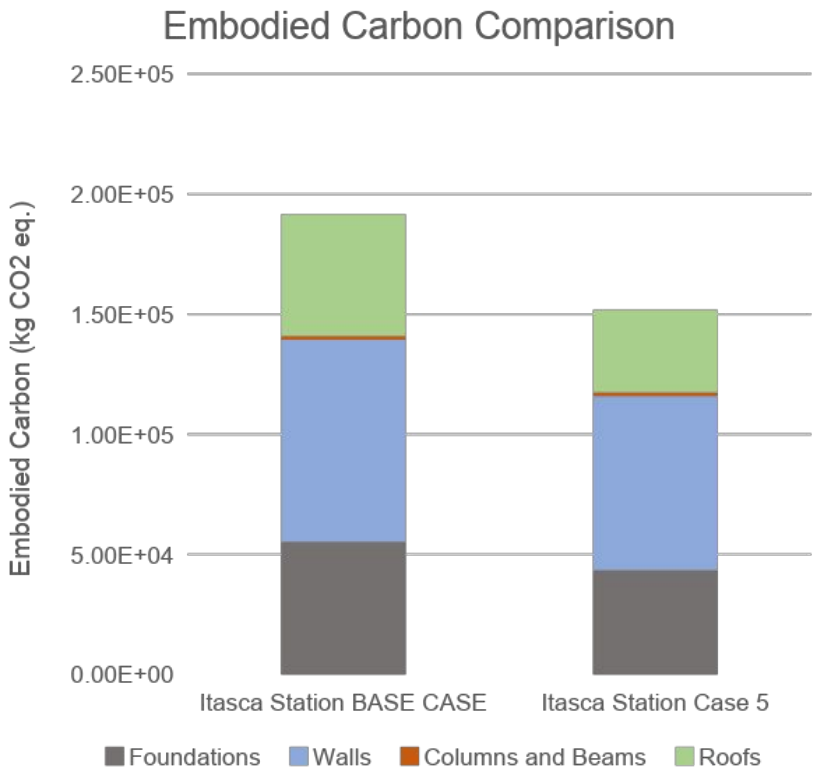
20.8% savings

275 kg CO2e/m2 - base case



WHOLE BUILDING LCA MODELS

ITASCA BIOLOGICAL STATION – wood frame, super-insulated, single story, slab on grade

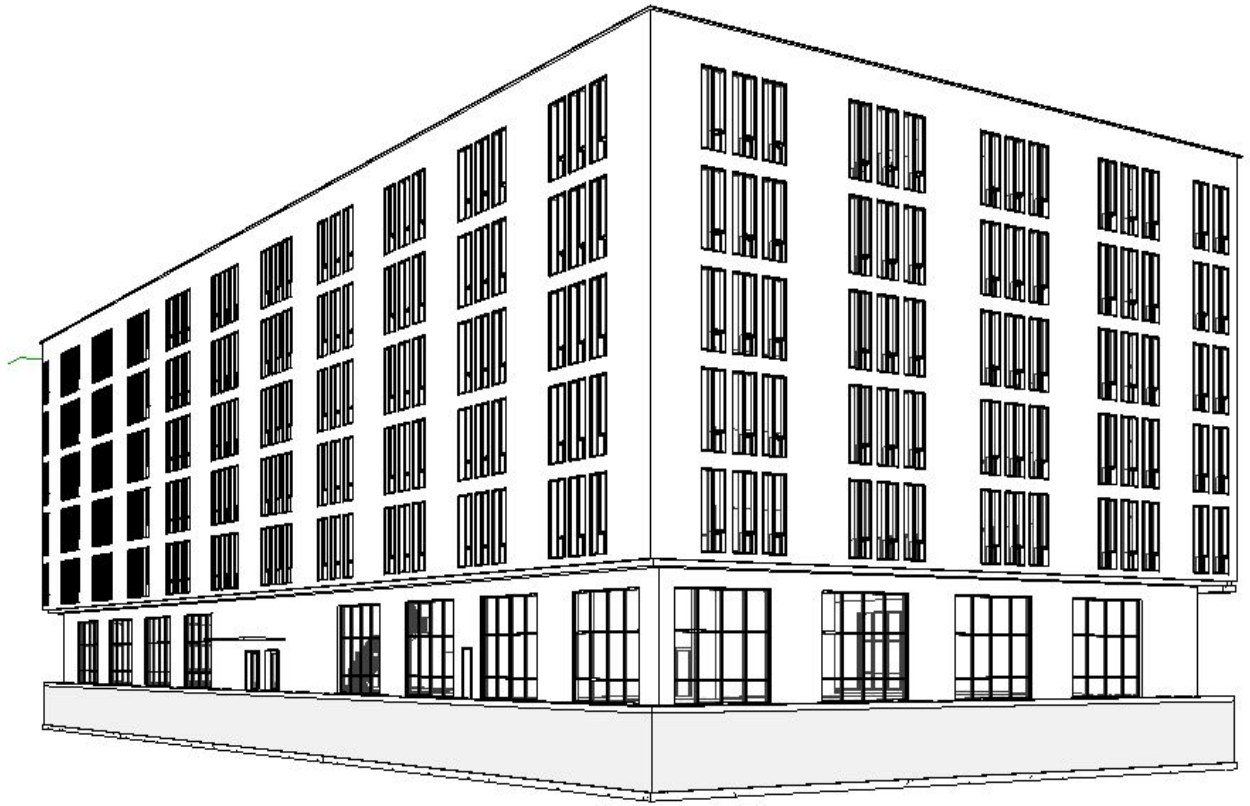


Majority of savings comes from 2 strategies:

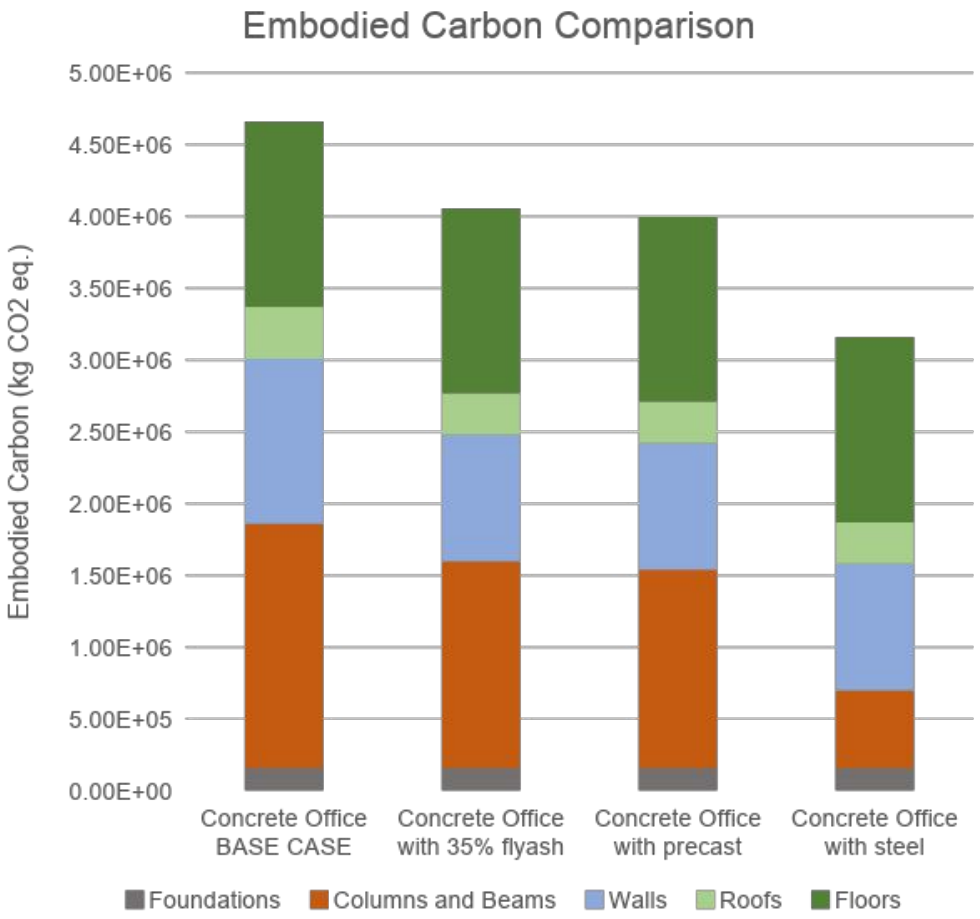
- "Dematerializing" – reducing thickness of concrete slab
- Material substitutions – replacing bitumen membrane on roof w 2 layers roofing felt, replacing spray foam w cellulose + air/vapor barrier

WHOLE BUILDING LCA MODELS

WELLS FARGO OFFICE BUILDING – 6-story office building, concrete frame (site-cast concrete posts & beams with precast concrete plank floors



WHOLE BUILDING LCA MODELS



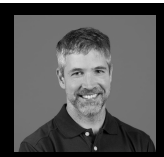
Base case foundation - perimeter and post footings, 4" concrete floor slab
Base case walls - CMU basement wall w 1.5" XPS + fib batt, CMU and steel stud exterior wall w fib batt + 1.5" XPS, brick and metal panel cladding
Base case C+Bs - site-cast concrete posts and beams
Base case roofs - concrete hollow core roof, 4" XPS, bitumen roofing membrane
Base case floors - concrete hollow core floors

Flyash case foundation - same as base case
Flyash case walls - EPS replacing XPS, stucco and fiber cement replacing brick and metal panel cladding, respectively
Flyash case C+B's - concrete columns and beams poured with 35% flyash content
Flyash case roofs - EPS replacing XPS insulation, EPDM replacing bitumen membrane
Flyash case floors - same as base case

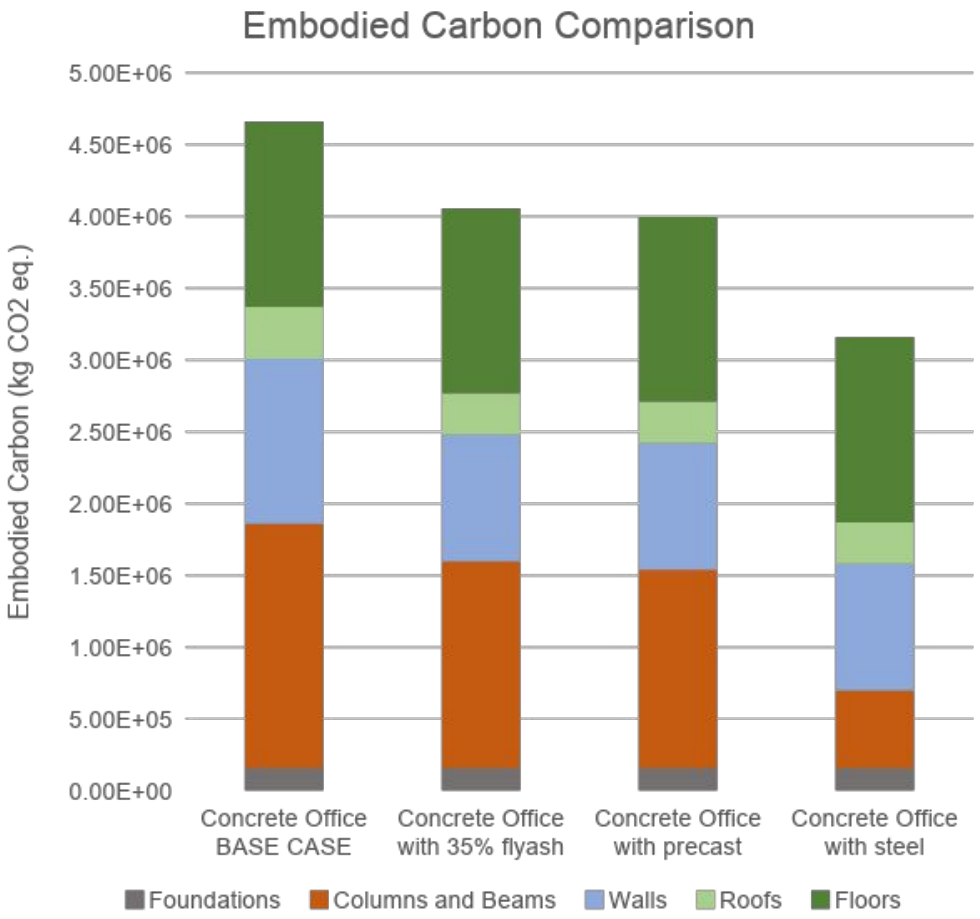
Precast case – same as Flyash case, but precast concrete columns and beams replacing site cast, flyash removed

Steel frame case – same as Flyash case, but steel frame replacing concrete columns and beams, flyash removed

12.9%, 14.2%, 32.2% savings
242 kg CO2e/m2 - base case



WHOLE BUILDING LCA MODELS



Base case foundation - perimeter and post footings, 4" concrete floor slab
Base case walls - CMU basement wall w 1.5" XPS + fib batt, CMU and steel stud exterior wall w fib batt + 1.5" XPS, brick and metal panel cladding
Base case C+Bs - site-cast concrete posts and beams
Base case roofs - concrete hollow core roof, 4" XPS, bitumen roofing membrane
Base case floors - concrete hollow core floors

Flyash case walls - EPS replacing XPS, stucco and fiber cement replacing brick and metal panel cladding, respectively
Flyash case C+B's - concrete columns and beams poured with 35% flyash content
Flyash case roofs - EPS replacing XPS insulation, EPDM replacing bitumen membrane

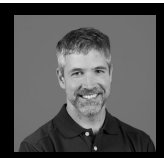
Precast case – same as Flyash case, but precast concrete columns and beams replacing site cast, flyash removed

Steel frame case – same as Flyash case, but steel frame replacing concrete columns and beams, flyash removed

12.9%, 20.7% savings
242 kg CO2e/m2 - base case

Majority of savings comes from 3 strategies:

- Structure design change – swap site-poured concrete for precast concrete columns and beams
- use flyash in concrete
- switch to steel construction



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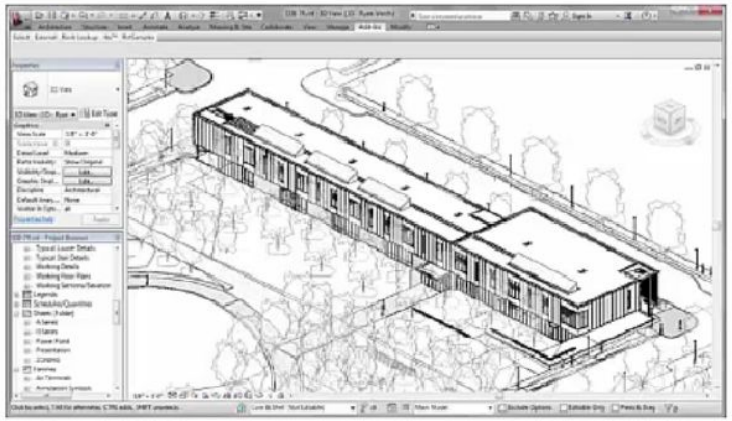
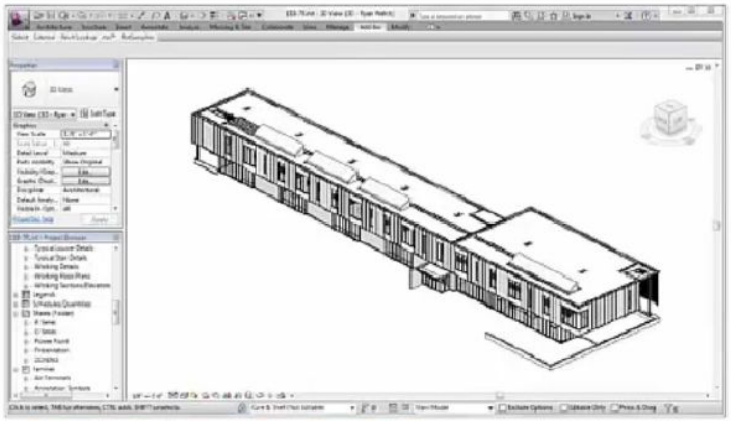
HOW TO ACHIEVE COMPLIANCE | PATH 1 – WHOLE BUILDING LCA APPROACH

Workflow:

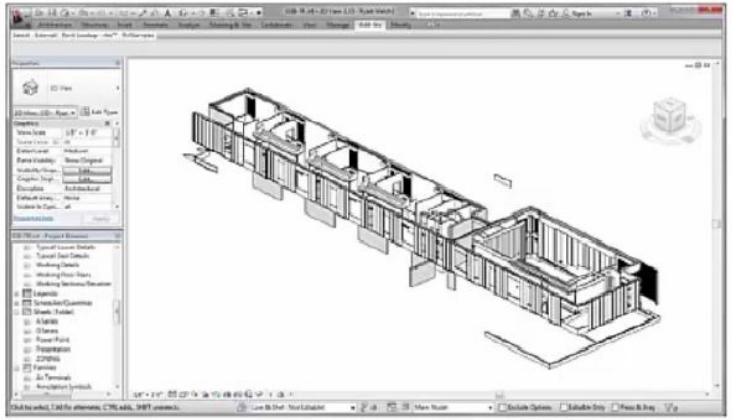
- *Start early (SD phase)*
- *Keep a record*
- *Include the whole team (structural engineers, etc)*



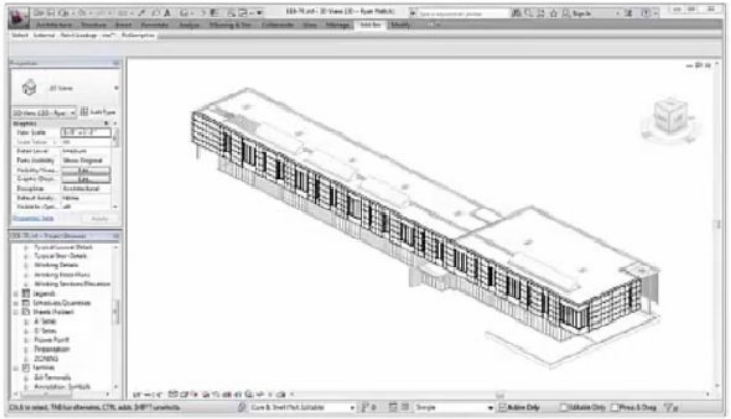
BUILDING INFORMATION MODEL



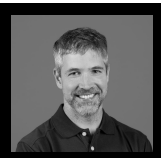
DEFINE SCOPE OF STUDY



ISOLATE AND STUDY



COMPARE OPTIONS



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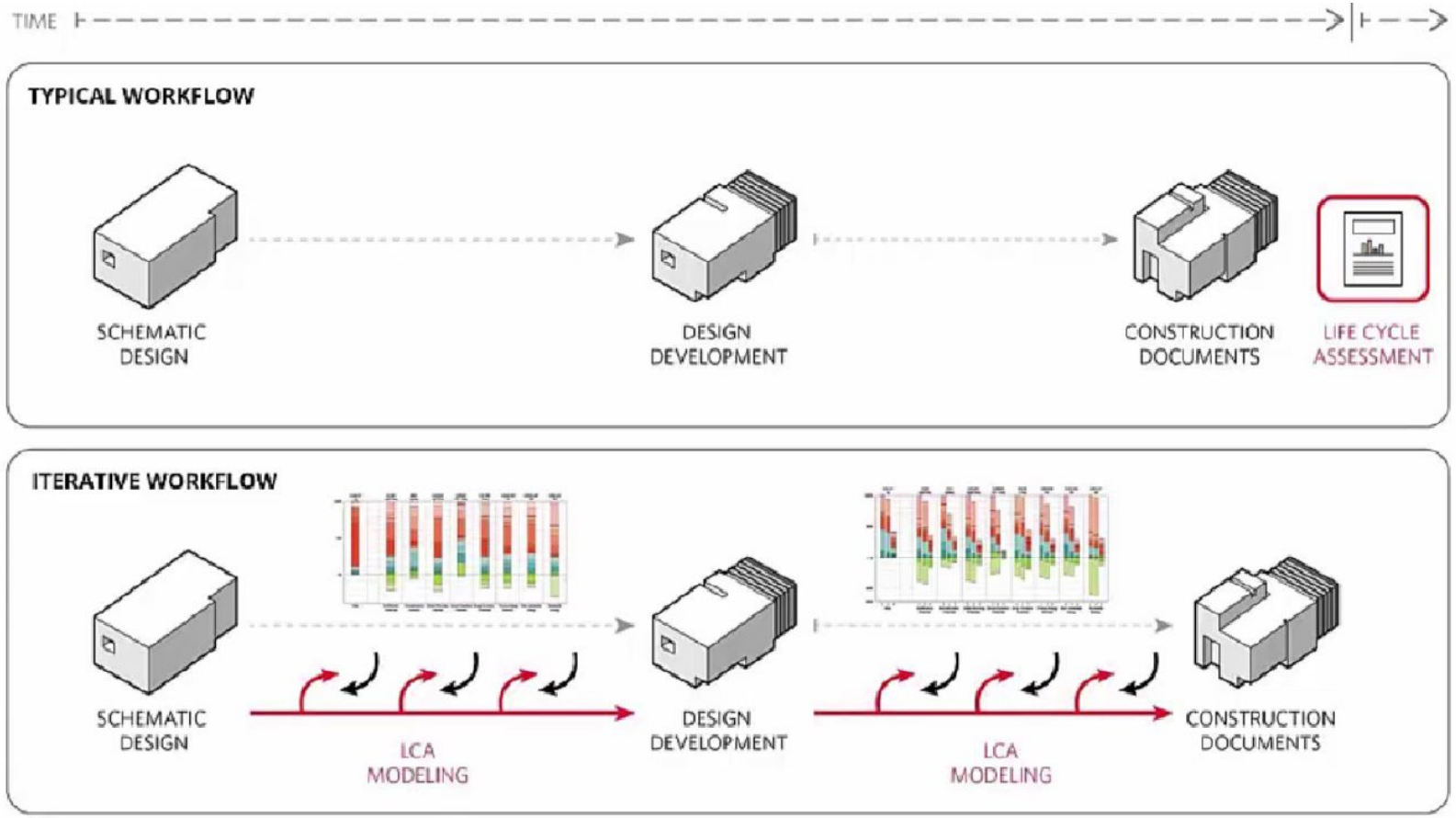
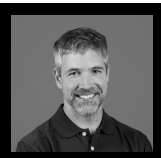
HOW TO ACHIEVE COMPLIANCE | PATH 1 – WHOLE BUILDING LCA APPROACH

Workflow:

- *Significant savings requires an iterative workflow.*





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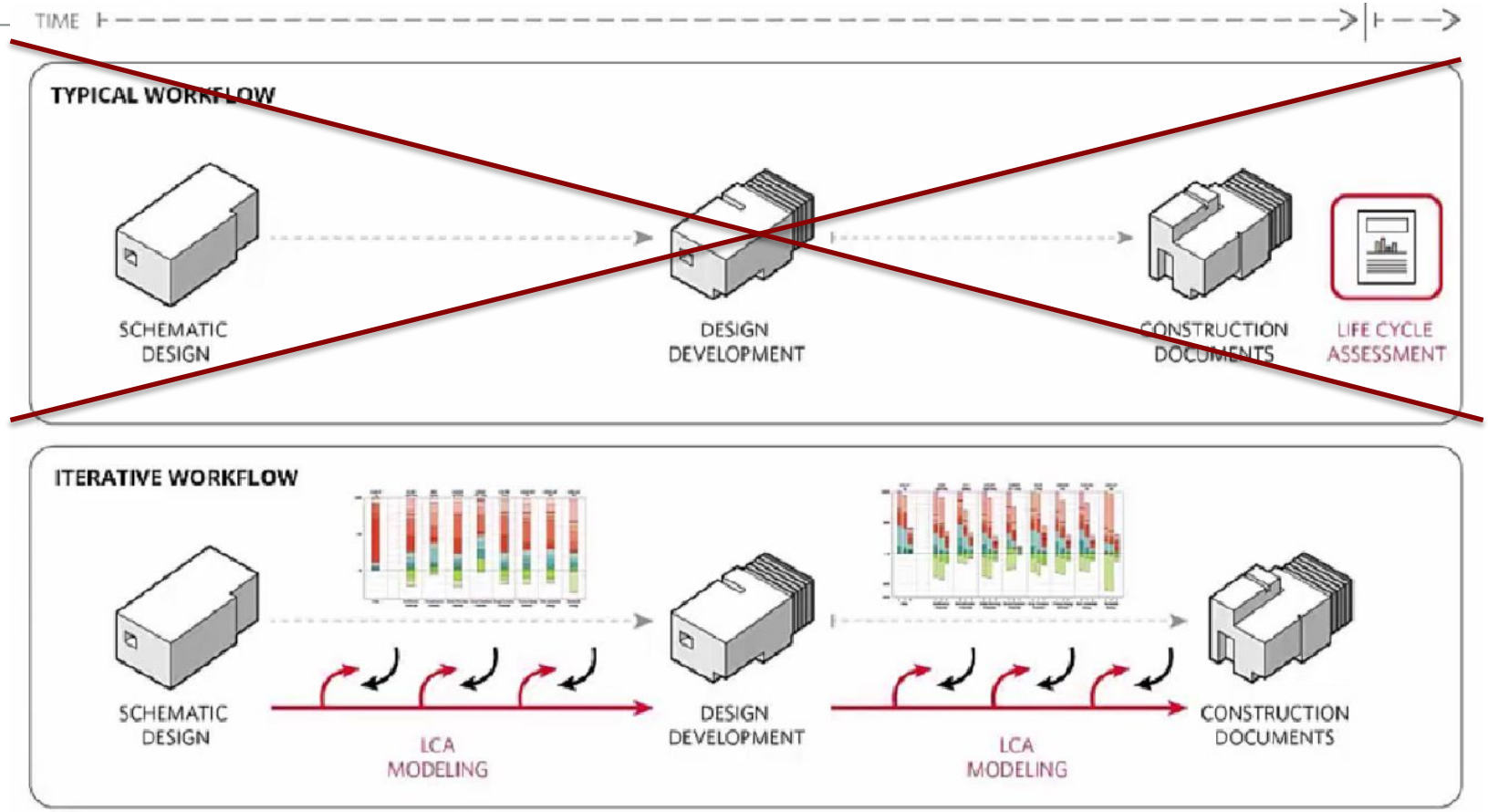
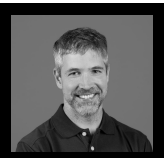
HOW TO ACHIEVE COMPLIANCE | PATH 1 – WHOLE BUILDING LCA APPROACH

Workflow:

- *Significant savings requires an iterative workflow. Is this difficult?*





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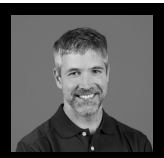
PRE-DESIGN		EARLY SD		50% SD		100% SD	EARLY DD		50% DD		100% DD	
Overall budget, program, and pro-forma set	*Draft of overall schedule set for project planning*	*OPR complete*	*Building siting (orientation + massing) set*	*Building type/ code set*	*Major systems set*	*Structural + envelope performance criteria set*	*Draft construction schedule set*	*Secondary structural systems set (curtain wall, etc.)*	*Outline specifications*	*Exterior elevations set*	*D-B: Manufacturer/ vendor chosen*	*Exterior assemblies set*
WHOLE BUILDING												
SET GOALS • Operational carbon: Set energy use intensity (EUI) goals + fuel source • Embodied carbon: Set carbon intensity limits ($kgCO_2eq/sf$), % reduction targets, and/or limits • Rating system metrics		**LCA: MASSING COMPARISON** Study massing options	Establish relevant regulations and rating systems (Buy Clean CA, LEED, LBC, etc.)			Set baseline if tracking relative improvements (% reduction)	**HOT SPOT ANALYSIS** • Perform whole building LCA • Identify top material impacts • Establish strategies for reducing or optimizing materials with the biggest impact		Identify optimization opportunities (see "Materials" section below)			Update LCA model + track change in life cycle impacts over DD
STRUCTURE												
		REVIEW GOALS • Architect and engineer discuss carbon reduction + goals • Discuss schedule + budget implications with contractor (D-B) • Work with geotechnical engineer + structural to optimize foundations		**LCA: STRUCTURAL COMPARISON** • Study structural concepts + alternatives • Confirm most appropriate system (P.T. vs. mild, steel, wood, etc.)	**STRUCTURE FIXED** • Structural performance criteria is fixed (loads, design strength, serviceability) • Incorporate embodied carbon reduction targets		**STRUCTURAL HOT SPOTS** • Push for cement reductions if using concrete (topping slab, mat foundations, and other low-hanging fruit at a minimum!) • Consider schedule implications		Architect/engineers collaborate to reduce volume of structural materials as possible			Finalize reduction strategies in structure (e.g. cement reduction in concrete, sourcing goals for steel, etc.)
ENVELOPE												
			Envelope constraints set through code analysis, daylighting + energy modeling studies	**LCA: ENVELOPE STUDIES** • Compare facade + assembly design options • Test assemblies - insulation layers, etc.			**ENVELOPE HOT SPOTS** • Identify target item reductions • Push for low carbon insulation + other hot spots		Identify optimization opportunities (see "Materials" section below)			Establish reduction strategies for envelope (e.g. insulation preference, window type, etc.)



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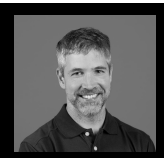
How to Achieve Compliance

Path 2 – Assembly Level LCA Approach (structural bays)

Document at least a 10% reduction in global warming potential as compared to a *Reference Case* structural bay model (or similar functional unit) using approved software. Compare the *Selected Design Case* (representing the design of the building at the end of the FD phase) to the *Reference Case*, developed by the end of the D phase.



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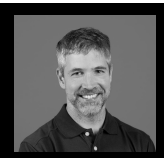
How to Achieve Compliance

Path 2 – Assembly Level LCA Approach (structural bays)

Modeling requirements:

1) Same as Path 1



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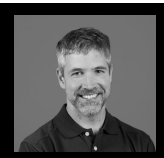
How to Achieve Compliance
Path 2 – Assembly Level LCA Approach (structural bays)

What to include in the model:

1) A typical “slice” through the building, 1 or 2 bays wide
2) The slice must extend from the front to the back of the building
3) It must include the complete building enclosure including glazing from the interior finish to the exterior cladding
4) Structural elements (posts, beams, bearing walls)
5) Full building height: foundation, basement, all intermediate floors, roof



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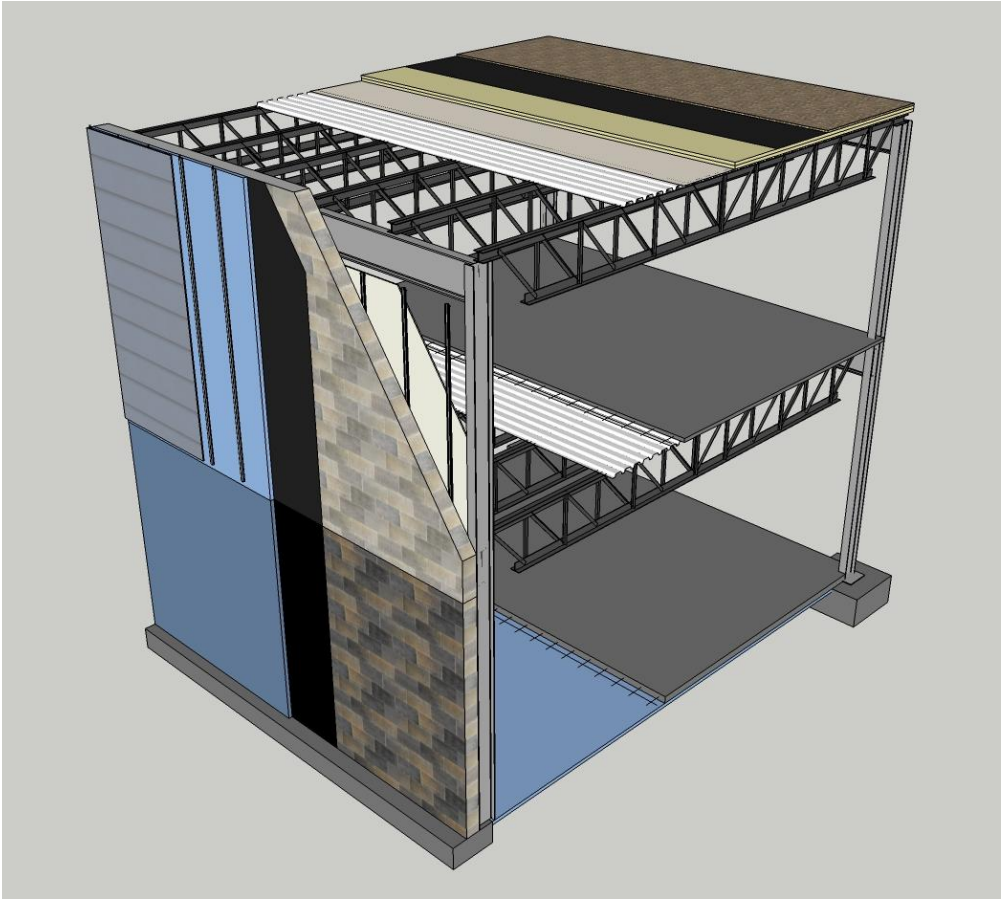
How to Achieve Compliance
Path 2 – Assembly Level LCA

What to include in the model:

Similar to this picture, foundation to roof, but include enclosure on the back side of the building as well.



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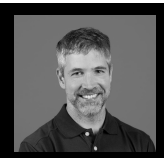
How to Achieve Compliance

Path 2 – Assembly Level LCA Approach (structural bays)

What to omit:

1) Same as Path 1, plus…
2) Unattached parking garages



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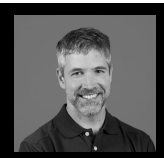
How to Achieve Compliance Path 2 – Assembly Level LCA Approach

Allowable impact reduction strategies:

Impact Reduction Strategies	Path 1 Whole Building	Path 2 Assembly Level	Path 3 Material Level
Building Size (floor area)	no	no	no
Building Service Life	no	no	no
Building shape (layout, surface area)	yes	no	no
Building structural spacing (grid layout)	yes	no	no
Assembly substitutions (swap types)	yes	yes	no
Assembly design changes (thicknesses and layers of materials)	yes	yes	no
Window-to-wall area ratio changes	yes	yes	no
Floor to Floor height changes	yes	yes	no
Structure design changes (type and sizing of beams + columns)	yes	yes	no
Material substitutions	yes	yes	yes



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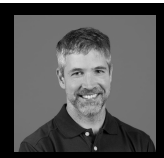
How to Achieve Compliance
Path 2 – Assembly Level LCA Approach (structural bays)

Steps:

1) As early as possible, begin developing a structural bay LCA model (a representative slice) of the proposed building.
2) Once the SD phase design is relatively complete (and projected to achieve the owner's project requirements and B3/SB2030 performance targets), create a structural bay model that defines the "Reference Case".
3) Through the remainder of SD, DD, and CD phases, work to achieve a 10% reduction in GWP compared to the "Reference Case" .
4) Submit a "Selected Design Case" representing the final building design at the end of the FD phase, which achieves a 10% reduction compared to the "Reference Case".



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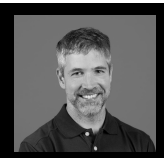
How to Achieve Compliance
Path 3 – Material Level LCA Approach

Achieve GWP savings by substituting lower GWP materials for higher GWP materials. Document savings by using the **B3 LCA Material Selection Calculator** and achieving an Impact Score of < 1.65 (or < 1.75 for B3 Small Buildings)

This compliance path is limited to building projects that utilize one dominant structural and enclosure type, which must make up at least 60% of the building's structural volume and exterior surface area respectively. In addition, the project's assemblies and materials must be well-approximated by those contained in the Material Selection Calculator.



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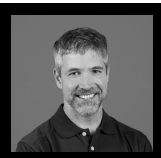
How to Achieve Compliance
Path 3 – Material Level LCA Approach

Allowable impact reduction strategies:

	Path 1	Path 2	Path 3
Impact Reduction Strategies	Whole Building	Assembly Level	Material Level
Building Size (floor area)	no	no	no
Building Service Life	no	no	no
Building shape (layout, surface area)	yes	no	no
Building structural spacing (grid layout)	yes	no	no
Assembly substitutions (swap types)	yes	yes	no
Assembly design changes (thicknesses and layers of materials)	yes	yes	no
Window-to-wall area ratio changes	yes	yes	no
Floor to Floor height changes	yes	yes	no
Structure design changes (type and sizing of beams + columns)	yes	yes	no
Material substitutions	yes	yes	yes



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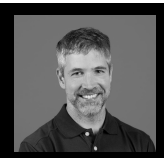
How to Achieve Compliance
Path 3 – Material Level LCA Approach

Modeling requirements:

1) There is no modeling! Use the B3 Material Selection Calculator. (But don't forget a final whole-building LCA model is due at the end of CD phase unless your building qualifies for the B3 Small Buildings approach.)



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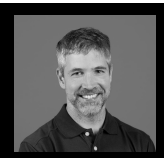
How to Achieve Compliance
Path 3 – Material Level LCA Approach

Steps:

1) As early as possible in the SD phase, identify the proposed building's most common material type in each of the following 10 categories:

- cladding
- low-slope roofing
- pitched roofing
- columns & beams structural material
- exterior wall structural material
- cavity insulation (for wall)
- cavity insulation (for roof)
- board insulation (for wall)
- board insulation (for roof)
- board insulation (for foundation)



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How to Achieve Compliance
Path 3 – Material Level LCA Approach

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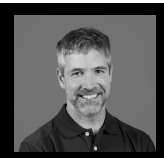
- columns & beams structural material
- exterior wall structural material
- cavity insulation (for wall)
- cavity insulation (for roof)
- board insulation (for wall)
- board insulation (for roof)
- board insulation (for foundation)

But it must account for at least 60% of the total surface area in its respective category.



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How to Achieve Compliance
Path 3 – Material Level LCA Approach

Steps:

1) As early as possible in the SD phase, identify the proposed building's most common material type in each of the following 10 categories:

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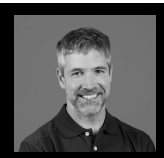
- columns & beams structural material
- exterior wall structural material
- cavity insulation (for wall)
- cavity insulation (for roof)
- board insulation (for wall)
- board insulation (for roof)
- board insulation (for foundation)

If there is no material in a category, that category is removed from consideration.



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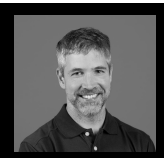
How to Achieve Compliance
Path 3 – Material Level LCA Approach

Steps:

1. Enter these materials in the B3 Material Selection Calculator. As the design progresses, work to substitute lower GWP materials for the original selections to achieve a score of < 1.65 and incorporate those changes in the building plans and specs.



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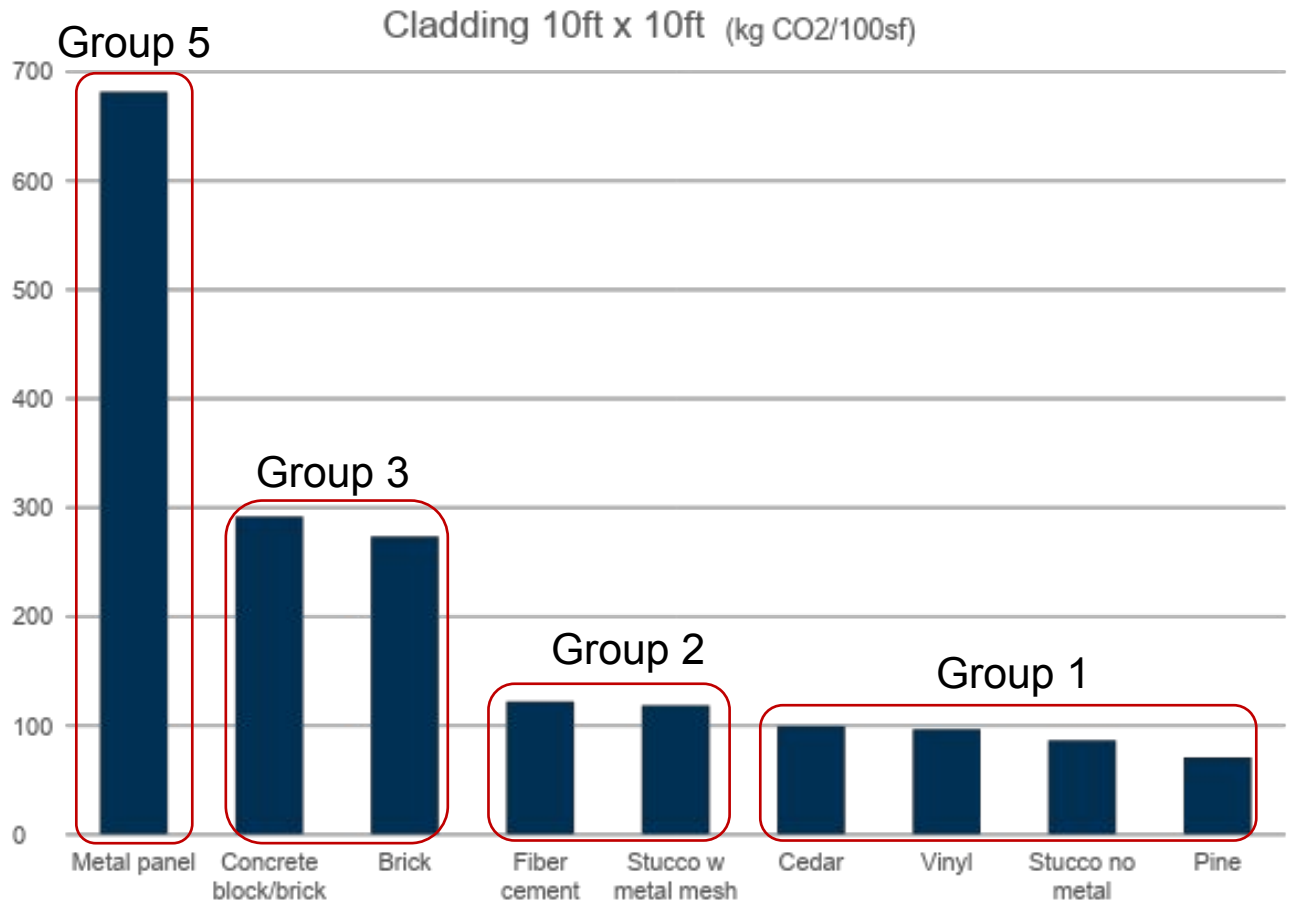
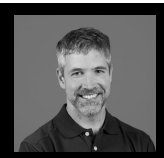
How to Achieve Compliance

Path 3 – Material Level LCA Approach

GWP charts





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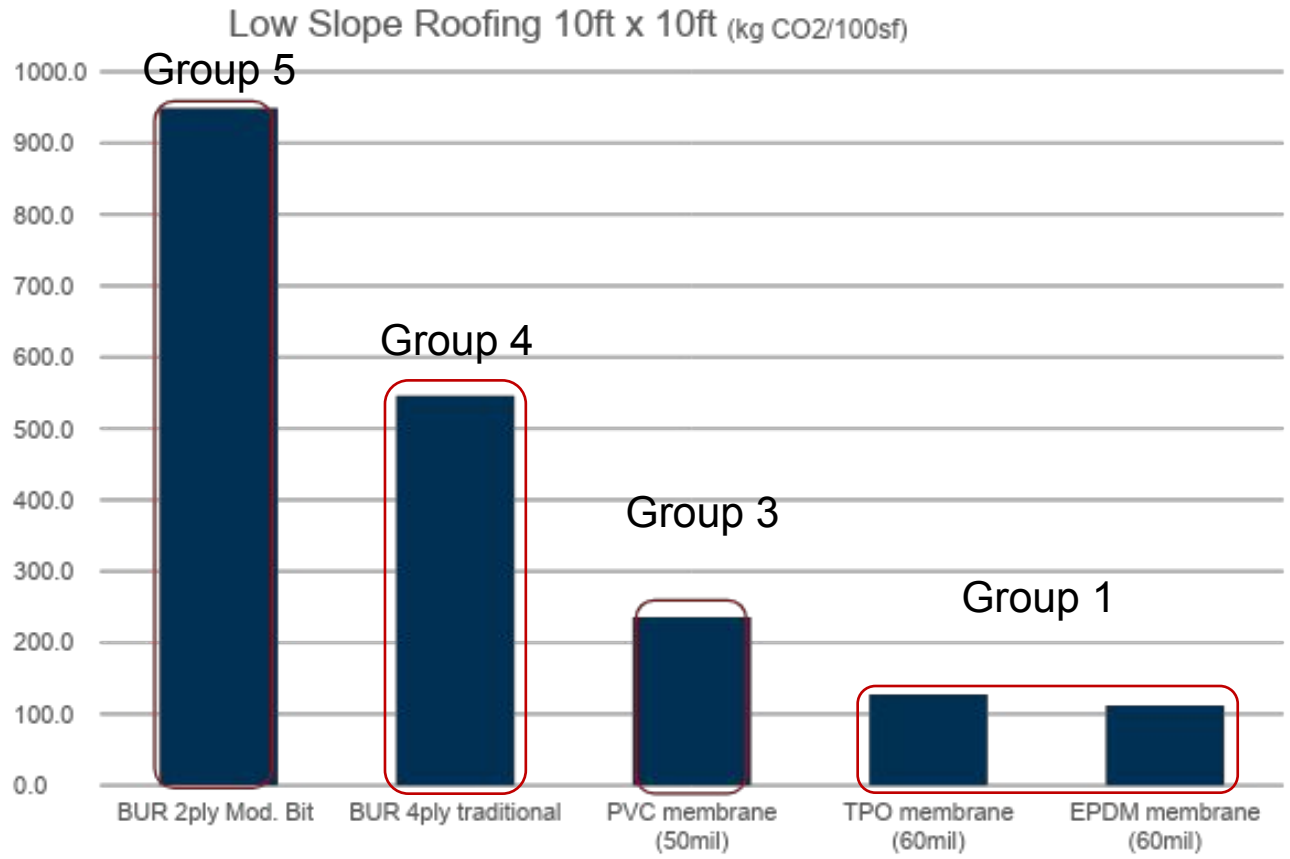
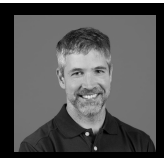
How to Achieve Compliance

Path 3 – Material Level LCA Approach

GWP charts





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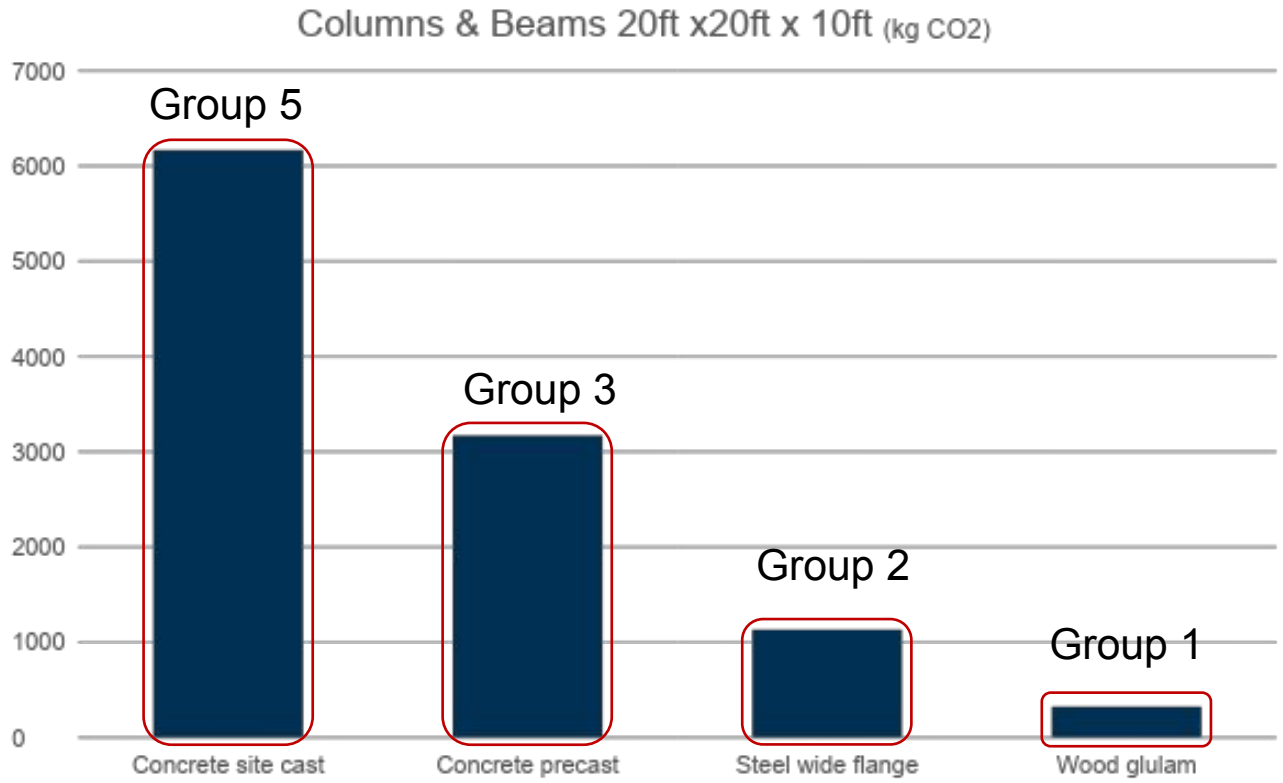
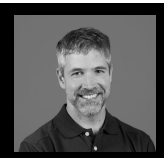
How to Achieve Compliance

Path 3 – Material Level LCA Approach

GWP charts





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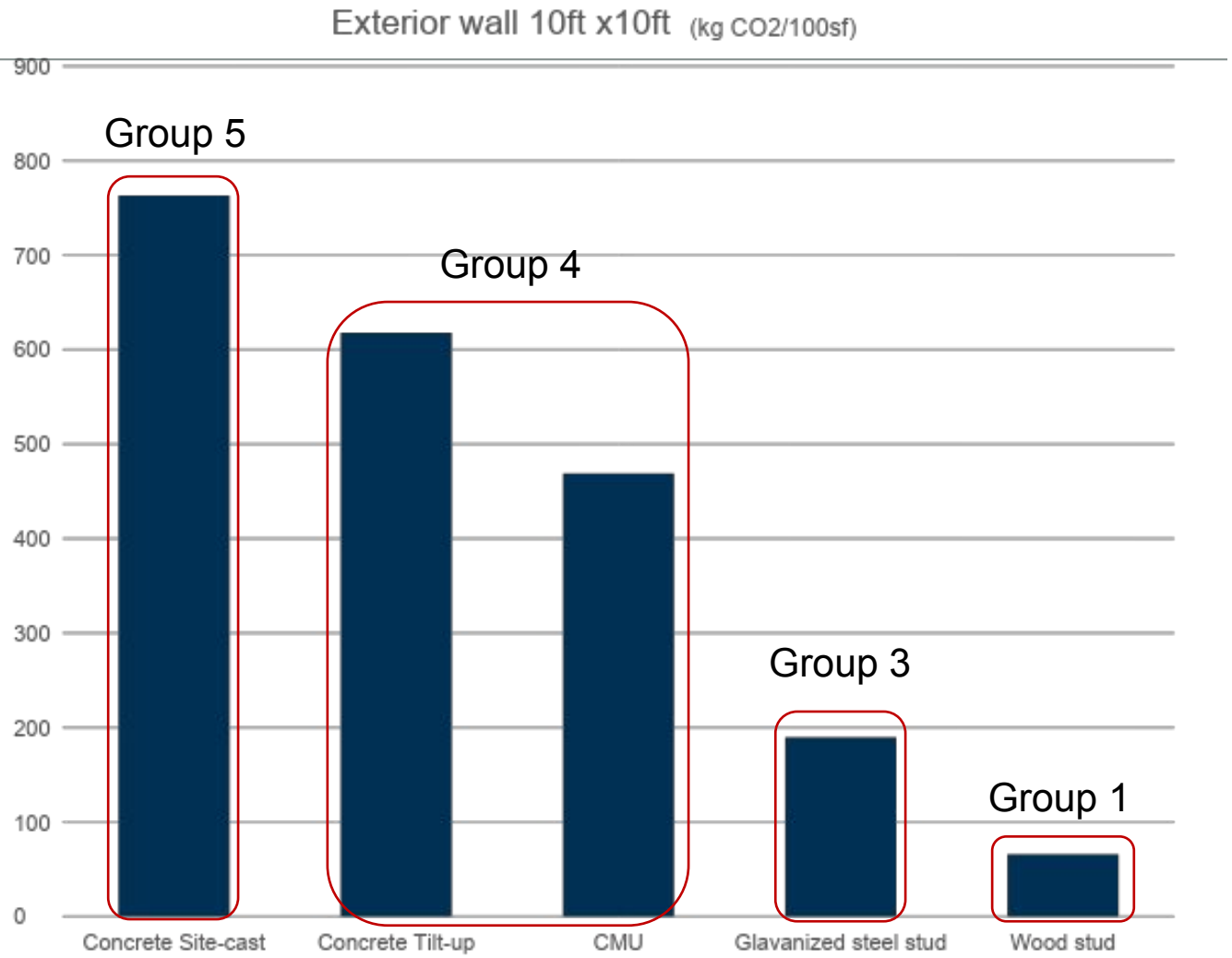
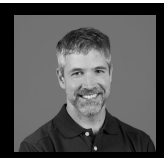
How to Achieve Compliance

Path 3 – Material Level LCA Approach

GWP charts





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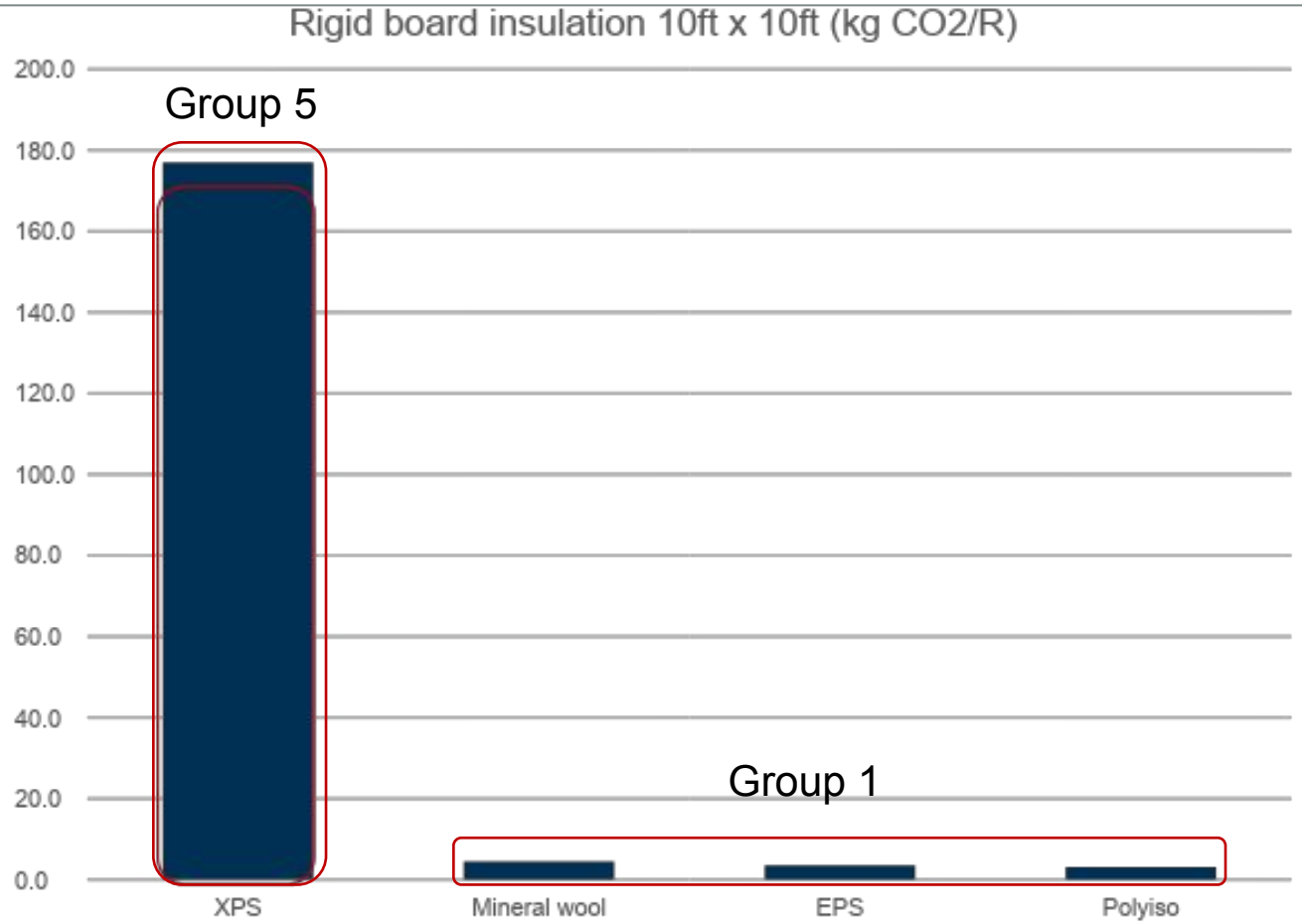
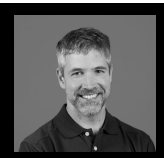
How to Achieve Compliance

Path 3 – Material Level LCA Approach

GWP charts





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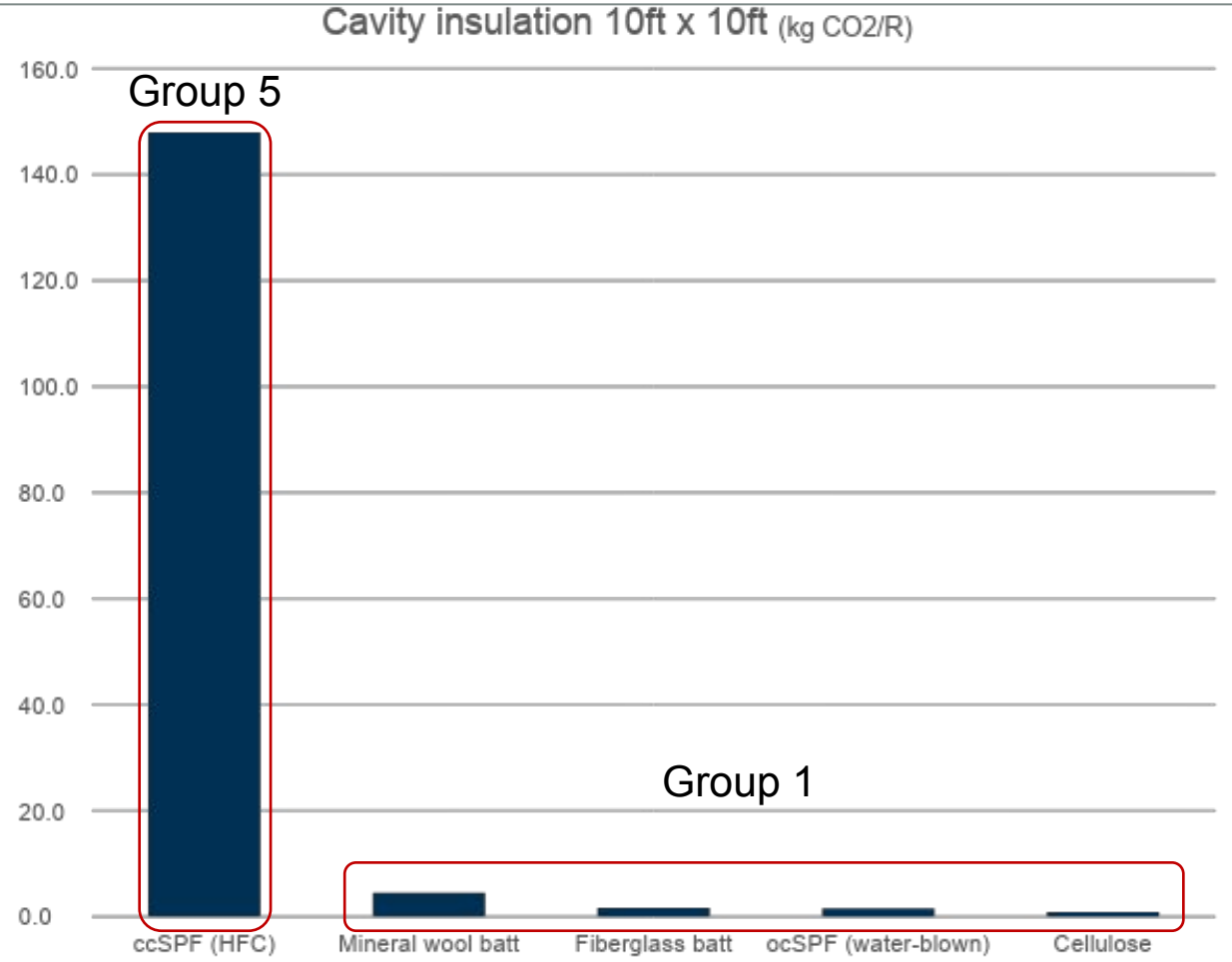
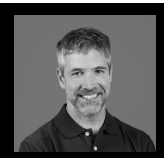
How to Achieve Compliance

Path 3 – Material Level LCA Approach

GWP charts



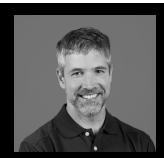


A NOTE ON BLOWING AGENTS

Chart from Building Green Guide to Insulation, 2017

XPS and closed cell SPF have historically had extremely high embodied GWP due to their blowing agents.

Type of Insulation	Blowing Agent	Atmospheric Lifetime (yr)	ODP[1]	GWP[2]
Polyisocyanurate				
Original	CFC-11	45	1	4,750
2nd Generation	HCFC-141b	9.3	0.11	725
3rd Generation	Pentane, cyclopentane	–	0	7[3]
Spray Polyurethane				
Original	CFC-11	45	1	4,750
2nd Generation	HCFC-141b	9.3	0.11	725
3rd Generation	HFC-245fa	7.2	0	1,030
3rd Generation	CO_2	–	0	1
4th Generation (2017)	HFO-1233zd	< 0.1	0	7
Extruded Polystyrene (XPS)				
Original	CFC-12	100	1	10,900
2nd Generation	HCFC-142b	17.9	0.065	2,310
3rd Generation	HFC-134a	13.8	0	1,430
4th Generation (TBD)	HFO-1234ze[4]	< 0.1	0	7



A NOTE ON BLOWING AGENTS

Chart from Building Green Guide to Insulation, 2017

In the last few years, manufacturers have begun to introduce products with vastly lower GWP, but availability is still limited, state to state, depending on regulations.

Type of Insulation	Blowing Agent	Atmospheric Lifetime (yr)	ODP[1]	GWP[2]
Polyisocyanurate				
Original	CFC-11	45	1	4,750
2nd Generation	HCFC-141b	9.3	0.11	725
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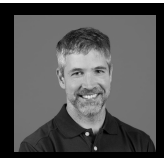


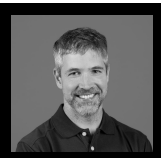
A NOTE ON BLOWING AGENTS

XPS products with low GWP:

- Owens Corning – Foamular NGX (still pink)
- Dupont – Reduced GWP Styrofoam (new look – grey instead of blue)
- Kingspan – Greenguard XPS LG (still green)

Closed cell SPF products with low GWP:

- Specify a ccSPF blown with Solstice LBA blowing agent (GWP = 1)
  - Demilic – Heatlok XT HFO
  - Lapolla – Foam-Lok 2000-4G
  - others…

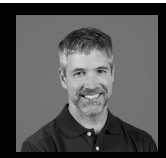


A NOTE ON BLOWING AGENTS

If these products are specified in the building plans and truly available for purchase, substitutions are allowed in the B3 Material Selection Calculator:

- ocSPF (water blown) for the low GWP ccSPF
- EPS for the low GWP XPS

Some states (not MN) have banned HFCs in the production of foam. Low GWP product may be more available in these states. https://www.hfcbans.com/bans-by-region.html

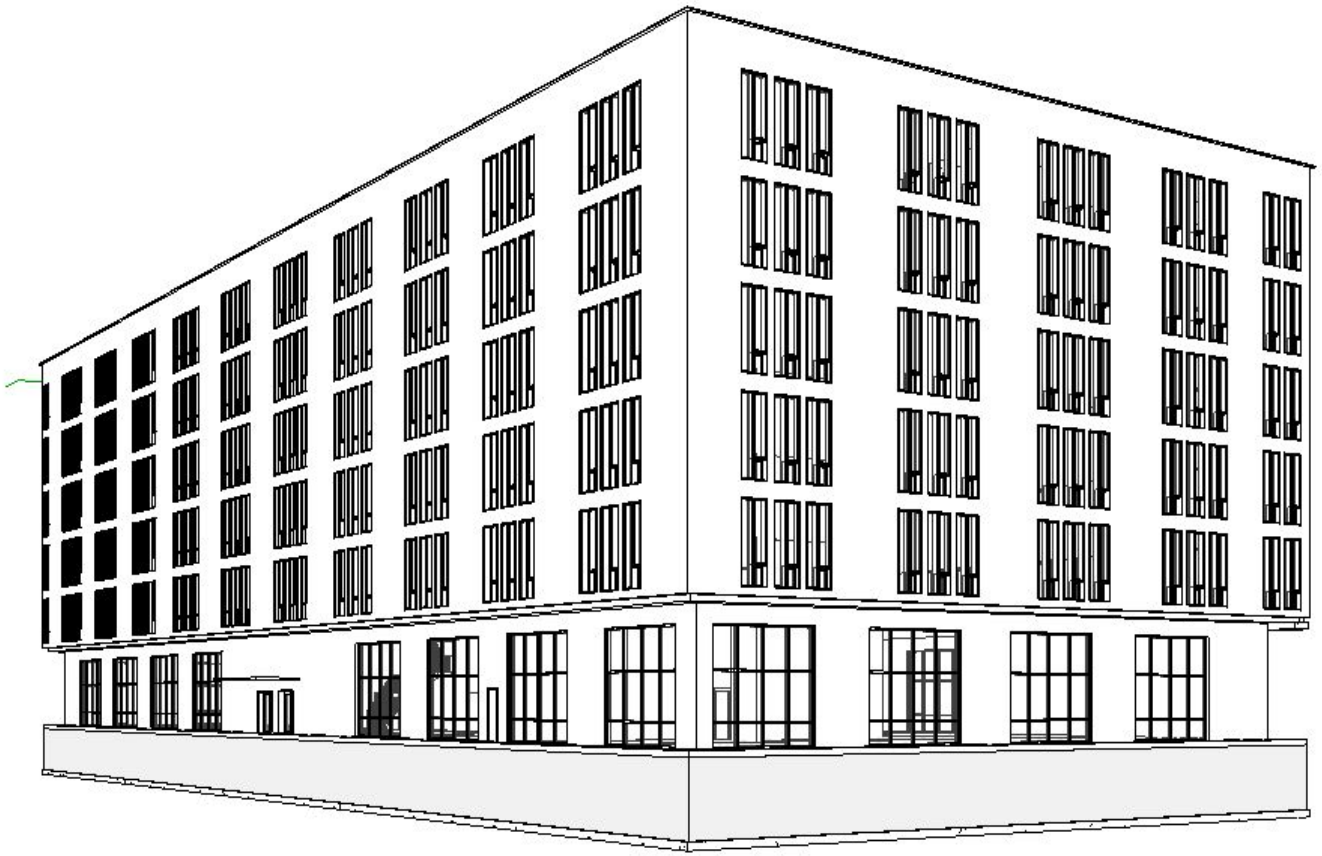


CREDIT M1A

How to Achieve Compliance

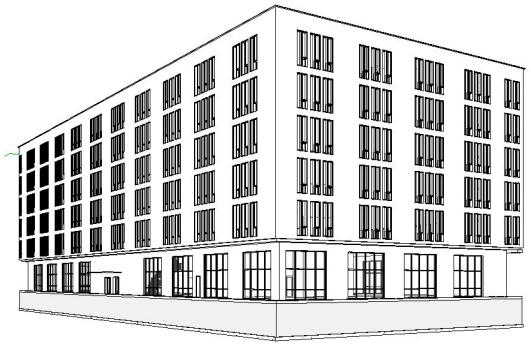
Path 3 – Material Level LCA Approach

Example – Wells Fargo Office Building



Appendix M-1a: Material Selection Calculator

B3 Guidelines - Version 3.2r01



KEY: Blue highlighted areas show
Yellow highlighted areas shc

Is this Project pursuing the B3 Guidelines Small Building Method?	No

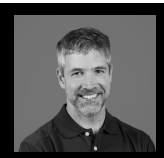
Category	Primary Material	Impact #
Cladding	Metal Panel	5
Low Slope Roofing	BUR 2-ply modified bitumen	5
Pitched Roofing	NA	0
Exterior wall material (above grade)	Galvanized steel stud	3
Columns & Beams material	Concrete site cast	5
Cavity insulation (wall)	Fiberglass batt/blown	1
Cavity insulation (roof)	NA	0
Board insulation (wall)	XPS	5
Board insulation (roof)	XPS	5
Board insulation (below grade)	XPS	5
	4.25	**Impact Score**
	FAIL	

Path 3 – Material Level LCA Approach

BASE CASE

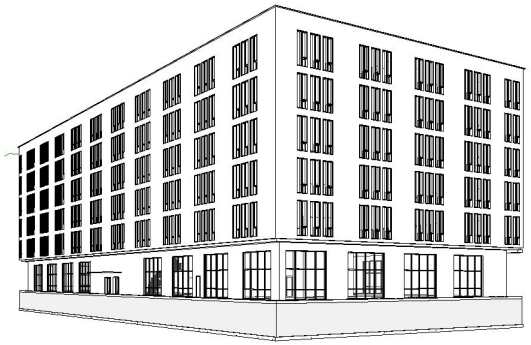
NOTES:

1. An Impact Score of < 1.75 is required for compliance with GWP Reduction Path 3 for projects pursuing the E
2. An Impact Score of < 1.65 is required for compliance with GWP Reduction Path 3 for all other projects



Appendix M-1a: Material Selection Calculator

B3 Guidelines - Version 3.2r01



KEY: Blue highlighted areas show
Yellow highlighted areas sho

Is this Project pursuing the B3 Guidelines Small Building Method?	Yes

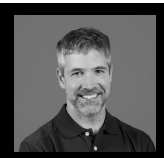
Category	Primary Material	Impact #
Cladding	Fiber cement	2
Low Slope Roofing	EPDM membrane (60mil)	1
Pitched Roofing	NA	0
Exterior wall material (above grade)	Galvanized steel stud	3
Columns & Beams material	Concrete precast	3
Cavity insulation (wall)	Mineral wool batt	1
Cavity insulation (roof)	NA	0
Board insulation (wall)	EPS	1
Board insulation (roof)	Polyiso	1
Board insulation (below grade)	EPS	1
	1.63	**Impact Score**
	PASS	

Path 3 – Material Level LCA Approach

BASE CASE

NOTES:

1. An Impact Score of < 1.75 is required for compliance with GWP Reduction Path 3 for projects pursuing the E
2. An Impact Score of < 1.65 is required for compliance with GWP Reduction Path 3 for all other projects



QUESTIONS?

BREAK

WHOLE BUILDING LIFE CYCLE ASSESSMENT FOR THE B3 GUIDELINES

Rolf Jacobson – Research Fellow
Center for Sustainable Building Research

IN CLASS EXERCISE

LOGISTICS AND EDUCATION CREDITS

LEARNING OBJECTIVES – AFTERNOON SESSION

1. Learn how to use Athena Impact Estimator to estimate the embodied impacts of a building design.
2. Learn how to assess the results from a whole building LCA and use them to determine effective improvements.
3. Begin to recognize the typical materials that generate the greatest environmental impact in a building project.
4. Understand when in the design process whole building LCA can be used most effectively to reduce embodied environmental impacts.

AFTERNOON AGENDA

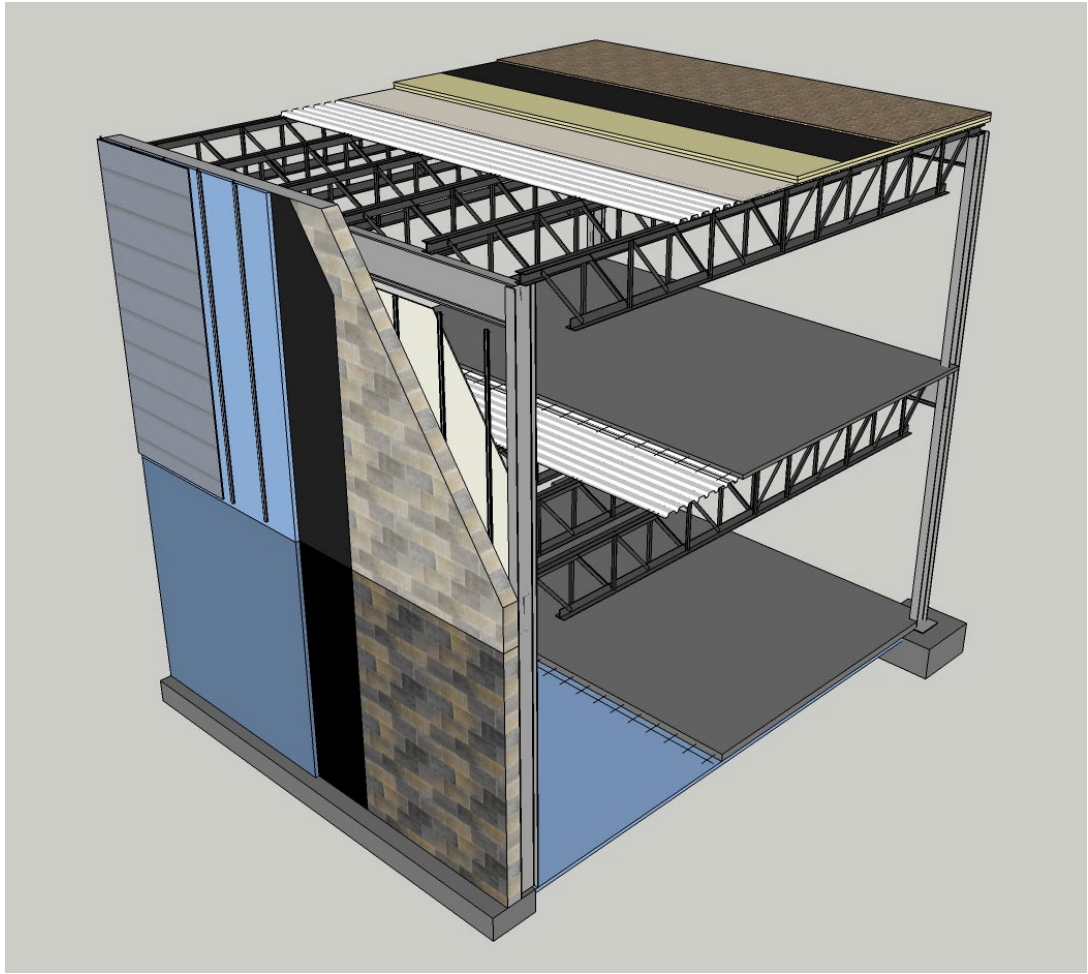
IN CLASS EXERCISE

Goal - Use Athena Impact Estimator to do a Path 2 (structural bays) LCA analysis

1) Walk-through of the tool (large group).
2) Create base model (reference case) following specifications.
3) Compare GWP results (large group).
4) Create two different models that meet the M1a requirement for 10% GWP reduction.
5) Compare GWP reductions + Discussion (large group).

ATHENA IMPACT ESTIMATOR

In-class exercise – Structural bay model



ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications

General Project Info:

- Project Location: Minneapolis
- Building Type: Institutional
- Building Life Expectancy: 60 yrs
- Building Height: 25’ (below grade slab to roof)
- Gross Floor Area: 500sf

ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications

Columns and Beams:
Wide Flange – supporting roof

- Supported Span: 25’ x Bay size: 20’ = 500sf
- Columns: 4 Beams: 2
- Column height: 14’
- Live Load: 50 psf

Columns and Beams:
Wide Flange – supporting floor

- Supported Span: 25’ x Bay size: 20’ = 500sf
- Columns: 4 Beams: 2
- Column height: 10’
- Live Load: 75 psf

ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications

Foundations:

Strip Footing

- Length: 20’ x Width: 2’ x Thickness: 12”
- Rebar: 118 lbs/yd3, 3000psi

Pad Footings

- 4 @ 3’ x 3’ x 18” deep (can enter as single length and width = 12’ x 3’ x 18”)
- Rebar: 118 lbs/yr3, 4000 psi

Concrete Slab on Grade

- Length: 20’ x Width: 25’ = 500sf
- Thickness: 4”, 3000psi
- Envelope Material: 2” extruded polystyrene (HFC 2018)
- Envelope Material: Vapor retarder (6mil poly)

ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications

Floor:

Open Web Steel Joist

- Span: 25’ x Width: 20’ = 500sf
- Include topping
- Live Load: 75 psf

ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications

Roof:

Open Web Steel Joist

- Span: 25’ x Width: 20’ = 500sf
- Exclude topping
- Live Load: 50 psf
- Envelope Category: 4-Ply Built-up Asphalt Roof System
- Envelope Material: Asphalt-Polyiso Foam Board Glass Felt (3” thick)
- Envelope Material: Air barrier, 6 mil poly (insert with Envelope category “Vapour Barrier”)
- Envelope Material: Ballast (insert with Envelope category “Roof envelope”

ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications

Wall:

Cast in Place – Foundation wall

- Length: 20’ x Height: 10f = 200sf
- #5 Reinforcement, 3000 psi, 8 in thick
- No openings
- Envelope Material: 2” extruded polystyrene (HFC 2018)
- WRB - peel & stick membrane (insert as a Wall “Extra Materials”, Modified Bitumen Membrane)

ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications

Wall:

Concrete Block – Exterior wall

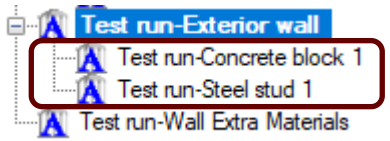
- Length: 20’ x Height: 14’ = 280sf
- 8” thickness
- No openings
- Envelope Material: 2” extruded polystyrene (HFC 2018)
- Envelope Material: Metal Wall Cladding, commercial 26 ga
- WRB - peel & stick membrane (insert as Extra Material - Modified Bitumen Membrane)
- Rebar and Z-furring (insert as Extra Material - rebar, rod. light sections), 0.5 tons

Steel Stud – Exterior wall

- Length: 20’ x Height: 14’ = 280sf
- Non-load bearing, light gauge, no sheathing, 1 5/8 x 3 5/8 stud
- 16” o.c.
- No openings
- Envelope Material: Gypsum board – Glass Mat Panel, 5/8”
- Envelope Material: 6 mil poly

ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications



Note – if creating multiple wall types under one wall name, they must all be the same wall (they share the same length and width and added Envelope Materials).

Wall:

Concrete Block – Exterior wall

- Length: 20’ x Height: 14’ = 280sf
- 8” thickness
- No openings
- Envelope Material: 2” extruded polystyrene (HFC 2018)
- Envelope Material: Metal Wall Cladding, commercial 26 ga
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ATHENA IMPACT ESTIMATOR

In-class exercise – Reference Case specifications

Note that when adding windows to a wall, Athena will reduce the opaque wall area by the same amount.

Be aware - glazing is very high GWP (higher per sf than 8” concrete block)

Wall:

Concrete Block – Exterior wall

- Length: 20’ x Height: 14’ = 280sf
- 8” thickness
- No openings
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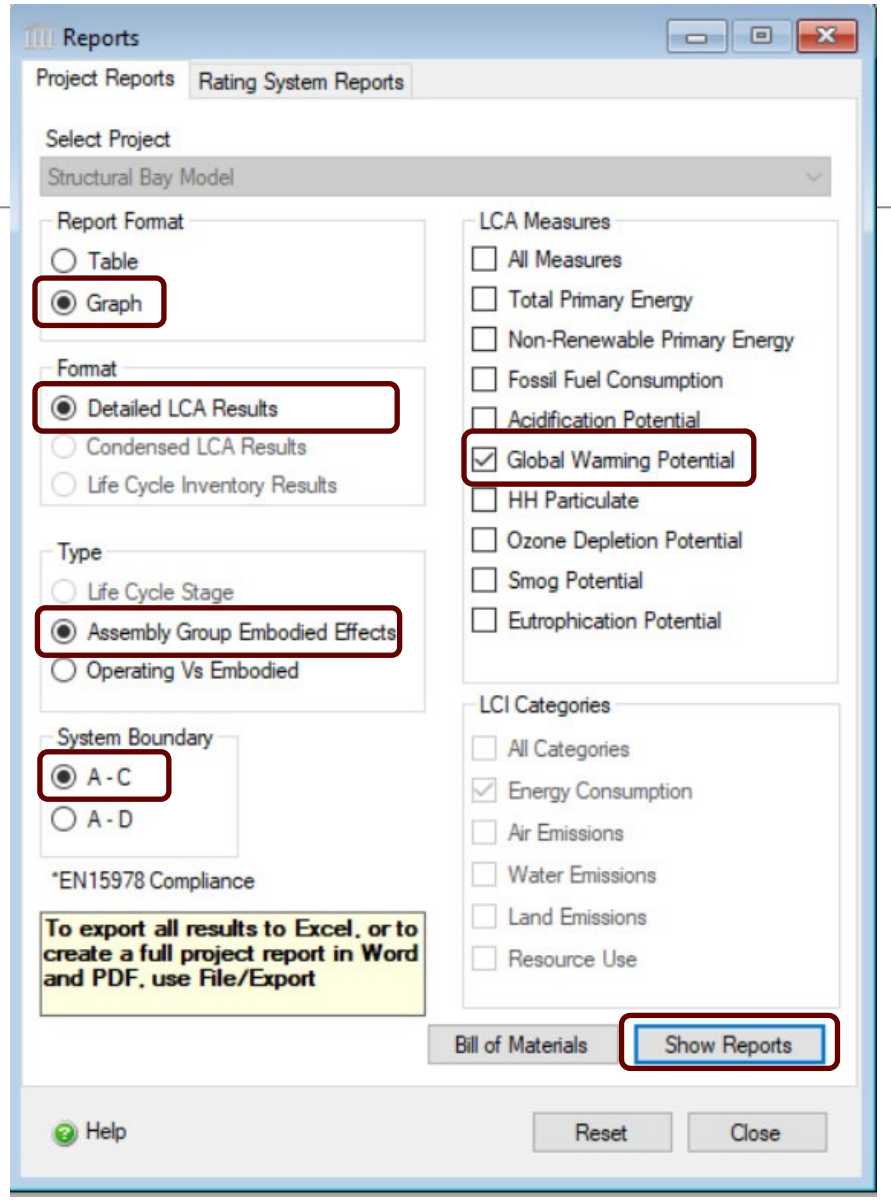
ATHENA IMPACT ESTIMATOR

In-class exercise – Results

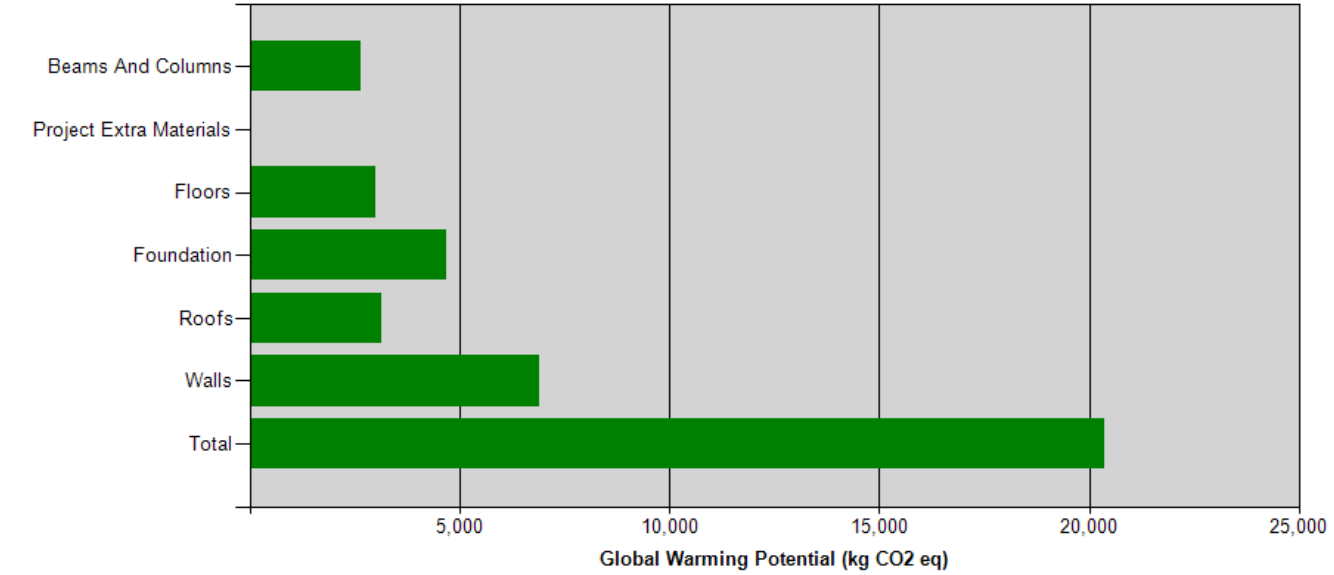


ATHENA IMPACT ESTIMATOR

In-class exercise – Results

Note:
Calcination GWP (additional carbon released from limestone breakdown in cement kilns) and Biogenic GWP (carbon storage for wood) – these are now available as separately tracked results, but are also factored into the total GWP results.

This means that wood products will often reduce total GWP.



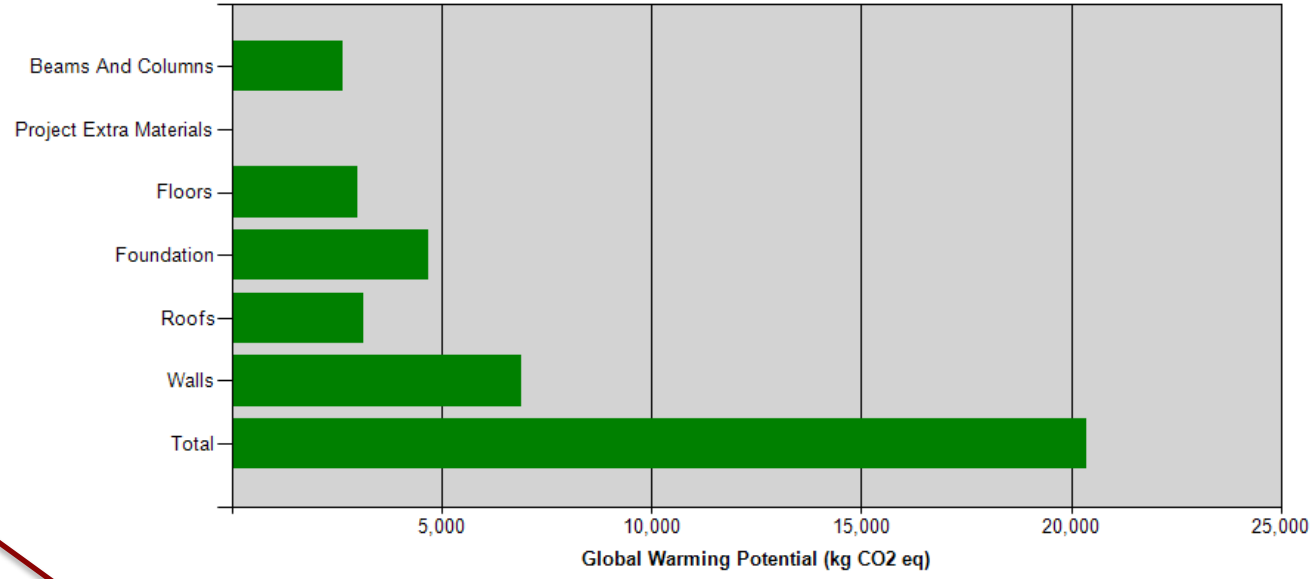
Assembly Group	Unit	Total
Beams And Columns	kg CO2 eq	2.64E+03
Floors	kg CO2 eq	3.00E+03
Foundation	kg CO2 eq	4.70E+03
Project Extra Materials	kg CO2 eq	0.00E+00
Roofs	kg CO2 eq	3.14E+03
Walls	kg CO2 eq	6.88E+03
Total	**kg CO2 eq**	**2.04E+04**

ATHENA IMPACT ESTIMATOR

In-class exercise – Results

If extra materials are added as “project extra materials” they will show up unattached to any assembly.

But they can also be added as “extra materials” within that assembly subgroup. In that case, their environmental impacts will be included as part of that assembly.



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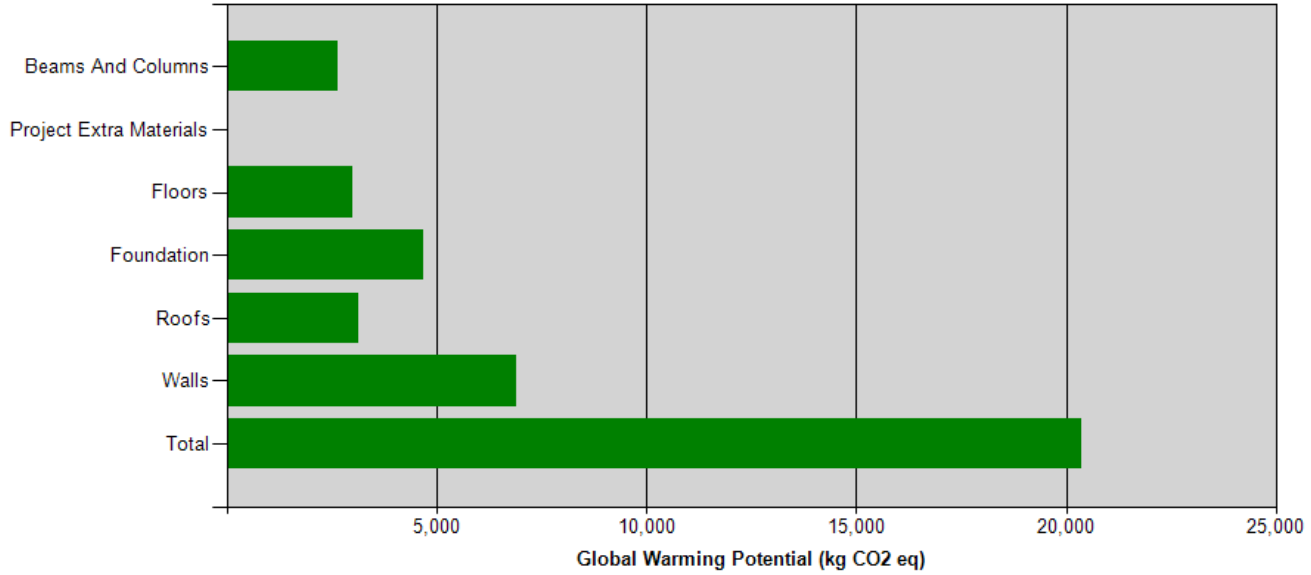
Walls	kg CO2 eq	6.88E+03
Total	**kg CO2 eq**	**2.04E+04**

ATHENA IMPACT ESTIMATOR

In-class exercise – Results

Results (both graph and table) can be exported directly to Excel.



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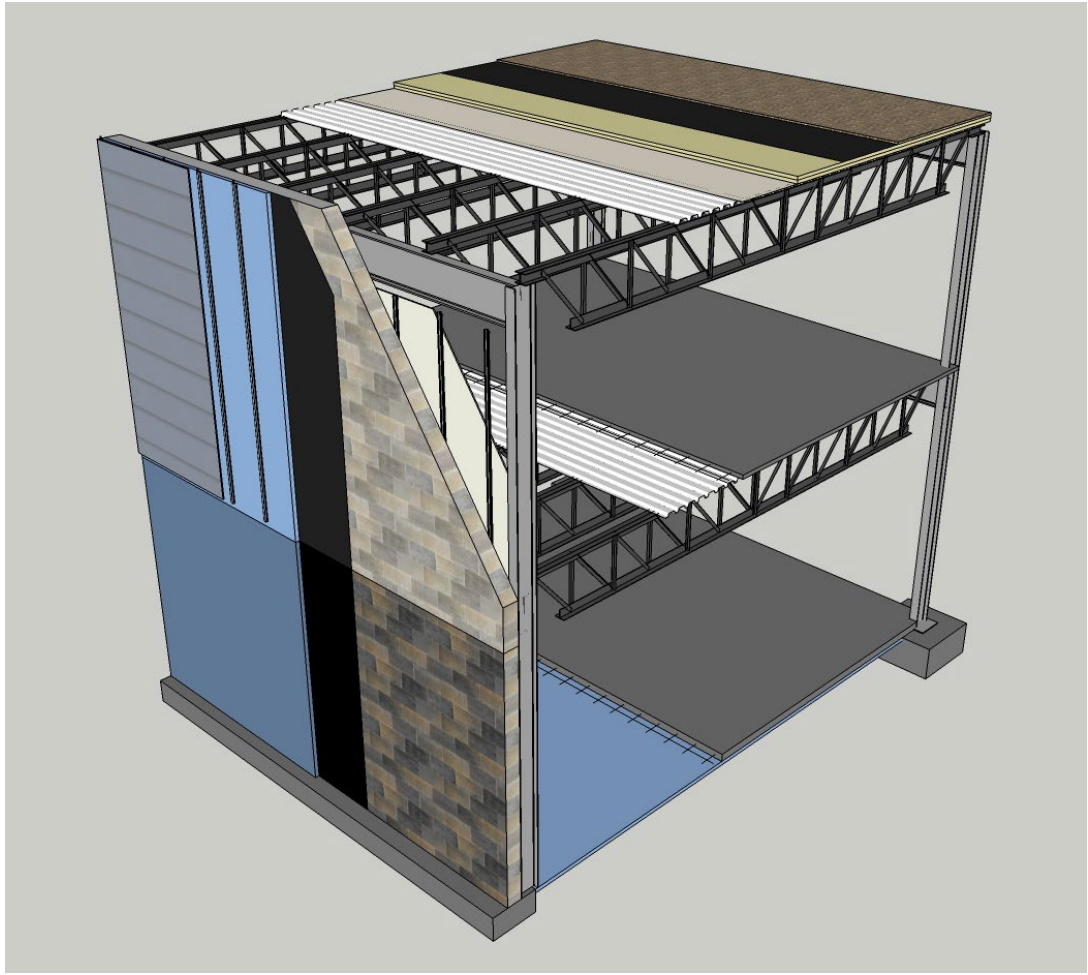
Foundation	kg CO2 eq	4.70E+03
Project Extra Materials	kg CO2 eq	0.00E+00
Roofs	kg CO2 eq	3.14E+03
Walls	kg CO2 eq	6.88E+03
Total	**kg CO2 eq**	**2.04E+04**

ATHENA IMPACT ESTIMATOR

In-class exercise – Design Cases

REQUIRED REDUCTION 10% GWP

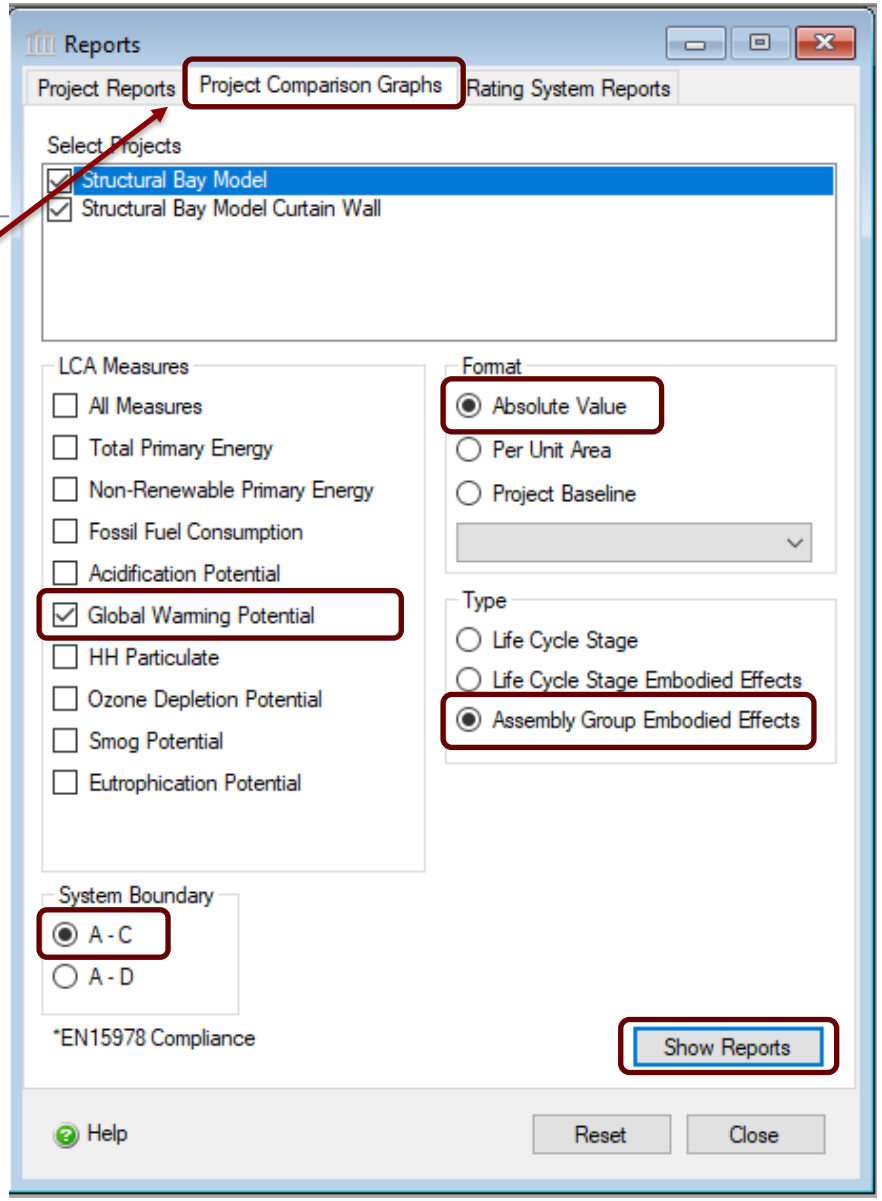
Achieve this two ways, in two separate models.



ATHENA IMPACT ESTIMATOR

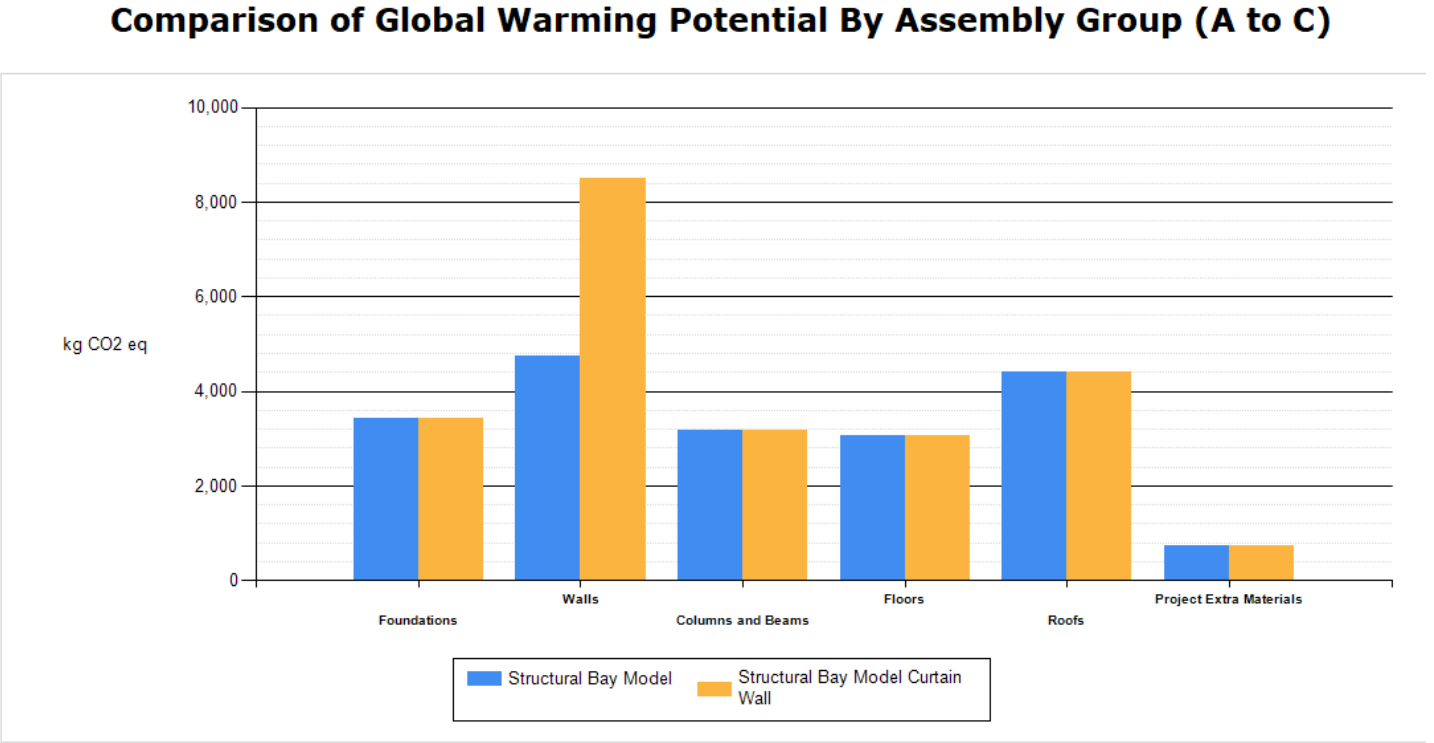
In-class exercise – Results Comparison

If two projects are open at once, you should see this option…



ATHENA IMPACT ESTIMATOR

In-class exercise – Results



Project Name	Unit	Foundations	Walls	Columns and Beams	Floors	Roofs	Project Extra Materials	Total
Structural Bay Model	kg CO2 eq	3.44E+03	4.74E+03	3.17E+03	3.07E+03	4.40E+03	7.23E+02	**1.95E+04**
Structural Bay Model Curtain Wall	kg CO2 eq	3.44E+03	8.50E+03	3.17E+03	3.07E+03	4.40E+03	7.23E+02	**2.33E+04**
Total	**kg CO2 eq**	**6.87E+03**	**1.32E+04**	**6.34E+03**	**6.15E+03**	**8.80E+03**	**1.45E+03**	**4.28E+04**