Welcome!

SEAW State

January Virtual Meeting

STRUCTURAL ENGINEERS ASSOCIATION OF WASHINGTON

STRUCTURAL ENGINEERING INSTITUTE

SE2050 COMMITTING TO NET ZERO

NET-ZERO EMBODIED CARBON STRUCTURES: THE SE 2050 COMMITMENT

PRESENTER: CHRIS JESERITZ
EMAIL: cajeseritz@pcs-structural.com

v. 22.00

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AGENDA

- SE 2050 Overview
  - Importance of SE 2050
  - Program Requirements
    - First Steps of Committing
    - Embodied Carbon Action Plan (ECAP)
    - Yearly Requirements
  - Database
    - Overview of Database
    - Tools Available for Reporting
    - Uploading Data
  - Resources
- Embodied Carbon Reduction Strategies
- Q&A

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LEARNING OBJECTIVES

1. Learn the purpose, goals, and requirements for joining the SE 2050 Commitment.
2. Learn about the SE 2050 database, how to upload data, and what tools are available for structural engineers to measure embodied carbon/global warming potential.
3. Learn about the resources available to structural engineers on se2050.org.
4. Learn different tactics to reduce the embodied carbon on structural framing systems.

SE 2050 OVERVIEW

- Raw material extraction
- Production
- Fabrication
- Shipping
- Construction and maintenance
- Demolition and disposal

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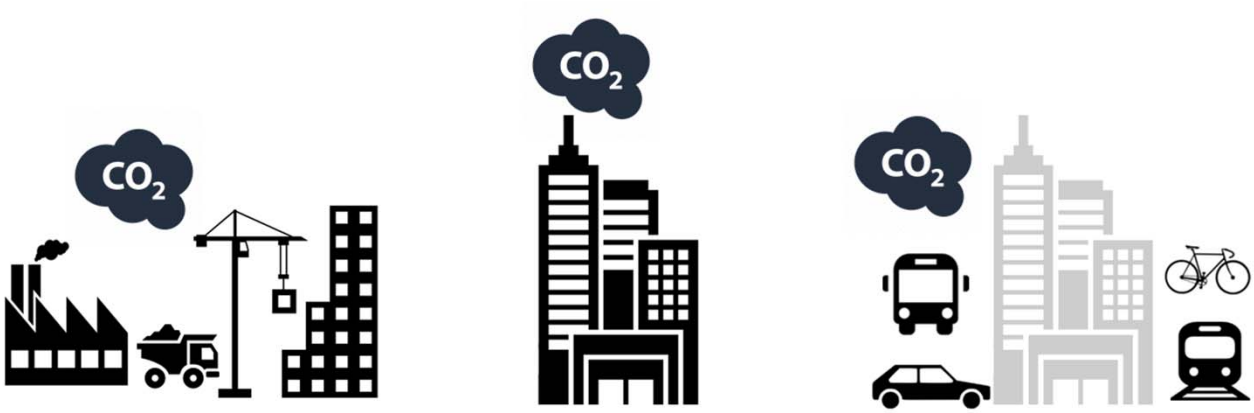
Total Carbon Emissions



Embodied + Operational + Transportation

Embodied Carbon (EC) = Greenhouse Gas (GHG) Emissions = Global Warming Potential (GWP)

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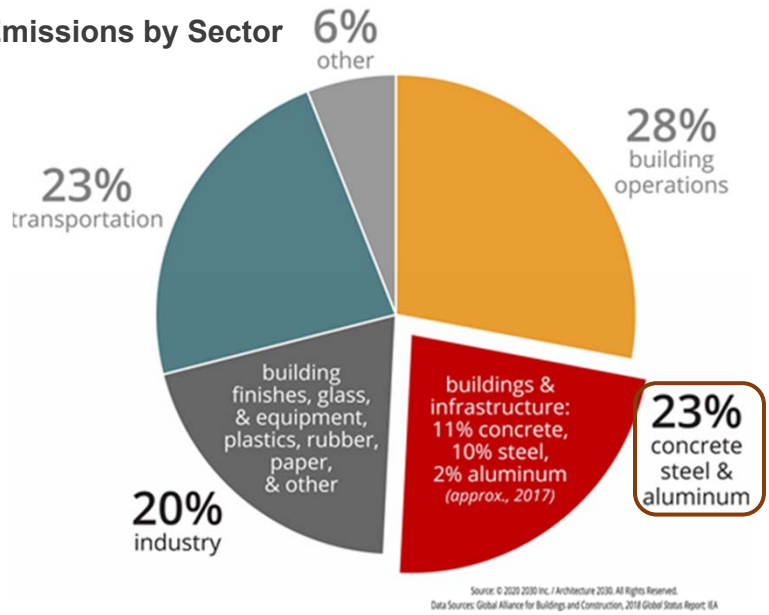
Global CO_2 Emissions by Sector



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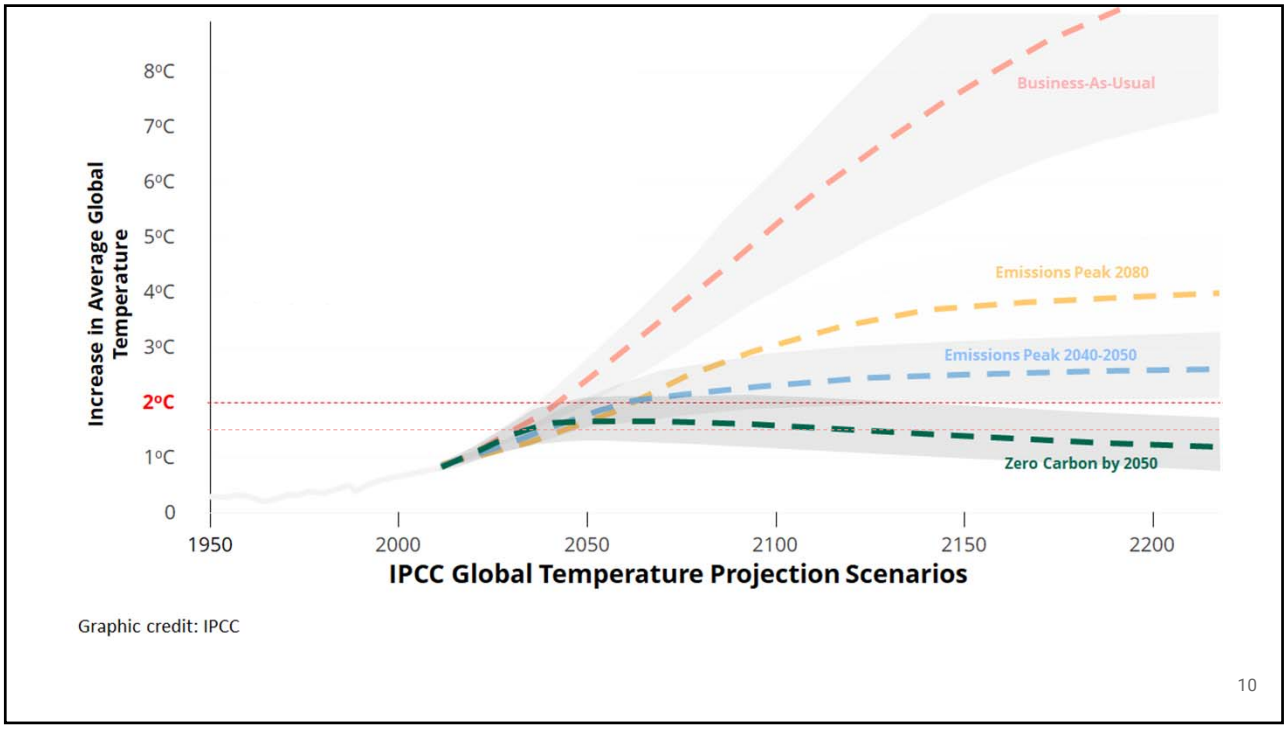
We're building a new **New York City every month** for the next 30 years


Increase in Average Global Temperature
8ºC
7ºC
6ºC
5ºC
4ºC
3ºC
2ºC
1ºC
0
1950
2000
2050
2100
2150
2200
Business-As-Usual
Emissions Peak 2080
Emissions Peak 2040-2050
Zero Carbon by 2050
IPCC Global Temperature Projection Scenarios
Graphic credit: IPCC
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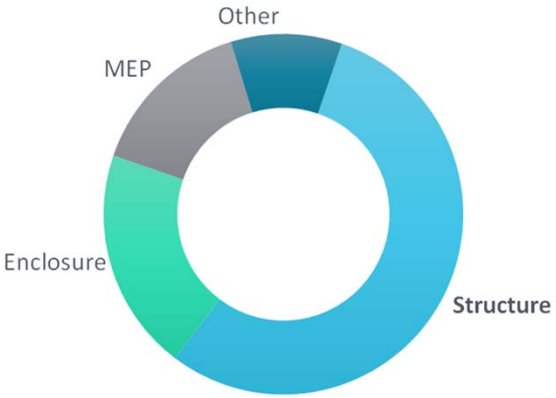

Say **50%** of all new building embodied carbon is from **structure**. That's about **1.9 billion metric tons CO2 per year** from the **structure** alone.

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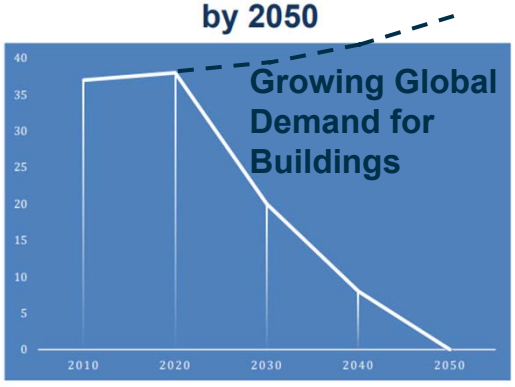
ACHIEVING NET-ZERO EMBODIED CARBON

- White Paper published in March 2020
- This paper addresses the first question many engineers ask about eliminating embodied carbon in construction:
- ***How is that even possible?***

Achieving Net Zero Embodied Carbon in Structural Materials by 2050

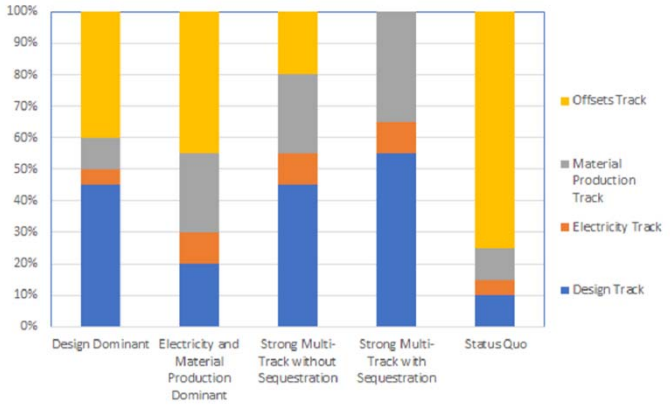


https://seisustainability.files.wordpress.com/2020/05/how-to-get-to-zero-200525.pdf

ACHIEVING NET-ZERO EMBODIED CARBON

Four Tracks:

1. Design improvements implemented by engineers and architects.
2. Greening the electrical grid.
3. Improving material production.
4. Carbon offsets.



May be combined in different proportions.

SEI ASCE STRUCTURAL ENGINEERING INSTITUTE

SE2050 COMMITTING TO NET ZERO

www.SE2050.org

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PROGRAM STATS – SIGNATORY FIRMS

Firms Committed

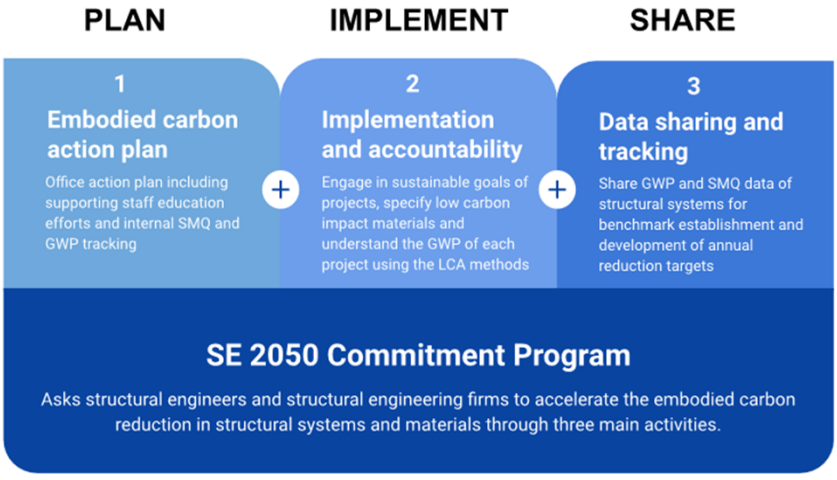
71

Projects Submitted to Database (Public)

48+

ECAPs Received

41



Education, advocacy, accountability, firm culture

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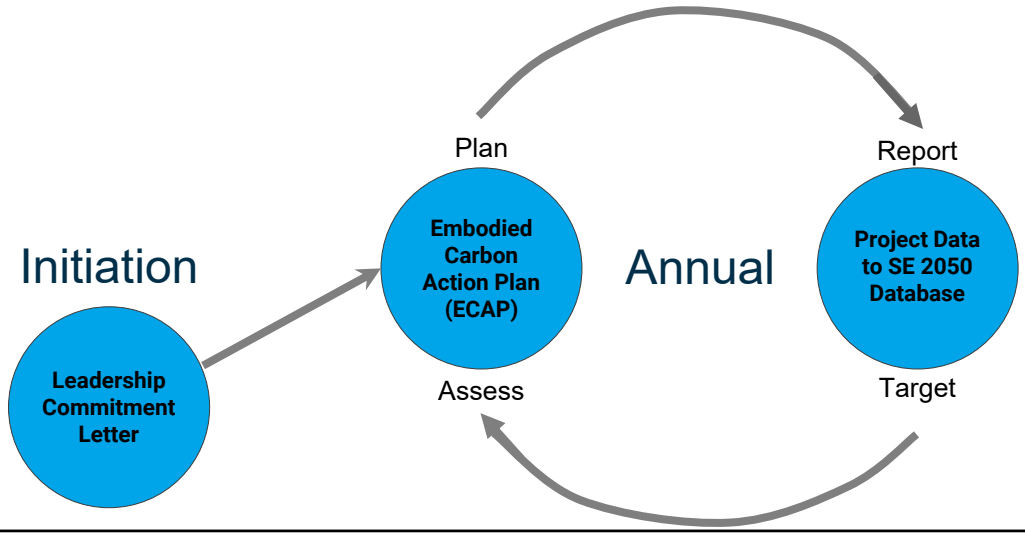
PROGRAM REQUIREMENTS

HOW IT WORKS



SUMMARY OF SE 2050 COMMITMENT PROGRAM REQUIREMENTS

1. Due at the time a firm commits
   - Commitment Letter from firm leadership
   - Internal announcement of firm's commitment & sharing of resources from the SE 2050 website
   - Nominate an internal embodied carbon champion
   - Public announcement of firm's commitment
   - High-resolution logo of firm
2. Within six months
   - Submit firm's Embodied Carbon Action Plan (ECAP)

SUMMARY OF SE 2050 COMMITMENT PROGRAM REQUIREMENTS (CONT.)

3. Due within one year
   - Submit project data to SE 2050 database
   - Present or host an "Embodied Carbon 101" webinar/presentation
   - Complete electives as selected in ECAP
4. Due each returning year
   - Submit updated ECAP
   - Updated internal embodied carbon champion (if desired)

EMBODIED CARBON ACTION PLAN (ECAP)

	KNOWLEDGE SHARING	DATA
INTERNAL	**Education** Building Understanding	**Reporting** Measuring to Manage
EXTERNAL	**Reduction** Strategies Making an Impact	**Advocacy** Building a culture of change

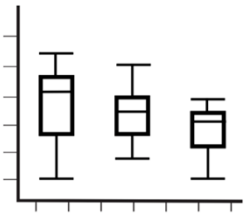
ECAP – EDUCATION

- Designate Firmwide Embodied Carbon Champion
- Narrative of Education Plan
- Embodied Carbon 101 Presentation/Webinar

ECAP – REPORTING

- Initial Reporting Minimums to Database

  2x number of firm offices
  but does not need to exceed more than
  5 Projects



ECAP – REDUCTION STRATEGIES

- Set a Goal and Report on Progress
- Discuss what strategies worked, and what didn't

ECAP – ADVOCACY

- Share your commitment
- Educate clients
- Engage in groups like CLF

CLF Carbon Leadership Forum

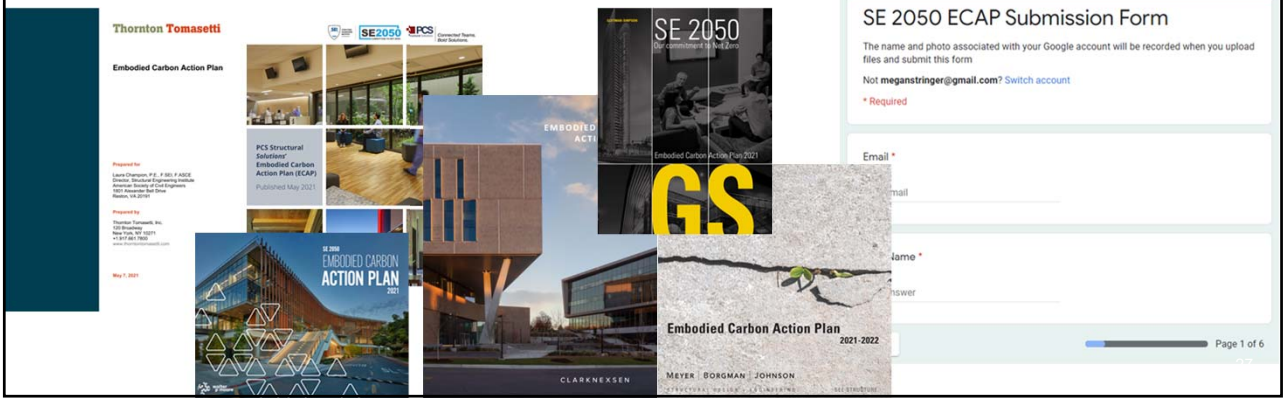
ECAP – ACCOUNTABILITY

ANNUAL Updates to ECAP
PUBLISHED on SE 2050 Website

Firm Name	Embodied Carbon Champion	Submitted ECAPs	Start Year	Next ECAP due	Next Data due
Ai-Alt Structural Engineering	Alvin Tabar	-	2021	2022-01	2022-07
Armstrong-Douglass Partners	Scott Douglass	2021 Submitted	2021	2022-07	2022-01
Arup (North America)	Frances Yang	2021 Submitted	2020	2022-06	2021-12
Aspect Structural Engineers	Ross Jardine	2021 Submitted	2021	2022-08	2022-02
Black Box Engineering	David Bueno	-	2021	2022-02	2022-08
Buehler	Ryan Miller	2021 Submitted	2021	2023-01	2022-07

ECAP – HOW TO START?

- Review other firm's ECAP's
- Reference website: https://se2050.org/ecap/
- Use Googleform on website



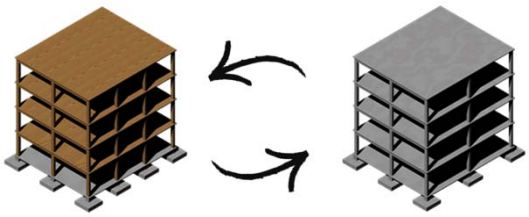
SE 2050 DATABASE

WHY A DATABASE?

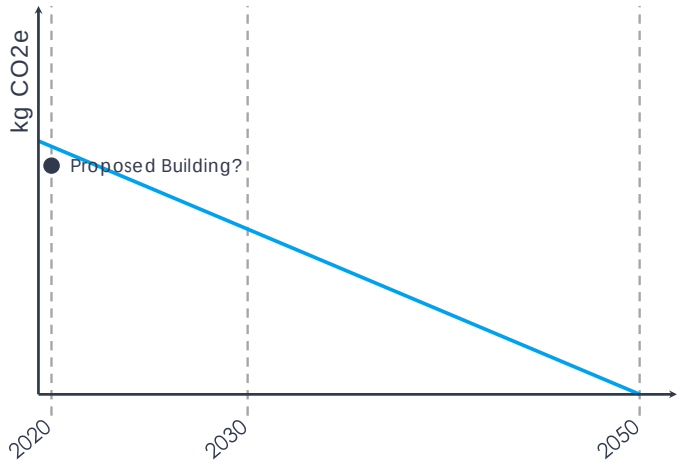
Embodied Carbon Data
using As-Designed and Reference building

Current approach (e.g., as used by green building rating systems):

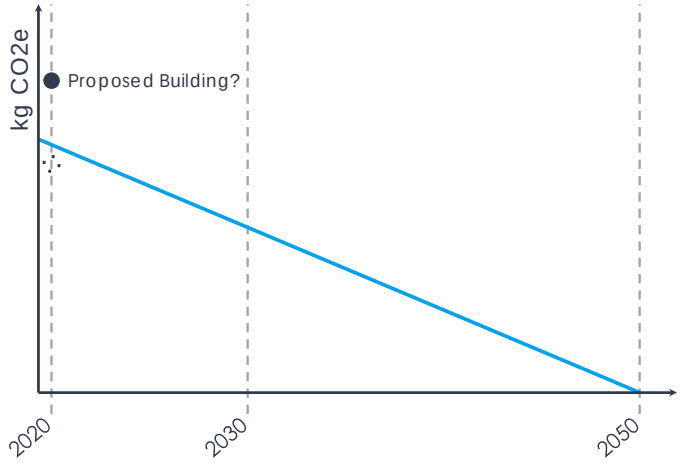
Comparative Structural System LCA
using As-Designed and Reference building



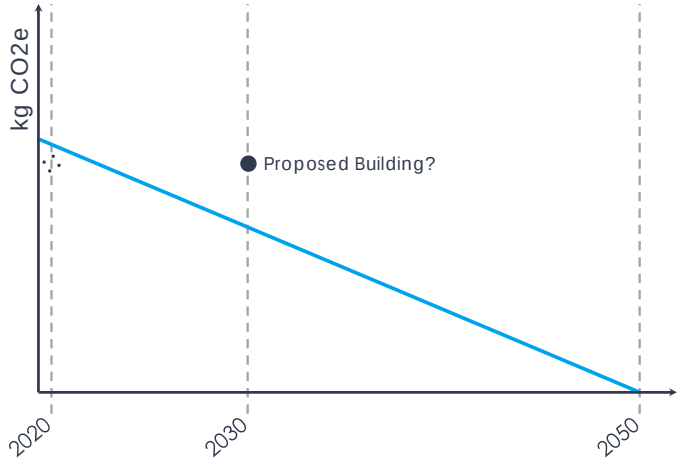
EMBODIED CARBON TARGETS



EMBODIED CARBON TARGETS (CONT.)

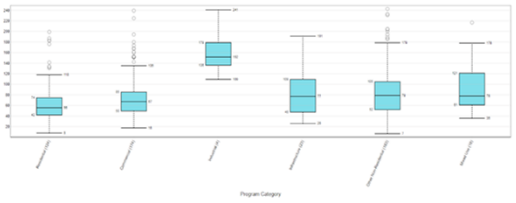


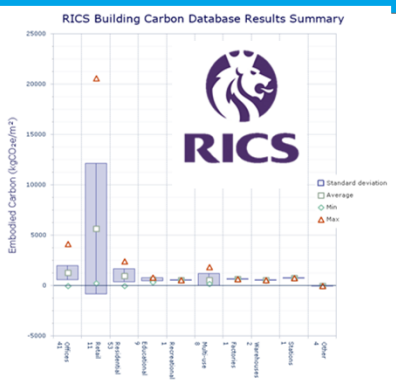
EMBODIED CARBON TARGETS (CONT.)



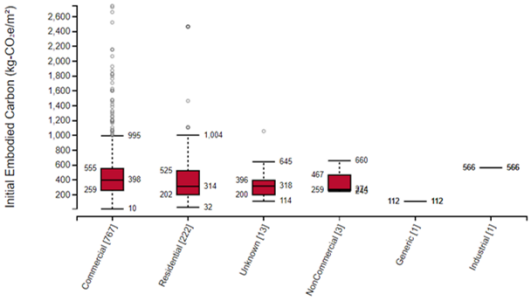
BETA DATABASE PRECEDENTS

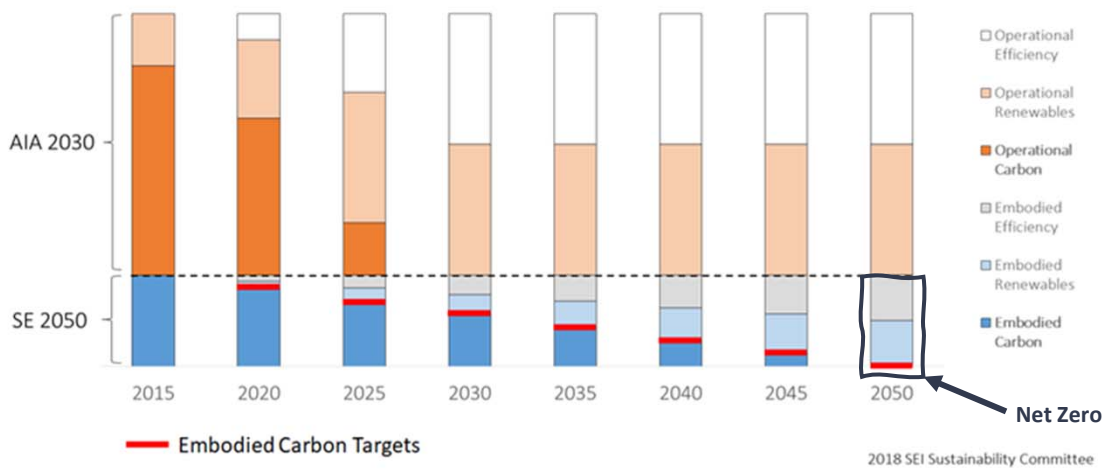
deQo





CLF Carbon Leadership Forum





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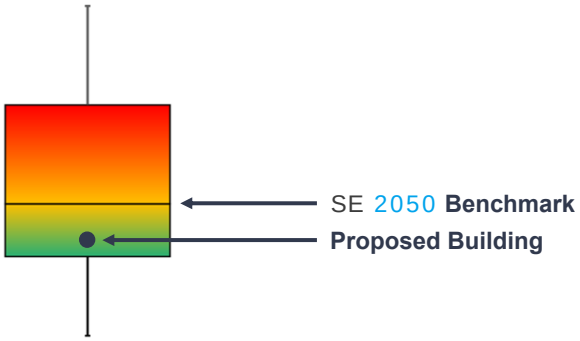
EMBODIED CARBON BENCHMARKS



SE 2050 BETA DATABASE

Priorities:

- Familiarize structural firms with embodied carbon reporting
- Collect GWP results at minimum
- Increase visibility of need for embodied carbon benchmarks

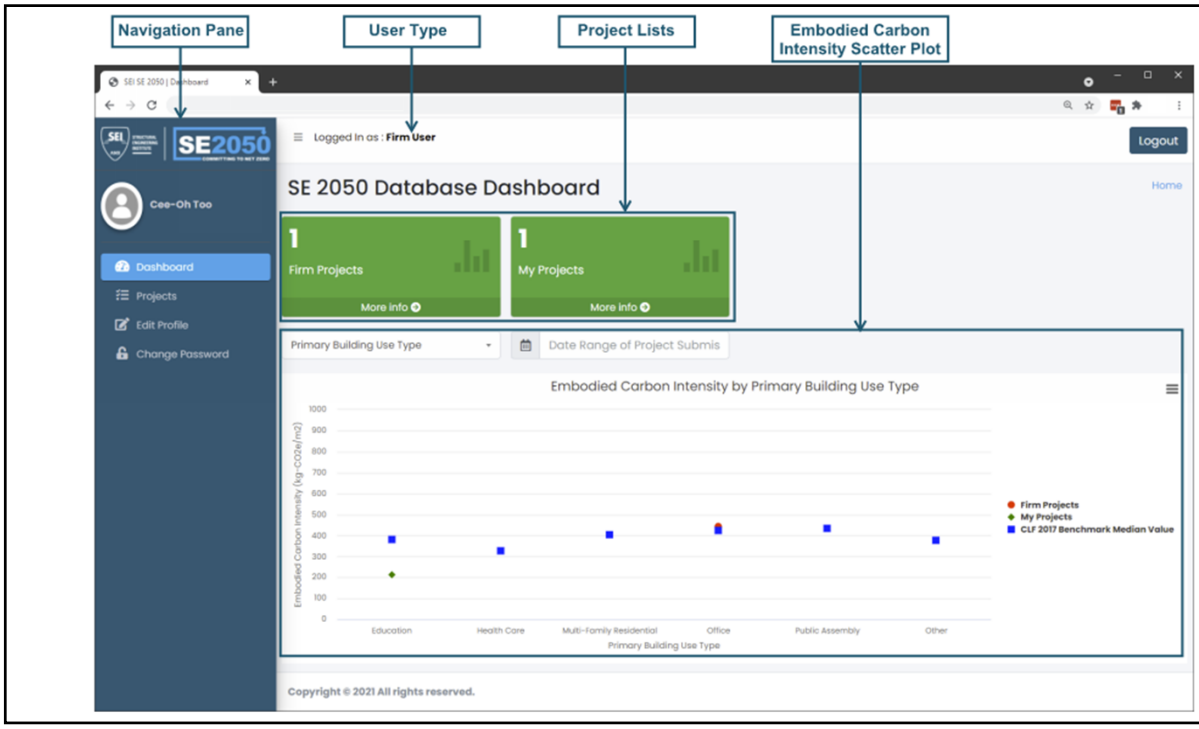
WHAT DATA IS COLLECTED?

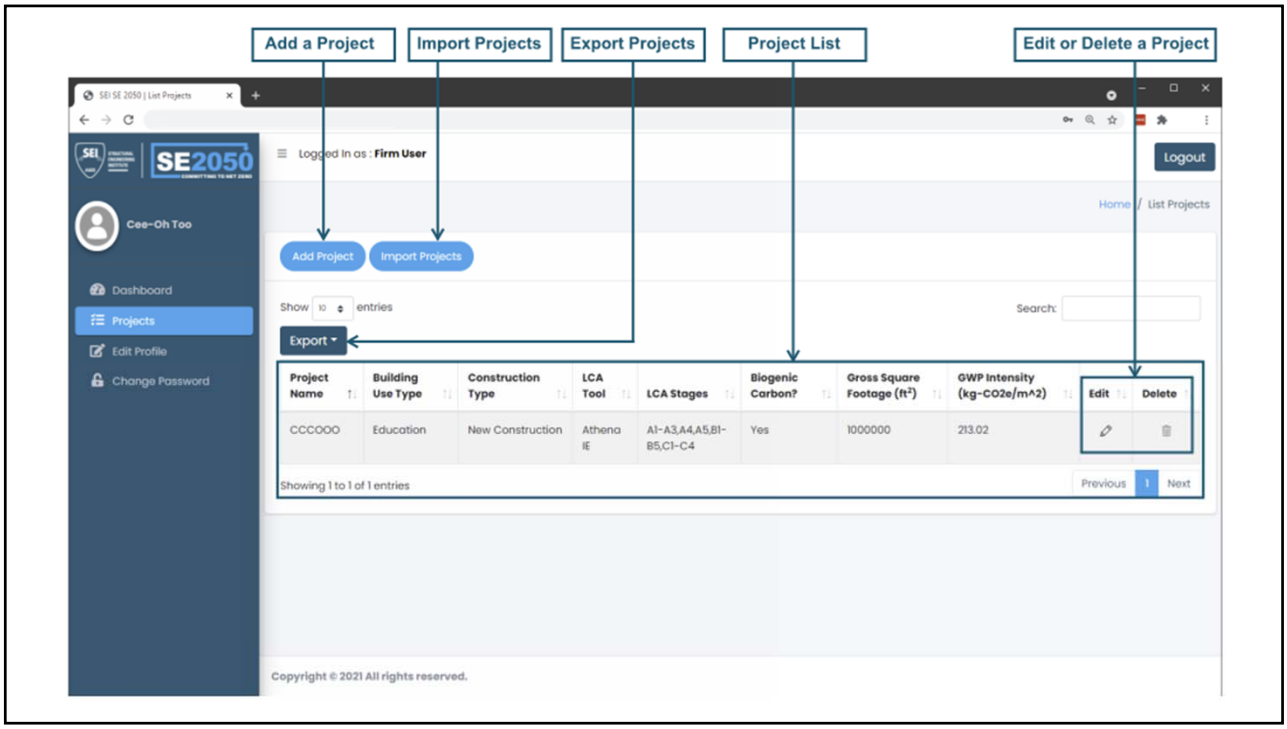
Structural System Descriptors, including:
- Risk category
- Seismic design category
- Typical floor live load
- Typical column grid
- Primary gravity, lateral systems
- Allowable bearing pressure

Project Descriptors, including:
- Building use type
- Project phase
- Expected building life
- Gross square footage

LCA Data, including:
- LCA tool used
- LCA stages included
- Biogenic carbon
- Components included
- GWP results

Embodied Carbon Intensity
kg-CO2e/m2





LCA/PRODUCT TOOLS AVAILABLE TO REPORT DATA

1. Life-Cycle Assessment (LCA) Tool
   - Utilizes a methodology to measure the environmental impacts of a building, product, or process over its full life cycle.
   - Measure beyond Product Stage (A1-A3). Stages included in LCA vary from product to product.
2. Product Tool
   - Limited scope
   - Typically measure Product Stage only (A1-A3)

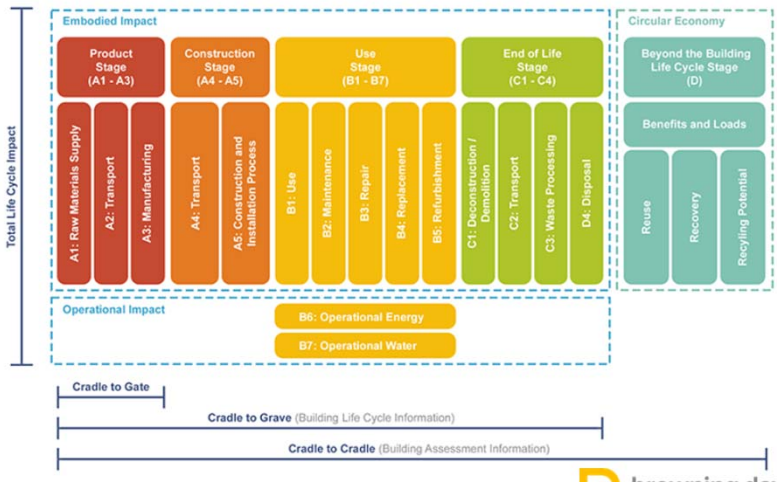


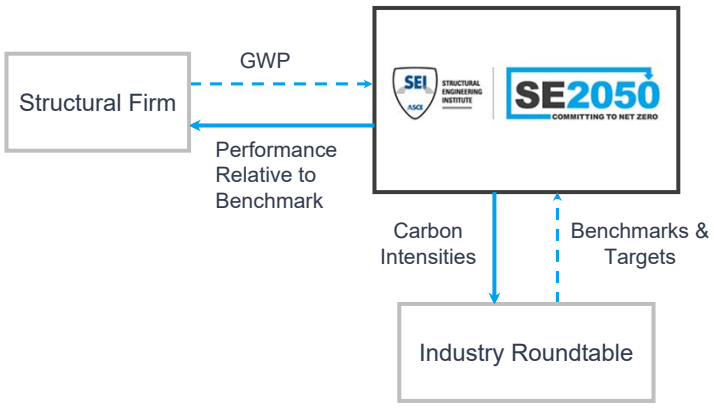
Image from browning day

LCA/PRODUCT TOOLS AVAILABLE TO REPORT DATA (CONT.)

Tool	LCA Phases Considered		Data Source			Metrics Considered		Revit Integration
	A1 - A3	*All*	*Industry Average EPDs*	*Product Specific EPDs*	*Generic Materials from EPDs & LCI Data*	*GWP Only*	*GWP & Other Environmental Impacts*	
Tally		X			X		X	X
Athena IE		X			X		X	
Beacon	X		X			X		X
ECOM	X		X			X		
The EC3 Tool	X		X	X		X		
One Click LCA		X			X		X	X

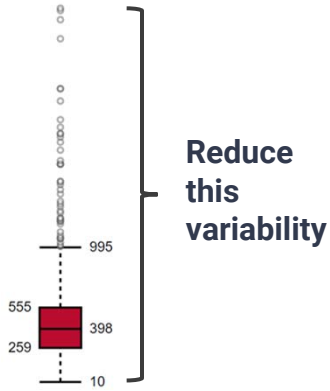
Table Abbreviations:
- EPD: Environmental Product Declaration
- GWP: Global Warming Potential
- LCA: Life Cycle Assessment
- LCI: Life Cycle Inventory

SE 2050 DATABASE: STAKEHOLDER INTERACTION

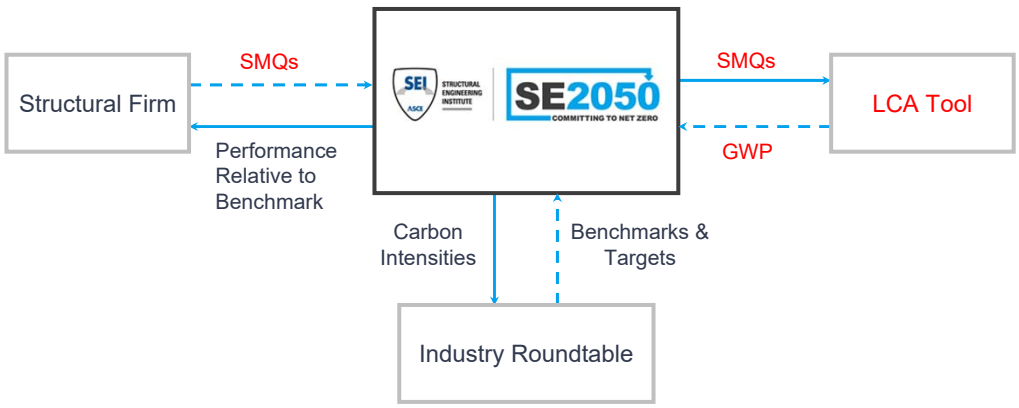


SE 2050 DATABASE: FUTURE?

- Collect structural material quantities ("SMQs")
- Focus on reducing data variability
- Establish industry benchmarks and targets using aggregated data



SE 2050 DATABASE: FUTURE?



TEST YOUR KNOWLEDGE:

A project has a total of 100 concrete trucks delivered to site.

The project has achieved a 20% carbon reduction in the concrete mix.

TEST YOUR KNOWLEDGE:

Approximately how many New York to Los Angeles flights would need to be avoided by one person in order to achieve the same carbon savings as the project?

A) 5 flights
B) 10 flights
C) 25 flights
D) 50 flights

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Approximately how many New York to Los Angeles flights would need to be avoided by one person in order to achieve the same carbon savings as the project?

A) 5 flights
B) 10 flights
C) 25 flights
D) 50 flights

RESOURCES

TWO-WAY STREET COMMITMENT

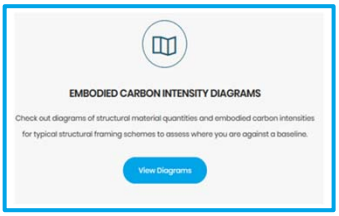
- Our ask *of* the Profession
- We Commit to Providing Resources and Support *to* the Profession

SE 2050 RESOURCES

Embodied Carbon

Structural Materials

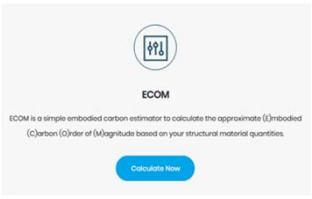
Strategies



Tools and Data

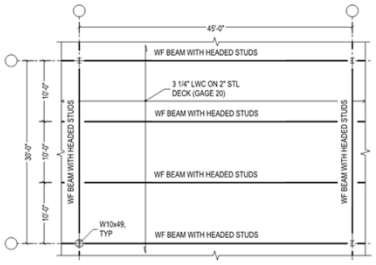
Case Studies

U.S. Green Rating Systems

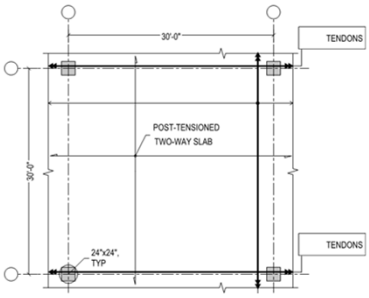


EMBODIED CARBON INTENSITY DIAGRAMS (ECID)

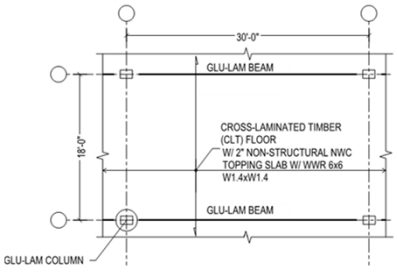
Intent: Start to establish fluency in EC metric



Steel

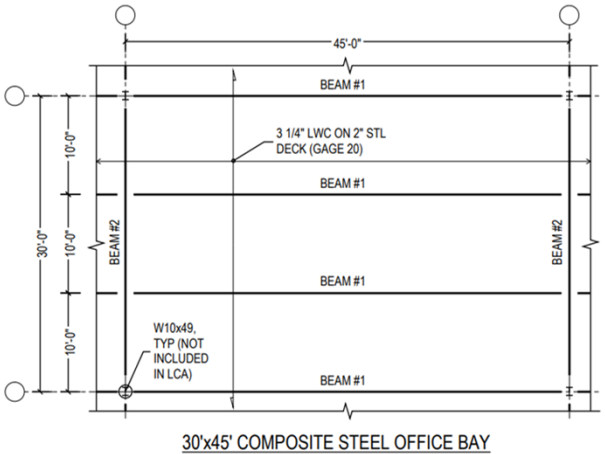


Concrete

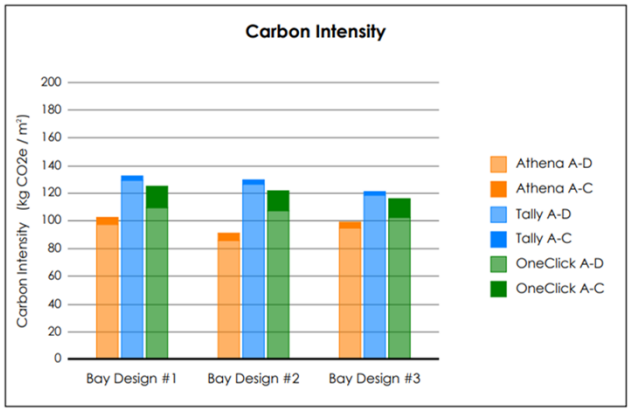


Timber

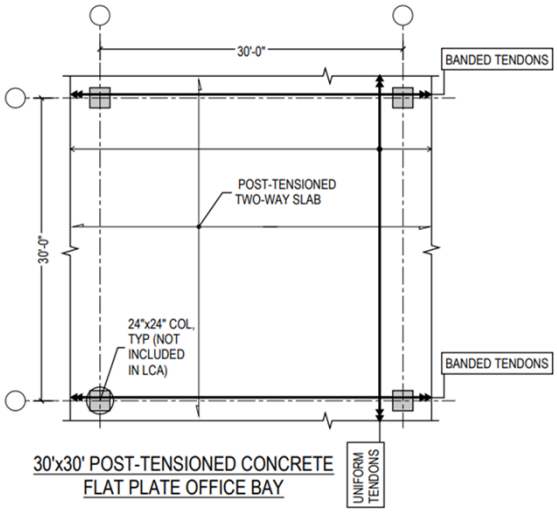
COMPOSITE STEEL OFFICE ECID



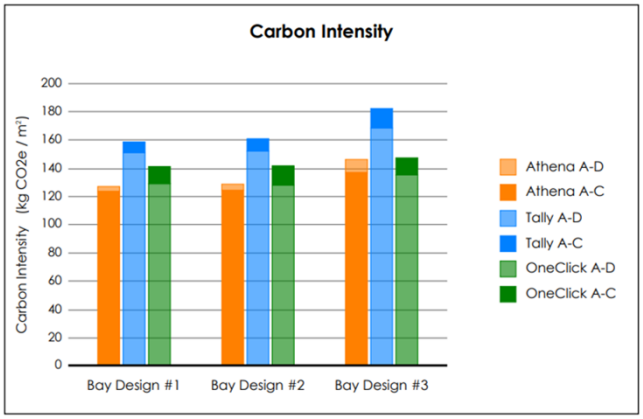
30'x45' COMPOSITE STEEL OFFICE BAY



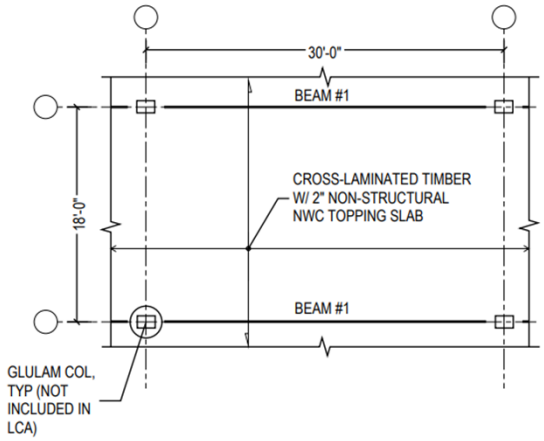
CONCRETE POST-TENSIONED FLAT PLATE OFFICE ECID



30'x30' POST-TENSIONED CONCRETE FLAT PLATE OFFICE BAY



MASS TIMBER (CLT) OFFICE ECID



18'x30' MASS TIMBER POST-AND-BEAM OFFICE BAY

INCLUDED IN LCA:

MASS TIMBER

(1) BEAM #1 *24F-V4 (DF) - 8.75"x31.5" TO 10.25"x30"*
CLT *V2 OR E1 (SPF) - 5-PLY (6.90") TO 7-PLY (7.56")*

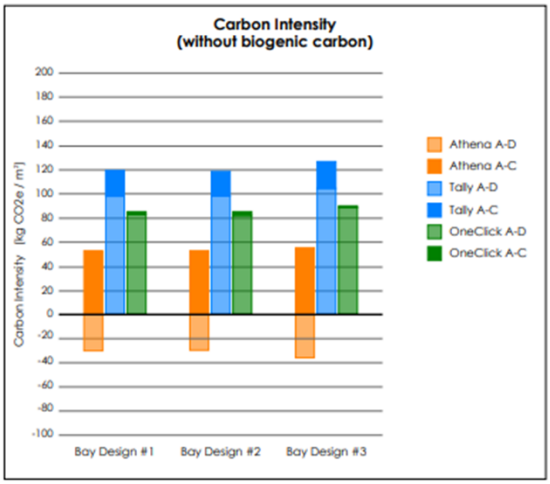
(1) STEEL BEAM-COL CONNECTION *125 TO 200 LBS*

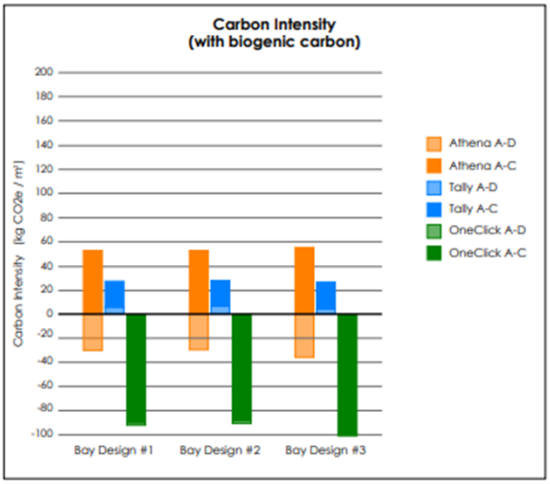
CONCRETE TOPPING

3,000 PSI NORMALWEIGHT, 20-29% SCMs

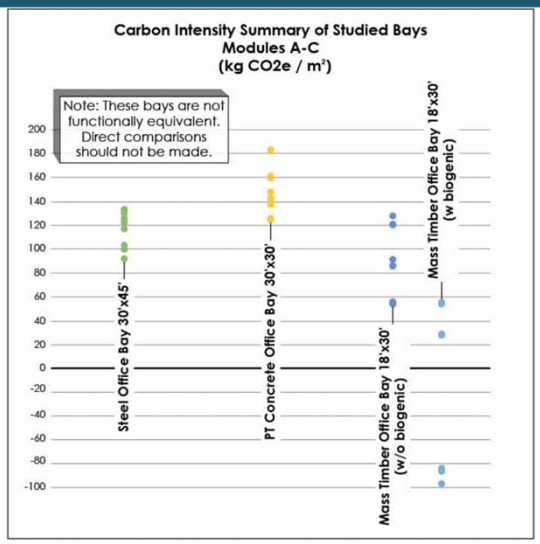
WWR 6x6 W1.4xW1.4

MASS TIMBER (CLT) OFFICE ECID (CONT.)





EMBODIED CARBON INTENSITY DIAGRAM SUMMARY

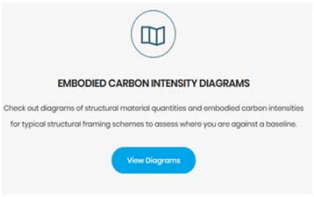


SE 2050 RESOURCES

Embodied Carbon

Structural Materials

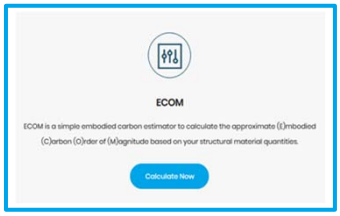
Strategies



Tools and Data

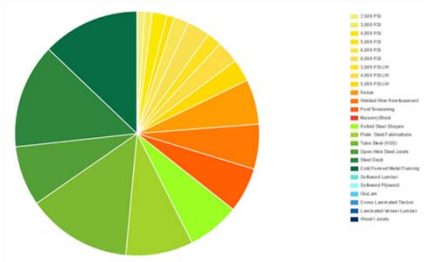
Case Studies

U.S. Green Rating Systems



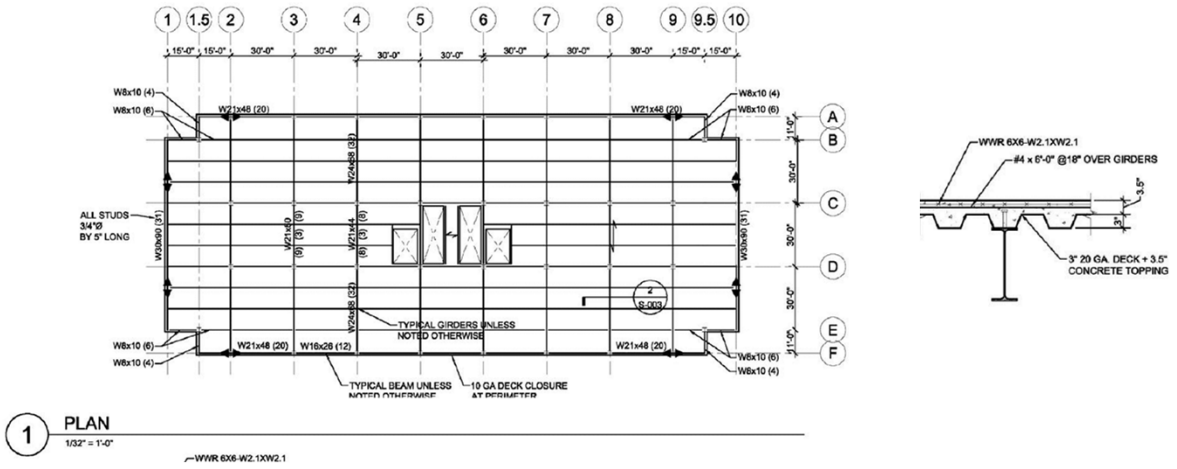
ECOM TOOL

- **E**mbodied **C**arbon **O**rder of **M**agnitude Tool
- A simple product tool that calculates global warming potential
- Designers can identify hot spots



https://se2050.org/ecom-tool/

EXAMPLE – FLOOR FRAMING



TEST YOUR KNOWLEDGE:

Estimate the embodied carbon (Phases A1 - A3) in the floor framing

- 3 Tons CO_2e
- 30 Tons CO_2e
- 300 Tons CO_2e
- 3,000 Tons CO_2e

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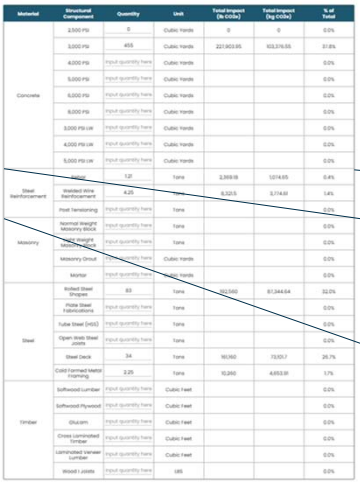
PROJECT'S MATERIAL QUANTITIES

Item	Quantity
3,500 Psi Concrete	455 Cubic Yards
Rebar	1.25 Tons
Metal Deck	34 Tons
Shear Studs	1 Ton
Welded Wire Reinforcement	4.25 Tons
Steel Shapes	83 Tons
Deck Closure	2.25 Tons

SE 2050 – ECOM - INPUT



Embodied Carbon Area	
Total Area (ft^2)	29,000
Total Area (m^2)	2,694.1

Steel Reinforcement	Rebar	1.21	Tons
	Welded Wire Reinfocement	4.25	Tons
	Post Tensioning	Input quantity here	Tons

TEST YOUR KNOWLEDGE:

Which assemblies are responsible for at least 25% of the embodied carbon in floor framing? (Choose all that apply)

- Steel Beams
- Steel Deck
- Rebar
- Concrete

TEST YOUR KNOWLEDGE:

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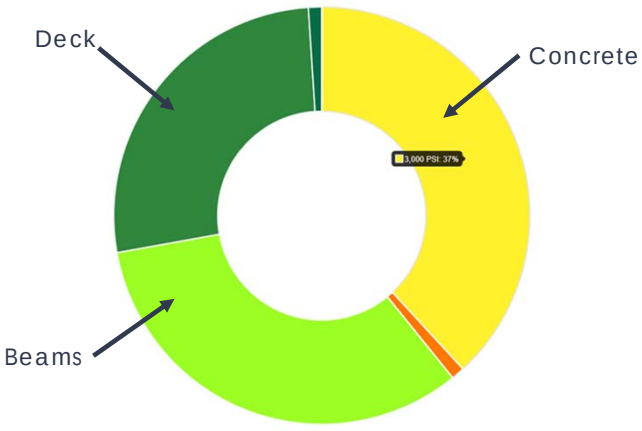
SE 2050 – ECOM OUTPUT



Embodied Carbon Totals	
Total Impact (lb CO_2e)	602,573
Total Impact (kg CO_2e)	273,322

Embodied Carbon Intensities	
Intensity (lb CO_2e/ ft²)	20.78
Intensity (kg CO_2e/ m²)	101.45

TEST YOUR KNOWLEDGE - CONTEXT

The embodied carbon in the floor is roughly equivalent to driving….

- >500 Miles?
- >5,000 Miles?
- >50,000 Miles?
- >500,000 Miles?

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FUTURE SE 2050 RESOURCES

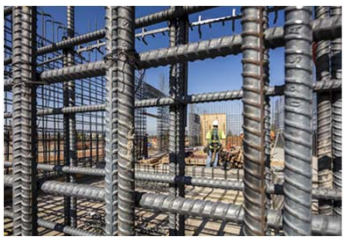
In Development:

- Case Studies of Structural System WBLCAs Using LCA Tools for Designers
- Updates to ECOM
- LCA Guidelines for Structural Engineers
- More Embodied Carbon Intensity Diagrams!

EMBODIED CARBON REDUCTION STRATEGIES

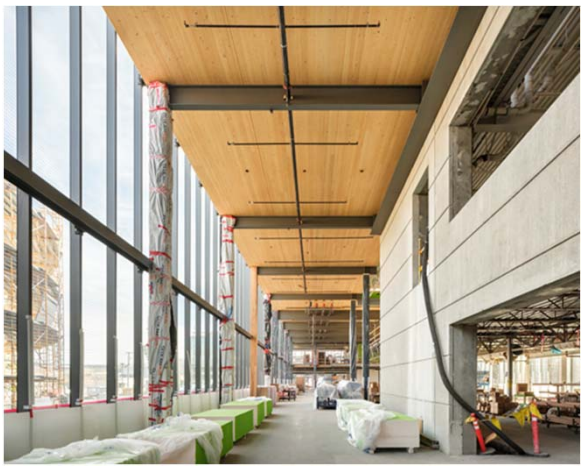
REDUCTION STRATEGIES FOR ALL MATERIALS & DESIGNS

- Update Specifications and General Notes
- Ask Suppliers to Provide EPDs
- Be Material Efficient
  - Use Less!
  - Voided slabs, castellated beams, composite construction etc.
  - High Strength Materials



REDUCTION STRATEGIES FOR ALL MATERIALS & DESIGNS (CONT.)

- Re-use
- Design for Deconstruction
- Design for Adaptability
- Consider Resilience
- Start with Geometry



REDUCTION STRATEGIES - MATERIAL SPECIFIC

Steel

- Consider Thermal Bridging
- Specify Recycled Steel Sections and Sections from EAF vs. BOF

Concrete

- Performance Based Specifications
- Specify Cement Replacement
- Consider including GWP limits

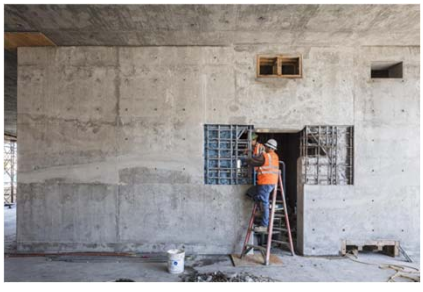
Wood

- Advanced Framing Techniques
- Utilize Mass Timber in lieu of Concrete or Steel

DESIGN NUANCES

Transfer Beam

LOCATION	MIN. STRENGTH @ 28 DAYS PSI	MAX. AGGREGATE SIZE INCHES	MAX. SLUMP INCHES	MIN. REQUIRED CEMENT REPLACEMENT	MAX. WEIGHT PCF
FOUNDATION	SEE NOTE 1	1-1/2	6	50%	150
MISC., CURBS, PADS	4000	-	6	30%	150
OFFICE BUILDING SHEAR WALLS	SEE NOTE 3	3/4	SEE NOTE 2	30%	150
GARAGE SHEAR WALLS	SEE NOTE 4	3/4	6	30%	150
SITE WALLS	4000	1-1/2	6	30%	150
FLOOR SLABS, BEAMS, CRASH WALLS	6000	3/4	6	20%	150
CONC. OVER MTL. DECK	4000	1/2	6	30%	120
COLUMNS	6000	3/4	SEE NOTE 2	30%	150



Concrete Mixes

Are you ready to join the movement?

https://se2050.org/sign-up/

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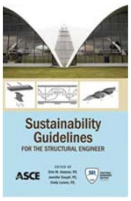
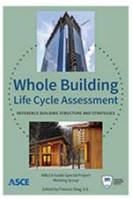
WHAT CAN I DO?

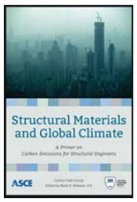
- Have your firm join the SE 2050 Commitment Program
- Educate yourself on embodied carbon, reduction strategies, and LCAs
- Ask to be included in a project's sustainability meetings and design charrettes
- When writing a proposal, ask if any fee should be included for LCAs or attendance at sustainability charrettes
- If a project is targeting a green rating system certification, encourage the client or architect to pursue credits regarding embodied carbon measuring and reductions
- Employ embodied carbon reduction strategies on projects
- Advocate within industry and to your clients!

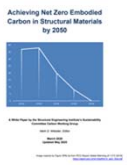
RESOURCES

- Reference Materials:
  - "Sustainability Guidelines for the Structural Engineer"
  - "Whole Building Life Cycle Assessment – Reference Building Structure and Strategies"
  - "Structural Materials and Global Climate"
  - "Achieving Net Zero Embodied Carbon in Structural Materials by 2050"
- Web Resources:
  - www.SE2050.org
  - www.seisustainability.org
  - https://carbonleadershipforum.org/









QUESTIONS?

SEI STRUCTURAL ENGINEERING INSTITUTE ASCE

SE2050 COMMITTING TO NET ZERO

THANK YOU!