



STRUCTURAL  
ENGINEERING  
INSTITUTE



# EMBODIED CARBON ACTION PLAN

2023



## Background

In the past year, Linchpin Structural Engineering, Inc. (Linchpin) made steps with the SE 2050 Program's collaborative effort of understanding our industry's impact on the environment. In our 2022 inaugural Embodied Carbon Action Plan (ECAP), we laid out a series of long- and short-term goals and a defined action plan to meet them. Our goals and efforts were focused in four main categories: Education, Reporting, Reduction, and Advocacy. In this report, we will reflect on our efforts toward our goals in each of those categories in the past year. By drawing on lessons learned for our first year, we will also present new goals for 2023 and our plans to achieve them.

This document does not provide overall background information on the SE2050 initiative or the basics of embodied carbon - for more comprehensive background information, please refer to Linchpin's inaugural 2022 ECAP, which provides significantly more detail.

## Education

In our first year of participation in the SE 2050 initiative, a great deal of our time and effort was spent in the pursuit of self-education in a number of areas. Linchpin's Sustainability Committee attended multiple webinars about embodied carbon, researched specification options for performance-based options, read scholarly articles regarding various approaches to sustainability, and attended a conference on sustainability in concrete construction put on by the Rocky Mountain ACI chapter.

Reflecting on our first year education initiatives, we were successful in three of the four initiatives that we set out to accomplish. Our first ECAP was developed and submitted to SE 2050, distributed within the firm, and made available on our company website. We created a resource library containing embodied carbon resources, which is available to all company employees. The webinar "Embodied Carbon 101" was presented at one of our company-wide monthly staff meetings. However, the goal of obtaining LEED accreditation for our Sustainability Committee members has not yet been achieved. While not all of our initiatives were realized, we feel a lot was learned in our first year and are in a good position to accomplish our revised education initiatives for the coming year.

### ***Current Education Initiatives:***

- Once our embodied carbon calculator has been tested and standardized, we will educate all designers in our firm on its use and on best modeling practices in Revit to ensure accurate takeoffs and GWP data.
- Updated Linchpin's employees on our accomplishments and status of last year's goals.
- Present a webinar focused on embodied carbon at one of our company-wide monthly staff meetings.
- Onboarding process for new employees will include embodied carbon education.
- Continued pursuit of LEED Green Associate status for the Sustainability Committee members.



## Reporting

Reporting was arguably our most successful area of progress in the past year; our sustainability committee developed a specialized, detailed embodied carbon calculation spreadsheet and initiated workflows to allow seamless linking between Revit model takeoffs and the spreadsheet. With a few basic schedule entries, our spreadsheet provides a complete embodied carbon summary of the modeled elements including graphical breakdowns of contributing building elements and comparative data to ground the data in a tangible way to our design team as well as our clients. See the *Advocacy* section of this report for an example of this data output.

We successfully used this spreadsheet to complete our required project reporting for SE 2050, as well as for select other projects for internal comparison. In the coming year, it is our goal to finalize the Revit scheduling and materials standardization required to make our calculator easily utilized by all designers on every project. This will allow us to begin building an internal company database of GWP of our projects, and identifying areas for potential improvement/reduction.

SE 2050 provides a web-based interface for reporting project data. Where project data is then summarized by building use type and embodied carbon intensity ( $\text{kg-CO}_2\text{e/m}^2$ ) in a graph on the site's dashboard. The graph shows data reported by all of the signatory firms. With having no real benchmark in our first year, we were excited to see that the projects we submitted fell at or below the average embodied carbon intensity of all the reported projects. Figure 1 presents the collective data; our projects are indicated by the green circle.

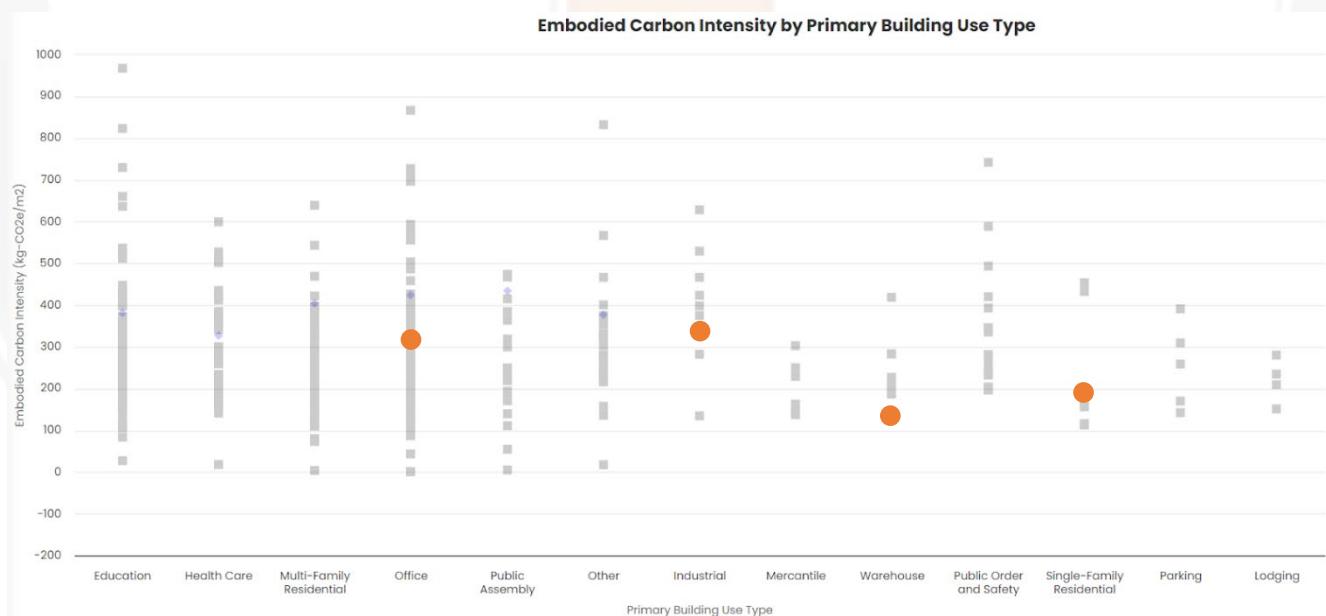


Figure 1: Resultant Embodied Carbon for project submitted by firms in the SE 2050 Commitment (Linchpin in Orange).

### **Current Reporting Initiatives:**

- Continue developing and standardizing Revit material libraries and schedule/takeoff system to allow for quick, seamless carbon takeoffs as a standard part of our design process.

- Integrate our GWP calculator into the company design template and encourage its use, with the long-term goal of making it required for all projects.
- Begin development of a GWP reporting widget to be included on the cover sheet of each project that shows the basic embodied carbon data for the structure. In the longer term, this widget will be standard in our project template for use as a tool in educating our clients and industry partners about these issues.
- Submit embodied carbon data for (4) projects to the SE 2050 database.

## Reduction

Reduction was our least successful undertaking for the first year of our program. A combination of workload, lack of education, and limited resources contributed to our not achieving most of our first year initiatives. We were unable to connect with industry partners in the concrete sector to review options for sustainable concrete specifications, and while we generally gained an understanding of the worst offenders in our designs from an embodied carbon perspective (concrete and cold-formed steel), we did not progress as much as desired in altering our specifications and designs to target those areas. However, we were able to incorporate CLT in one of our designs and gained experience and clarity that will allow us to more readily work with it on future projects. We also participated in the design of a LEED project, although our involvement in the LEED aspects of the design process was limited.

In spite of these roadblocks in our first year, we feel that we are now better equipped to advance some of our proposed initiatives, with a clearer roadmap forward with some concrete steps much closer to realization than they were previously. We now have an established contact in the concrete industry willing to work with us on creating efficient, performance based specifications and beginning to introduce EPD requirements. We have begun revising our concrete specifications to promote performance-based design and provide introductory GWP benchmarks for reference and discussion:

CONCRETE MIX DESIGN TABLE

STRUCTURAL COMPONENT	f <sub>c</sub> (PSI) DESIGN 2500 f <sub>c</sub> (PSI)	EXPOSURE CLASS	MAX. W/C RATIO	MAX. AGG. SIZE (IN)	NOTES	ENTRAINED AIR (%)	RECOMMENDED SCM CONTENT (NOTE 1)		TARGET GWP (KG CO <sub>2</sub> e/YD <sup>3</sup> ) (NOTE 6)
							MAX	MIN	
BASEMENT, RETAINING, AND STEM WALLS	4500 at 28 DAYS	F2	0.45	3/4		6.0	70%	40%	300
FOUNDATIONS	4500 at 28 DAYS	F2	0.45	3/4		6.0	70%	40%	300
SLAB ON GRADE	3500 at 28 DAYS	-	-	3/4	2		70%	40%	250
COLUMNS AND SHEAR WALLS U.N.O.	4000 at 28 DAYS	-	-	3/8			50%	35%	270
CONCRETE OVER METAL DECK	3000 at 28 DAYS	-	-	3/4			50%	15%	230
MILD REINFORCED BEAMS & SLABS	4000 at 28 DAYS	-	-	3/4			50%	15%	270
POST-TENSIONED BEAMS	6000 at 28 DAYS	-	-	3/4			50%	15%	350
POST-TENSIONED SLABS	3000 at STRESSING 5000 at 28 DAYS	-	-	3/4	5		50%	15%	330
TILT-UP WALL PANELS	4500 at 28 DAYS	F1	0.55	3/4	4	5.0	50%	35%	300
ALL OTHER CONCRETE	4000 at 28 DAYS	-	-	3/4			70%	40%	270

Figure 2: Linchpin's updated concrete specification, to be implemented this year

This new specification calls out maximum water/cement ratios only as mandated by code and provides benchmark values and ranges for SCM content and GWP, with the intent of making these guidelines into requirements over time. The goal in providing these modifications is to allow for more efficient, performance-based concrete mix designs and to begin slowly incorporating sustainability language to foment discussion with suppliers on feasible carbon reduction approaches.

We are also working on several projects that are rehabilitations of existing buildings, including a large public service building and a multi-building public market, which we have strongly advocated for as an alternative to new construction. We hope to pursue more of these projects to emphasize the importance of sustainable reuse of existing infrastructure.

#### ***Current Reduction Initiatives:***

- Update concrete specification to performance-based design and explore options of replacing Portland Cementitious materials with equivalent supplementary materials (such as fly ash and other natural pozzolans).
- Update all materials specifications to request (but not require, yet) Environmental Product Declarations (EDPs) from manufacturers, fabricators, and suppliers, to begin the conversation regarding material impacts and lower-carbon options.
- Aim to specify partially grouted CMU walls when appropriate to reduce material and improve design efficiency.
- Work with concrete suppliers to understand their capacity to provide concrete mixes designed to reduce embodied carbon and familiarize ourselves with the Environmental Product Declarations of manufacturers. Collaborate to develop a sample design that meets the NRMCA baseline.
- When possible, make an effort to specify wood construction to take advantage of carbon sequestration.
- Seek out and participate in a LEED project design, particularly in the early stages of design collaboration.
- Continue developing and standardizing Revit material libraries and schedule/takeoff system to allow for quick, seamless carbon takeoffs as a standard part of our design process. This will allow us to establish trends and focus our reduction efforts.

## **Advocacy**

Our first year of SE2050 advocacy was largely focused on internal firm knowledge sharing and program establishment. We established an internal sustainability committee to focus our efforts on sustainability initiatives, to lead education efforts, and to collaboratively seek creative solutions. We added the SE2050 logo to our website and included it in social media postings. We also developed standard explanatory language that is now included in all our proposals to educate our clients about these efforts and attempt to foster conversations about sustainability options for projects:

“Linchpin is a signatory to the SE2050 agreement, an effort to address the negative environmental impacts associated with structures and their construction and eliminate embodied carbon in our designs by the year 2050. To that end, we will be modifying our structural engineering approach over time to adopt new specifications and design mechanisms aimed at reducing the carbon emissions associated with our designs. There is no impact on the project fees for this endeavor, and we will work with the project team to help mitigate any construction cost impacts and ensure understanding of the design intent. Feel free to reach out to Linchpin with questions about this effort or visit [SE2050.org](https://SE2050.org).”

While our committee members did not attain LEED accreditation in the first year, it remains a priority goal for the next. We have developed a knowledge base that will allow us to more effectively communicate with industry partners, clients, and local jurisdictions to continue promoting the discussion and consideration of sustainability issues as part of the project design and construction process. We are committed to widening our reach in the coming year and pushing for real change in the design approach we take with our clients and in the industry.

We have developed a preliminary output for our Embodied Carbon Analysis tool that provides comparative and graphical data regarding the analysis for each project, an example of which is shown in Figures 3 and 4.

TOTAL IMPACT		INTENSITY	
219,084	lb CO2e	39.5	lb CO2e/ft <sup>2</sup>
99,403	kg CO2e	192.9	kg CO2e/m <sup>2</sup>
The emissions from the structural materials used on this project are equal to:			
21.4	Passenger vehicles driven for one year		
73.8	Round Trip flights between NYC and LA		
19.3	Single-family homes powered for one year		
12,093,429	Smartphones charged		
Offsetting these emissions would require:			
1,643	Tree seedlings planted today and grown for 10 years		
117.6	Acres of forestland preserved for 1 year		

Figure 3: Resultant carbon emissions from one of Linchpin’s 2022 projects.

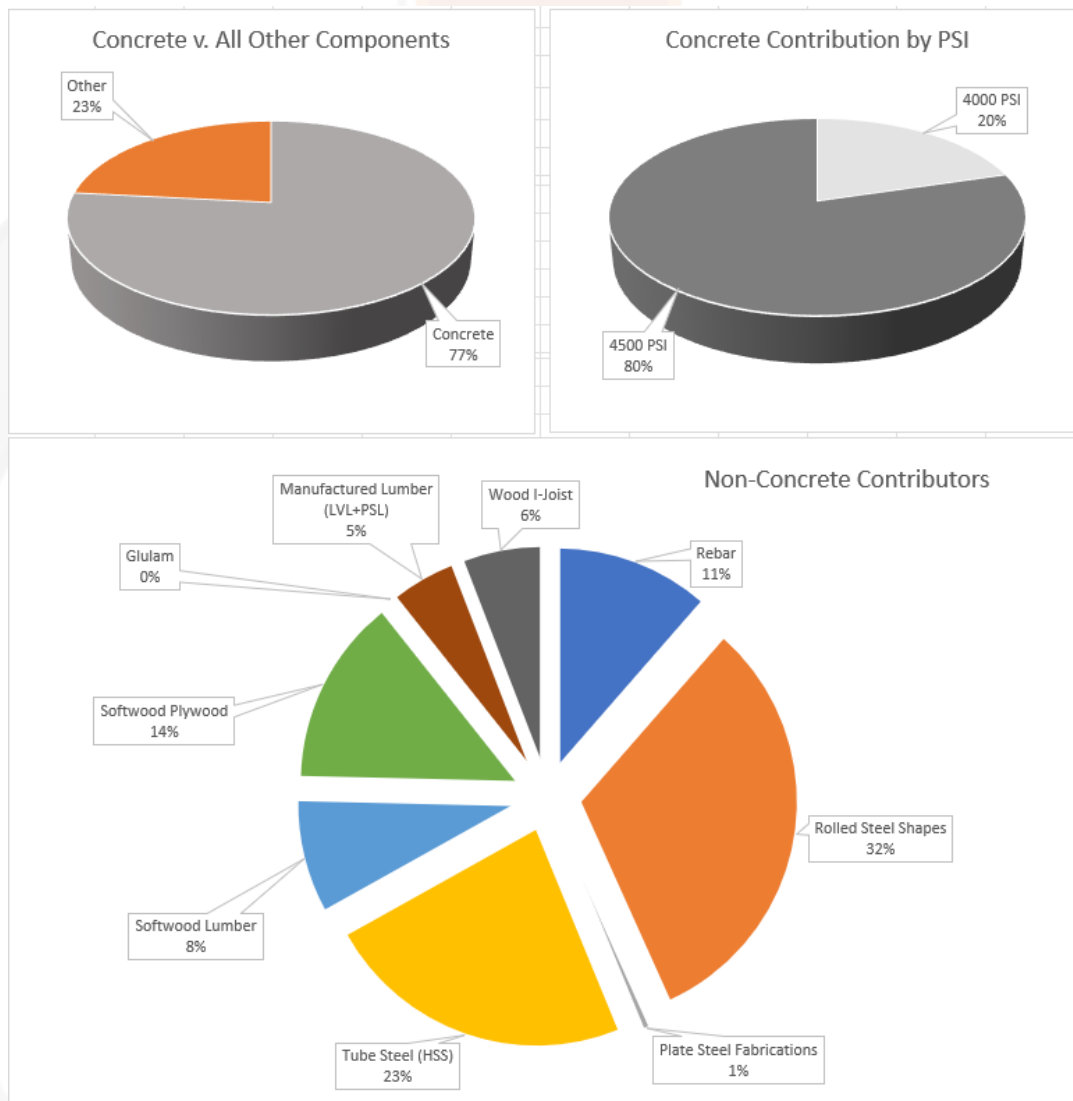


Figure 4: Contributing carbon emissions by construction material type from one of Linchpin's 2022 projects.

While this tool still needs refining and formatting, it is our goal to begin including it in our project deliverables this year as a tool to educate our clients and industry partners and facilitate conversations about reduction options.

Additionally, we have established relationships with several clients who have indicated an interest in pursuing sustainability on project, and we will continue to develop those relationships and seek out projects that allow for and encourage creativity in sustainable solutions. Included in those relationships are multiple architectural firms with a stated focus on sustainable building design, from whom we have already learned a great deal about alternative materials and detailing. We look forward to continuing to discuss and share new ideas to reduce the carbon impact of our future designs, and the opportunity to utilize those new solutions on other projects beyond those with these specific partners.

### ***Current Advocacy Initiatives:***

- Collaborate with project design teams to implement designs to reduce embodied carbon and pursue LEED projects, as we educate our team on sustainable design solutions.
- Continue reaching out to area materials suppliers to open avenues of conversation about lower-carbon material options and EPDs.
- Seek opportunities to discuss sustainability requirements with the local government and lobby for basic benchmark requirements like EPD mandates.
- Develop a template for including our embodied carbon analysis results in the deliverable package for each project, with benchmark data comparisons to illustrate the relative impact of the project. This will serve to educate our clients about the importance of sustainability work on future projects.

## **Conclusion**

Reflecting on our SE 2050 initiatives within the past year, we feel that we are progressing in most areas with varying degrees of success. We feel confident that we are gaining the knowledge and resources required to make real progress on our goals and begin implementing design changes that will markedly improve our embodied carbon outlook. We look forward to the coming year's initiatives and are motivated to continue striving for sustainability excellence!