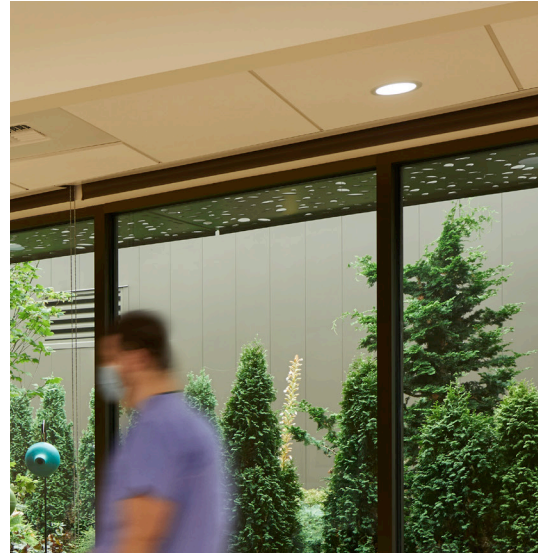




*Connected Teams.
Bold Solutions.*



**PCS Structural
Solutions'
Embodied Carbon
Action Plan (ECAP)**

Published May 2021





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May 28, 2021

Structural Engineering Institute
American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 20191

RE: *SEI SE 2050 Embodied Carbon Action Plan*

As a single-discipline structural engineering firm, PCS Structural *Solutions* understands the impact that our structural systems have on the environment—both now and for future generations. We recognize the importance of measuring and tracking structural embodied carbon at a national level, setting benchmarks, and working towards future carbon reduction levels. By offering sustainable project solutions, educating staff and clients, and actively participating in national programs, PCS Structural *Solutions* will join other structural engineering firms around the nation in making progress towards our collective goal of net-zero embodied carbon by 2050.

The following document is PCS Structural *Solutions'* Embodied Carbon Action Plan (ECAP) outlining our internal and external commitments for 2021. These commitments will be the launching point for PCS to further efforts towards net-zero embodied carbon by 2050. For the first couple of years, PCS's ECAP will heavily focus on educating our staff and clients on embodied carbon. Internally, we will elevate our knowledge about embodied carbon, how we measure it, and what strategies exist to reduce it. This education will allow PCS to adequately measure carbon on our projects for our clients and the SEI SE 2050 Challenge. Externally, we will teach our clients what embodied carbon is and how structural engineers play a pivotal role in its measurement and reduction. This will help solidify structural engineers' critical role in sustainability and mitigating embodied carbon within the architecture, engineering, and construction community.

A strong beginning will be crucial as PCS Structural *Solutions* embarks on the journey towards net-zero embodied carbon by 2050. Along the path, PCS will share accomplishments and lessons learned regarding education, measurement, reduction strategies, and advocacy to aid in the development of future ECAPs.

Sincerely,

PCS STRUCTURAL *SOLUTIONS* Board of Directors

- Brian Phair, SE, CEO / Managing Principal
- Craig Stauffer, SE, President / Managing Principal
- Jason Collins, SE, Principal
- Todd Parke, SE, Associate Principal
- Don Scott, SE, Senior Principal
- Jeff Klein, SE, Principal
- Ted Ryan, SE, Associate Principal



Education

PCS Structural *Solutions* understands that the key to making meaningful and impactful reductions in structural embodied carbon starts with a strong, formal educational program for our staff. Sustainability and embodied carbon are typically not taught within the civil engineering university curriculum. Therefore, PCS acknowledges that we must start with the basics and work towards advanced and nuanced topics about embodied carbon reduction strategies and measurements.

PCS's internal education program will begin by introducing our staff to the subject of sustainability in structural engineering. Over time, the program will continue to develop the staff's knowledge and skills to a practicing level. Additionally, as the understanding and science of sustainability evolve, the program will keep staff updated with the latest knowledge and practices. Through the robust and continuing educational program, PCS can equip our employees with the necessary expertise and tools in sustainability to dramatically impact our company's and client's goals to reduce embodied carbon.

ECAP Educational Commitments and Goals

Commitment 1: Distribute a firm-wide announcement of PCS pledging to join the SEI SE 2050 Commitment.

- Status at time of ECAP Publication: **Complete**
 - » Shortly after PCS's commitment to the program, social media posts were created and an internal email was sent to all staff announcing PCS's commitment to SEI SE 2050. See Figure 1 and Figure 2 in the Appendix for PCS's internal and external announcements.

Commitment 2: Provide a brief narrative describing how PCS promotes a firm-wide education program for embodied carbon reduction and the firm's commitment to SEI SE 2050.

- Status at time of ECAP Publication: **Complete**
 - » Promotion of a firm-wide embodied carbon reduction education program will come from PCS's internal sustainability team. The team will select external webinars and produce presentations, white papers, and guidance documents relating to embodied carbon reductions in structural engineering. These webinars, presentations, and documents will be announced and available to the entire company.

Commitment 3: Nominate an Embodied Carbon Reduction Champion for PCS.

- Status at time of ECAP Publication: **Complete**
 - » Chris Jeseritz, located within PCS's Seattle office, was nominated as the embodied carbon reduction champion for PCS.

Commitment 4: Set a date within the first year of PCS's commitment to present an "Embodied Carbon 101" webinar.

- Status at time of ECAP Publication: **Complete**
 - » PCS's internal sustainability team developed an Embodied Carbon 101 presentation for the entire



ECAP Educational Commitments and Goals, continued

company and presented it on the 22nd of April 2021. The presentation defined key terms, including embodied carbon and operational carbon, the method and tools available to measure embodied carbon, and discussed strategies to reduce embodied carbon by material and system type. See Figure 3 in the Appendix for a few slides taken from the presentation.

Commitment 5: Share the “Top 10 Things Every Structural Engineer Should Know about Embodied Carbon” with all structural engineers within PCS.

- Status at time of ECAP Publication: **Complete**
 - » PCS’s internal sustainability team shared the “Top 10 Things Every Structural Engineer Should Know about Embodied Carbon” before our internal “Embodied Carbon 101” webinar on the 22nd of April 2021. See Figure 4 in the Appendix for the email sent out to the company sharing and encouraging employees to read the top ten list.

Commitment 6: Have one firm representative attend quarterly external educational programs provided by SEI SE 2050, the Carbon Leadership Forum, and/or local Structural Engineering Association’s Sustainability Committee.

- Status at time of ECAP Publication: **In progress**
 - » Currently, PCS has a couple of employees attending and actively involved with external educational programs provided by SEI SE 2050, the SEI Sustainability Committee, the Carbon Leadership Forum, and the Structural Engineering Association’s Sustainability Committee.

Commitment 7: Present the document “How to Calculate Embodied Carbon” to PCS’s internal sustainability team.

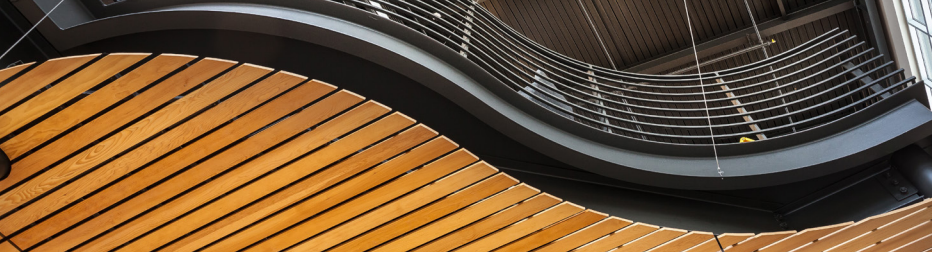
- Status at time of ECAP Publication: **Not complete**
 - » The document “How to Calculate Embodied Carbon” will be presented at one of PCS’s internal sustainability team meetings during 2021.

Commitment 8: Attend a presentation or demo of an LCA-based tool used to calculate embodied carbon.

- Status at time of ECAP Publication: **Not complete**
 - » PCS plans to focus on educating a select few individuals from each office through available literature, attending presentations/demos, and hands-on training to learn our company’s LCA program of choice, Tally.

Commitment 9: Initiate an embodied carbon interest group within your firm and provide a narrative of their goals.

- Status at time of ECAP Publication: **Complete**
 - » During the end of 2020, PCS formally created an internal sustainability team and opened enrollment to the entire company. The group will share the latest news, research, and information about embodied carbon and sustainability. The team will also coordinate internal presentations and produce guidance documents for all of PCS’s structural engineers.



ECAP Educational Commitments and Goals, continued

Commitment 10: Provide a narrative of how the Embodied Carbon Reduction Champion will engage embodied carbon reduction at each office. (Intended for multi-office firms).

- Status at time of ECAP Publication: **Complete**
 - » The embodied carbon reduction champion will engage and aid with embodied carbon reductions at each PCS office through members of the company's internal sustainability team. At least one team member will represent each office and learn about new developments and studies in embodied carbon reduction through the team's meetings, discussions, and research. The team members will share knowledge obtained from the sustainability team with other employees at each office. For complex or difficult inquiries about reducing embodied carbon, a team member can bring the question to the entire group to decide on the best answer.

Reporting

PCS Structural Solutions will follow the life-cycle analysis (LCA) methodology provided by the latest version of ISO 14040 and ISO 14044. At a minimum, the LCA scope we will analyze for all projects is Cradle to Grave (EN 15978 life-cycle phases A to C).

PCS will be calculating embodied carbon for structural materials using the Autodesk Revit application, Tally. This application was selected since most of the EN 15978's LCA phases A-D are included in the analysis, material quantities can be extracted directly from Revit during different design phases, and it allows PCS to collaborate with our clients using Tally. The database in Tally offers industry-wide and manufacturer-specific Environmental Product Declarations (EPDs). The life-cycle inventory (LCI)/LCA data in Tally is provided by the US Life Cycle Inventory Database, GaBi, and ASTM EPDs.

During the design phases, we will extract material quantities through the Revit model using Tally. We plan on extracting these quantities during the key milestone phases of the project, including Schematic Design, Design Development, and Permit. During construction, we'll transition to material quantities supplied by the contractor.

ECAP Reporting Commitments and Goals

Commitment 1: Provide a narrative on how your firm plans to measure, track, and report embodied carbon data.

- Status at time of ECAP Publication: **Complete**
 - » Task completed above under *Reporting*.

Commitment 2: Describe the internal training for embodied carbon measurement you provided or will provide.

- Status at time of ECAP Publication: **Not complete**
 - » PCS plans to offer internal classes and a user guide for Tally and other embodied carbon measurement tools available to all internal staff members.

Commitment 3: Submit an annual minimum of (2) projects per US structural office but need not exceed (5) total projects for the firm to the SE 2050 Database.

- Status at time of ECAP Publication: **In progress**
 - » PCS has completed an LCA for a healthcare project and is currently performing LCAs for another healthcare and high-end residential project. PCS will attempt to perform LCAs on projects located throughout the Pacific Northwest region and in multiple building sectors.



Embodied Carbon Reduction Strategies

Studies have shown the construction and building industries contribute to as much as 40% of global carbon emissions¹. Any effort to limit the impacts of climate change must consider how these emissions can be decreased.

The carbon emissions associated with a building can be split into two categories: embodied carbon and operating carbon. As operating carbon emissions continue to decrease, the embodied carbon is becoming a significant portion of a building's total carbon emissions. Embodied carbon is also where the decisions of structural engineers have the most impact. At the core of PCS Structural *Solution's* commitment to SEI SE 2050 is the belief that structural engineers can, and should, actively reduce the environmental impacts associated with our structural systems.

ECAP Embodied Carbon Reduction Strategy Commitments and Goals

Commitment 1: Set an Embodied Carbon reduction goal for the coming year.

- Status at time of ECAP Publication: **Complete**
 - » For the first year, we will be focusing on education and data gathering in lieu of setting a reduction goal. Our education will consist of a firm-wide presentation, distribution of resources, creating a sustainability-focused group, and nomination of a carbon reduction champion (for further details, see the Education section above). We will perform a minimum of five life-cycle analyses and use the results to inform our reduction goal for next year.

Commitment 2: Describe what we learned about embodied carbon reduction over the last year.

- Status at time of ECAP Publication: **Complete**
 - » We commit to discussing what we learned about embodied carbon reductions in our first year of commitment in next year's ECAP.

Commitment 3: Incorporate biogenic materials on a least one project annually.

- Status at time of ECAP Publication: **In progress**
 - » As a Pacific Northwest firm, incorporating biogenic materials in our projects is a natural fit. The timber industry played a significant role in the region's history, and it continues to innovate and evolve. Using wood products from local suppliers will help reduce the embodied carbon associated with the transportation of the material and support our local economy.
 - » The incorporation of biogenic materials into a project will generally lead to a reduction in the embodied carbon. The carbon savings come from several sources. It takes less energy to process the raw wood into building elements compared to the equivalent steel or concrete member. A wood element will also generally weigh less than the equivalent steel or concrete member, which results in lower emissions from transporting the material to the construction site.

1. UNEP and IEA, "Global Status Report 2017: Towards a Zero-Emission, Efficient, and Resilient Buildings and Construction Sector," 2017.



ECAP Embodied Carbon Reduction Strategy Commitments and Goals, continued

- » Another advantage of biogenic materials is they provide carbon storage. During the tree's growth, it absorbs carbon dioxide emissions from the atmosphere. It will store this carbon until the wood either burns or decays. Since this carbon is eventually released, it may not be considered in the life-cycle analysis. However, the delay in the release of carbon is valuable. Carbon present in the atmosphere currently will have a much more significant impact on climate change than carbon released years into the future.



Advocacy

PCS Structural Solutions recognizes that structural engineers can have an impact on addressing climate change. We now have the tools we need and are excited for the opportunity to be directly involved with quantifiable carbon reduction strategies. However, this work cannot be done by one company alone. A key component to achieving our goals is creating awareness of and amplifying the great work done by SEI SE 2050 and similar organizations. The SEI SE 2050 Commitment community is a fantastic place to grow and learn.

As structural engineers, we bring a unique perspective to the world and built environment. PCS must take its place in providing solutions and sound judgment in advocating for embodied carbon reductions to our clients, material suppliers, and peers. Our advocacy will be accomplished through involvement with outside organizations, outreach through media outlets, and the marketing materials and project proposals PCS provides to our clients.

ECAP Advocacy Commitments and Goals

Requirement 1: Provide a narrative about how PCS plans to share knowledge and data to accelerate the adoption of embodied carbon reductions.

- Status at time of ECAP Publication: **Complete**
 - » PCS utilizes multiple channels to help amplify the message of SEI SE 2050 and our commitment to sustainability. We have created a white paper that outlines the 'Top 10' strategies for reducing embodied carbon and sent it to several design partners—Owners, Developers, Architects, Contractors, etc. We have also announced our commitment to SEI SE 2050 via our website, targeted email campaigns, and social media (see Figures 1 and 2 in Appendix). Additionally, we have engaged with local and regional journalists to help spread awareness to a larger audience through their respective publications.

Requirement 2: Describe the value of SEI SE 2050 to clients. How can we collaborate to drive adoption? At your option, attach any associated marketing materials.

- Status at time of ECAP Publication: **Complete**
 - » PCS sees the most significant value to clients of the SEI SE 2050 Commitment Program as the ability to inform project decisions in early conceptual and schematic design phases. By establishing industry benchmarks and leveraging the national database, PCS can help design partners evaluate the impact of structural system options on the embodied carbon associated with the project.

Requirement 3: Declare your firm as a member of the SE 2050 commitment on boilerplate proposal language.

- Status at time of ECAP Publication: **Complete**
 - » PCS has created a qualifications page, which focuses on our commitment to SEI SE 2050 and other sustainability efforts to include in project proposals. See Figure 5 in the Appendix.

Appendix



PCS Joins SE2050 Commitment Program

PCS Structural Solutions is thrilled to announce its support of the SEI Structural Engineers 2050 (SE2050) Commitment Program! The program works to educate, engage and report the impacts of the built environment and its associated embodied carbon. **The Goal—to achieve net zero embodied carbon by 2050.**

As a coalition partner, PCS will educate staff, report, develop reduction strategies, and advocate for embodied carbon reduction on its projects. Embodied carbon data reported by PCS and other Commitment Program partners to the SE2050 database will be used to help track embodied carbon in the industry, set industry benchmarks, and establish reduction targets. The data base is a powerful step toward meaningful and effective change.

[Read More About SE2050](#)

Figure 1: Example of PCS's internal email announcing the company's commitment to SE 2050.

Appendix, continued



Figure 2: Example of PCS's external social media (LinkedIn) post announcing the company's commitment to SE 2050.

Appendix, continued

Sustainability in Structural Engineering
Earth Day 2021

Embodied Carbon vs. Operational Carbon

Global emissions breakdown:

- Nearly 40% from building sector
- 11% from embodied carbon
- 28% from operational carbon

Sector	Percentage
Industry	30%
Building Operations	28%
Transportation	22%
Building Materials and Construction	11%
Other	9%

Source: 2020 Sustainability 2020

Life Cycle Assessment (LCA)

Product	Construction					Use							End of life				Beyond	
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D
Raw materials supply																		
Transport																		
Manufacturing																		
Transport																		
Construction/installation																		
Use																		
Maintenance																		
Repair																		
Replacement																		
Refurbishment																		
Operational energy use																		
Operational water use																		
Deconstruction/demolition																		
Transport																		
Waste processing																		
Disposal																		
Reuse, recovery, recycling																		

Source: EN 15978

Where Does a Majority of Embodied Carbon Come from for Steel Production

- Basic Oxygen Furnace (BOF)**
This process converts pig iron from the blast furnace into liquid steel by blowing oxygen into the furnace to remove carbon as carbon monoxide gas.
- Electric Arc Furnace (EAF)**
In this process an electric furnace melts (recycles) steel scrap for the production of liquid steel using electrical power.

W-shape/ Rebar are typically produced in EAF
HSS/ Wire reinforcement production are split about 50/50 between EAF and BOF

Source: <https://www.enr.com/resources/economics/article/2015/05/for-changing-embodied-carbon-of-steel>

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Where Does a Majority of Embodied Carbon Come from for Wood Production

- Raw wood can be considered renewable material
- Wood products from old growth forest may not be considered renewable
- Sawn lumber**
Manufacturing energy requirements for the sawn lumber includes, but are not limited to, the sawing, drying, transportation and planing processes.
- Engineered wood products emits more carbon than sawn lumber.
Finger-jointing, planing, gluing, curing.

Product	Default GWP	GWP - On Site (kg CO ₂ e)	GWP - Factory (kg CO ₂ e)	GWP - Production (kg CO ₂ e)	Source
Softwood Lumber	1.07	75	11	58	AWCCRC 2019a
OSB	1.07	240	17	233	AWCCRC 2019a
Plywood	1.07	130	33	117	AWCCRC 2019a
Glulam	1.07	186	11	187	AWCCRC 2019a
CLT	1.07	262	14	186	AWCCRC 2019a
Hybrid	10.0	107	13.8	13.8	AWCCRC 2019a

Source: Table 01a/ www.enr.com

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Strategies to Reduce Embodied Carbon in Wood

- Optimize wood design for architectural and mechanical requirements (Note: Design strategy applicable to other structural materials)
 - Stick frame vs. Mass timber
 - Selection of proper timber elements
 - Sawn lumber v. Glulam v. SCL
 - CLT v. GLT v. DLT v. NLT
- Specify wood is sourced from a third-party sustainable forestry certification
 - Forest Stewardship Council (FSC) - Preferred
 - Sustainable Forestry Initiative (SFI)
 - American Tree Farm System (ATFS)

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Figure 3: PCS's internal Embodied Carbon 101 presentation.

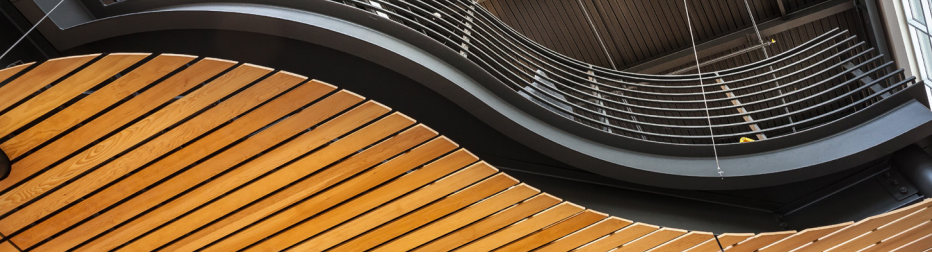
Appendix, continued

Good Morning All,

As a friendly reminder, this Thursday at noon is our next PCS-U class. Annabel and Hai will be giving a presentation titled “Sustainability in Structural Engineering.” This course will provide the basics of embodied carbon and provide general carbon reduction strategies to implement on the four primary structural materials used in our daily designs. As a primer to the course and embodied carbon, we recommend reading the [“Top 10 Things Every Structural Engineer Should Know about Embodied Carbon”](#) beforehand. Please bring any questions you may have on sustainability and embodied carbon!

Happy Earth Month,
PCS Sustainability Team

Figure 4: PCS’s internal email sharing the “Top 10 things Every Structural Engineer Should Know About Embodied Carbon.”



Appendix, continued





SE2050 works to educate, engage and report the impacts of the built environment and its associated embodied carbon. The Goal—to achieve net zero embodied carbon by 2050.




Sustainability at PCS

PCS is an official supporter of the **Structural Engineers 2050 Challenge (SE2050)** initiative to measure progress toward carbon neutrality in buildings by 2050. Endorsed by SEI in late 2019, SE2050 will challenge structural engineers to meet embodied carbon benchmarks and increasingly higher reduction targets in a race towards the most efficient building as we approach the year 2050.

PCS is an early adopter of the newly launched **Embodied Carbon in Construction Calculator (EC3) Tool**, which provides A/E/C teams, owners, and policy makers with a platform to compare and reduce the carbon footprint of construction materials.

A core team of our engineers is training to become proficient with the EC3 tool and will teach its use throughout our firm. The tool will help inform us of our designs' carbon impact on the environment, and the data will be shared and used for the SE2050 challenge to develop the A/E/C industry's education and movement toward carbon neutrality.

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Sustainability at PCS

Figure 5: Example of PCS qualifications included in project proposals that highlight SEI SE 2050.

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