Education

☑ Distribute ECAP within your firm upon publishing

HOK will distribute in October 2022 via the intranet on the Structural Knowledge page

☑ Make (1) webinar focused on embodied carbon available to employees.

PM training (April 2022) and West Coast Technical (June 2022), Health Care Sustainability training (Aug 2022) trainings have been recorded and available to employees.

For new employees, we will refer them to Boston Society for Architecture's Embodied Carbon 101 video series. https://www.architects.org/embodied-carbon-101-video-archive

ELECTIVES

☑ Provide a brief narrative describing how your firm is promoting a firm-wide education program for embodied carbon reduction and the firm's commitment to SE 2050.

HOK is promoting a firm-wide education program through internal presentations and the development of the internal "How-To Guide" document.

The "How-To Guide" document is a reference for anyone in the company interested in conducting a LCA within the "HOK Policy LCA". It provides background information to the purpose of LCAs within the framework of SE 2050. The "How-To Guide" is ever evolving and most recently updated in May 2022

☑ Have one representative of your firm (any employee) attend quarterly external education programs (e.g. webinar, workshop) provided by SE 2050, Carbon Leadership Forum (CLF), or other embodied carbon resources.

Jaclyn Lee is actively engaged/aware of external education programs provided by the SE community through NCSEA, SEAOC, SE 2050, CLF and others.

☑ Nominate a minimum of (1) employee per office to participate in a CLF Community Hub and/or task force.

Currently, there is an employee from the New York, Houston, and San Francisco offices that participate in the CLF Community and members of regional hubs.

☑ Provide narrative outlining plans for minimum (2) firm-wide presentations per year on the topic of embodied carbon

HOK structural will continue to give firm-wide presentations including at least two encompassing an introduction to embodied carbon, HOK's progress on SE2050's commitment, structural engineering strategies to reduce carbon intensities, and any general industry-wide updates.

Thus far, these presentations have been given to groups separately within the firm given the size of the firm and timezones of different offices. These groups include HOK's core board, market specific interdisciplinary groups, disciplines (such as structural engineering), project architect and project manager groups, and 10 individual regional offices.

☑ Minimum 1 employee attends a presentation or demo of an LCA-based tool used to calculate embodied carbon such as Tally, Athena IEB or One-Click LCA.

OneClick LCA is the primary tool that HOK engineers and analysts use to calculate embodied carbon. We will be attending a demonstration on their Net Zero Tool and Carbon Strategy Tool. Included in HOK's license are 2x tailored onboarding sessions that we will take advantage of biannually.

☑ Lessons Learned

Education is ever evolving. Over the past year HOK has given multiple internal presentations to educate staff, new and old, of the need to analyze the embodied carbon on all our projects to meet the IPCC recommended emissions envelope. We are making strides towards having all project managers and project architects aware of ExCom's directive of a firmwide LCA Policy to run at least one iteration of LCA on all whole new building projects. At the beginning of the commitment and enforcement of HOK's policy, there were some challenges in educating project managers and clients of the added value of a life-cycle analysis on their projects. However, the resistance has quickly given way to enthusiasm as industry, architects and contractors understand the urgency to make embodied carbon reductions. The challenge now is overcoming the hurdle of individuals supporting sustainability only until they must give something up (whether it is a design feature, typical construction method, etc.), and understanding that radical change in results can only be accomplished with radical change in design.

Reporting

☑ Submit a minimum of (2) projects per US office with SE services to the SE 2050 Database, but no more than 5 is required.

7 projects have been submitted since 2021, across 5 market and 5 different states.

ELECTIVES

☑ Submit all of firm's projects to the database

HOK has made a policy to perform at minimum a single iteration structural system LCA on new construction whole building projects that are over 5,000 square feet. While we are not submitting all of them to SE2050 database, it will help inform HOK of their projects embodied carbon across their portfolio of various projects and develop appropriate reduction targets.

☑ Report a greater percentage of projects than you did the previous year.

HOK plans to submit at least 5 projects in the coming year to the database.

☑ Lessons Learned

Since joining the SE 2050 challenge and enacting HOK's LCA Policy we have nearly 30 projects for which we have the GWP intensity data. At first it was challenging to get project managers to see the value and, in some cases, find the budget to run the analysis. However, through the education within the firm of the intent and benefits of an LCA and the communication that the HOK LCA Policy is a directive from ExCom, more projects are being analyzed earlier in the design process.

At HOK we log project information into an internal database which is separate from how we log projects into SE 2050's database. We are working on a way to merge the information/inputs so that project teams do not have to input it in multiple locations.

Embodied Carbon Reduction Strategies

☑ Set an EC reduction goal for the coming year and an implementation narrative. Qualitative goals focused on education are appropriate for the first year.

For the majority of the first and second year HOK has focused its efforts on collecting data from its past and current projects to determine current baselines for various types of projects and gather data to develop appropriate reduction strategies.

By the end of the third year we intend to have baseline/benchmarks and/or trends using the data collected from HOK projects and SE2050's public database of projects from the first and second year.

Starting from 2021, HOK is striving for a 55% reduction of embodied carbon by 2030. In order to meet our goal we have a yearly target of 6-7% reduction of carbon intensity.

ELECTIVES

☑ Provide a project case study in your ECAP sharing embodied carbon lessons learned.

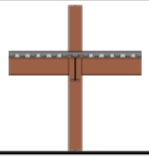
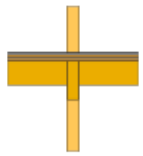
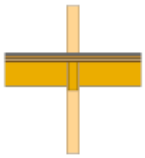
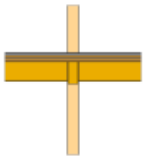
A WBLCA was performed on the Moss Courthouse renovation project located in Utah. The purpose of the study was to quantify the carbon savings of renovating a building as compared to building a new replacement building. The study looked at the substructure, superstructure, enclosure and interiors.

We always hear that renovating an existing building is less embodied carbon intensive than building new however can't quantify the statement. For this study we were able to provide guidance on the potential carbon savings on reusing existing GSA building stock. The overall results indicated that the renovations yield 59% less embodied carbon as compared to building a new replacement building. When comparing the analysis of only the structure and enclosure, as is required by LEED, there is 64% less embodied carbon when renovating than new construction. The interiors only analysis shows 15% less embodied carbon in the renovation than the new building.

☑ Complete an embodied carbon comparison study during the project concept phase.

For a Science & Technology building where it is proposed to have a majority of the space to be office space with some light lab space, HOK looked at the potential use of mass timber as compared to steel in conjunction with the impacts of vibration criteria on the base structure.

The baseline building was steel framing with composite metal deck. The following is a matrix of the various design scenarios and the embodied carbon results. The results show that a 30'x20'grid, regardless of vibration criteria, with CLT panels and LW concrete slab with mass timber framing has 68.9% of the EC as compared to a baseline building.

	Grid	Metrics per Option:	Baseline Building (Code MIN)	ISO Office (16,000 mips)	Computer Systems (8,000 mips)	Framing Sketch
3.25" LWC/W3 Steel Framing	30'x30'	Floor System Depth:	W18 Beam W24 Girder	W18 Beam W24 Girder	W21 Beam W27 Girder	
		Steel Tonnage:	6.1 PSF	6.3 PSF	8.4 PSF	
		Vibration Level:			< 8000 mips	
		Embodied Carbon:	**100.0%**	100.6%	106.5%	
CLT5 + 3.25" LWC Slab Mass Timber Framing	30'x30'	Floor System Depth:	GLB 10.75x27 Beam GLB 12.25x43.5 Girder	GLB 10.75x27 Beam GLB 12.25x43.5 Girder	GLB 10.75x27 Beam GLB 12.25x43.5 Girder	
		Mass Timber Quantities:	22.4 PSF Decking 13 PSF Framing	22.4 PSF Decking 13 PSF Framing	22.4 PSF Decking 13 PSF Framing	
		Vibration Level:			< 6000 mips	
		Embodied Carbon:	69.1%	69.1%	69.1%	
	30'x20'	Floor System Depth:	GLB 10.75x27 Beam GLB10.75x31.5 Girder	GLB 10.75x27 Beam GLB10.75x31.5 Girder	GLB 10.75x27 Beam GLB10.75x31.5 Girder	
		Mass Timber Quantities:	22.4 PSF Decking 11 PSF Framing	22.4 PSF Decking 11 PSF Framing	22.4 PSF Decking 11 PSF Framing	
		Vibration Level:			< 5000 mips	
		Embodied Carbon:	68.9%	68.9%	68.9%	
	20'x20'	Floor System Depth:	GLB 6.75x21 Beam GLB10.75x24 Girder	GLB 6.75x21 Beam GLB10.75x24 Girder	GLB 6.75x21 Beam GLB10.75x24 Girder	
		Mass Timber Quantities:	22.4 PSF Decking 7.6 PSF Framing	22.4 PSF Decking 7.6 PSF Framing	22.4 PSF Decking 7.6 PSF Framing	
		Vibration Level:			< 5000 mips	
		Embodied Carbon:	69.1%	69.1%	69.1%	
CLT5 + 3.25" LWC Steel Framing	30'x30'	Floor System Depth:	W18 Beam W27 Girder	W18 Beam W27 Girder	W21 Beam W27 Girder	
		Mass Timber/Steel Quantities:	22.4 PSF CLT 8.5 PSF Steel	22.4 PSF CLT 8.5 PSF Steel	22.4 PSF CLT 8.8 PSF Steel	
		Vibration Level:			< 8000 mips	
		Embodied Carbon:	90.1%	90.1%	90.9%	

Design Team Recommendation:
Mass Timber framing and floor systems can deliver the strength, serviceability, and vibration requirements of Building. The reduction of embodied carbon with the inclusion of mass timber is considerable. This study did not include foundations, but there will be additional savings there by making a lighter structure on a site that requires ground improvement.

The trade-off between grid spacing and framing weight requires additional review by the architectural team and to consider programming and future flexibility.

☑ Participate in a LEED, ILFI Zero Carbon, or similar project design charrette and speak to potential design considerations impacting embodied carbon.

For an interiors project pursing LEED we met with the client throughout the analysis and design process identifying materials for improvement; notably choosing a domestically sourced stone and reducing the amount of carpet. Although this is an interiors project, the exercise of doing multiple analyses and seeing the affects on how the total embodied carbon changed was valuable for both the client and the overall project to determine realistic reduction goals.

☑ Calculate your firm average benchmark for embodied carbon

HOK has a variety of projects in their portfolio that it would be inaccurate to calculate a firm average. Thus, we are working to develop a benchmark for various building types, similar to RIBA or CLF's benchmark. We are in the process of developing a dashboard that summarizes the results of all HOK projects that have an LCA. The intent is to be used as a tool for engineers to use filters on the data such as the location, building type, structural system, etc to quickly see what the embodied carbon is of projects and be able to determine an appropriate reduction target. Eventually we hope the dashboard can also be a used to pursue projects to inform clients the potential sustainability goals of their project based on historical data.

☑ Integrate embodied carbon mitigation strategies in your General Notes.

HOK has incorporated max GWP values in the steel and concrete specifications. Within the specifications we have requirements under the submittals and product section that the contractor must met in regard to Whole Building Life Cycle Assessment. The intent is for the contractor to provide EPDs, bill of materials and procure products that met GWP limits that meet the requirements outlined in the Structural General Notes.

☑ Lessons Learned

As there are no industry wide benchmark/baselines to reference to like AIA2030, determining an appropriate reduction target for HOK as a firm and for particular projects has been difficult. We know that we want to get to zero by 2050, but how to get there realistically has yet to be determined. We have found value in analyzing projects earlier in the design phase to make suggestions on how the embodied carbon could be reduced, but have found it difficult for projects/clients to agree to multiple iterations, especially when budgets are tight, or even follow through with the suggestions. We will continue to tweak the life cycle analysis/embodied carbon/GWP language that we have incorporated into our specifications and general notes as we receive feedback from contractors and trends of the industry.

Advocacy

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

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

See below for two-page spread excerpt from HOK's "Commitment to Achieving a Carbon Positive Future" leaflet

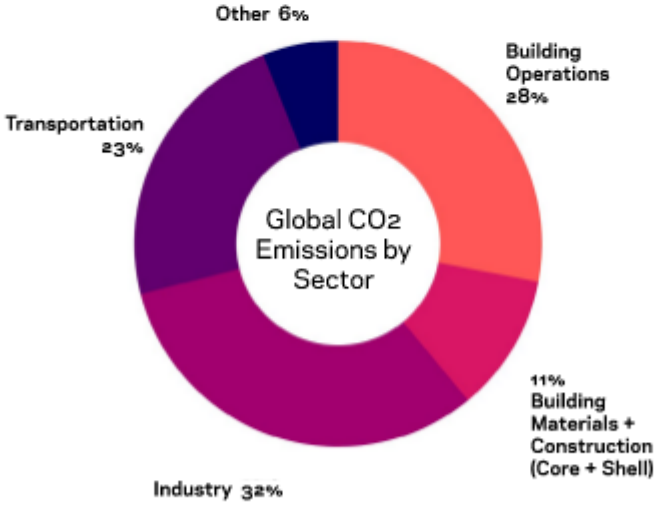
SE 2050 CHALLENGE

HOK is committed to eliminating embodied carbon on all projects by 2050.

Buildings account for nearly 40 percent of global carbon emissions; 28 percent from operations and 11 percent from embodied carbon.

To address this substantial source of global emissions, the Carbon Leadership Forum created the Structural Engineers 2050 Challenge (SE 2050), aimed at inspiring structural engineers to meet embodied carbon benchmarks and increasingly higher reduction targets and to provide measurements of progress towards that vision. With the goal of achieving zero embodied carbon by 2050 and zero operational carbon by 2030, we are designing for a carbon positive future.

Hybrid timber-and-steel truss system at Seattle-Tacoma International Airport, *Seattle, WA*



Source: Global Alliance for Building and Construction. *2018 Global Status Report.*

Adaptive reuse of two WWII-era airplane hangars at NOAA Daniel K. Inouye Regional Center, *Honolulu, HI*

Furthermore, we encourage our clients to reuse existing buildings whenever possible, which often results in cost and time savings during the construction process as well as mitigates an enormous amount of embodied carbon emissions.

HOK is working closely with our structural engineering teams to improve our multiattribute optimization design tools and workflows that will help streamline the LCA process to inform design. This collaboration is challenging designers to become more thoughtful and innovative in rethinking structural grids and spans to address reduction in overall material use and the impact of embodied carbon.

At the same time, HOK expects our consultants to be able to conduct LCAs and manufacturers to provide Environmental Product Declarations (EPDs) for their products and materials.

Since embodied carbon will account for nearly half of total new construction emissions over the next 30 years, HOK taking responsibility for implementing design strategies to reduce overall material use and the impact of embodied carbon, working with clients and partners to better understand the environmental impact of their buildings.

The building envelope is often the second biggest source of embodied carbon, contributing to approximately 33 percent of the embodied carbon in a typical building. Our facade specialists are exploring new building skin prototypes, such as the Circadian Curtain Wall and Structural eXterior Enclosure, that reduce the amount of carbon-heavy material within the building envelope while improving performance. We will continue to research the embodied carbon of wall assemblies and push to develop new, low-carbon alternatives.

ELECTIVES

☑ Share your commitment to SE 2050 on your company website.

HOK's commitment was shared on the company's website and updated March 2022

☑ Give an external presentation on embodied carbon that demonstrates a project success or lessons learned (Tip: Get connected at a CLF local hub near you!).

HOK has given a presentation on embodied carbon to a Passive House Chicago chapter (presented by D Desai PE and J Lee PE). For Passive House Chicago, we focused on studies that demonstrated the use of parametric modeling, a renovation versus new build project and an interior finishes study. HOK also presented carbon reductions on the Emory HSRB-II at the Atlanta I2SL conference in 2021, prepared by M Neal PE and D Desai PE.

On CLF, HOK actively participated in a discussion about how interiors affect embodied carbon totals.

D Desai PE will be presenting at NCSEA Summit November 2022. Her presentation is titled "Towards Net-Zero Embodied and Operational Carbon in Large Civic, Educational and Commercial Projects." Past related lectures were given at Penn State University, MIT, UMich, and Northeastern University to structural engineering students.

☑ Encourage industry and policy change by promoting and using low-carbon and carbon-sequestering materials

With newly enacted legislation such as Buy Clean California and GSA's Low Embodied Carbon Standards, HOK will be steered in this direction to not only promote but also use low-carbon materials on projects. New York State's LECCLA also works well with our embodied carbon limits in specs and general notes.

☑ Propose alternative methods for advocacy and describe their value

HOK intends to continue being engaged with CLF and help with their benchmarking efforts so that the industry can have enough data to see trends and determine appropriate and realistic reduction targets. HOK plans to be involved with local sustainability design committees to share our experiences as well as learn from other firms. We will continue to engage with contractors and manufacturers for in-field perspectives on how execution of low-carbon materials is progressing and/or being accomplished successfully.

☑ Lessons Learned

HOK realizes the importance of industry awareness to see change. We have benefited from giving internal and external presentations as well as attending external presentations because we learn something new every time. Whether it is about a new product, lessons

learned or simply updates we must keep advocating the importance of measuring and reducing embodied carbon in the building industry. Furthermore, we are committed to aggressive change, and understand that buildings that open in 2030 are often on the drawing board today, so we must target reductions well beyond our LEED credit thresholds and set precedents for the industry.