



**2022 CONVENTION PROCEEDINGS**

**SEAOC ANNUAL CONVENTION**

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**HYATT REGENCY INDIAN WELLS**

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# Structural Engineers Association of California



## 2022 Convention Proceedings

### SEAOC Annual Convention

Aug. 31 – Sept. 3, 2022  
Hyatt Regency Indian Wells  
Indian Wells, CA

### Convention Proceedings

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# Reaching Net-Zero Structures - SE 2050 Commitment Program Status and Vision for the Future

**Genevieve Graham, EIT, LEED GA**

Arup, Los Angeles, CA, USA

**Megan Stringer, PE, SE, LEED AP BD+C**

Holmes, San Francisco, CA, USA

**Michael Gryniuk, PE**

LeMessurier, Boston, MA, USA

**Luke Lombardi, PE**

Buro Happold, Los Angeles, CA, USA

**Eric Borchers, PE, SE**

KAI Hawaii, Honolulu, HI, USA

**Chris Jeseritz, PE, SE, LEED AP BD+C**

PCS, Structural Solutions, Seattle, WA, USA

**SE 2050 Leadership Group and Subcommittee**

## Abstract

*Studies have shown that a significant portion of embodied emissions within the built environment are due to structural materials (Construction21, 2019). Additionally, the proportion of embodied vs operational emissions of a structure is trending such that embodied carbon emissions are becoming the more significant source (as operational building services increase in both efficiency and affordability). Despite these findings, many structural engineers remain unaware that their decisions have the potential to be significantly carbon-reducing. The consequences of this lack in awareness are further exacerbated due to the absence of a uniform system, or platform, by which structural engineers may benchmark the embodied carbon of their own designs. This prevents the natural cycle of learning within structural design as it relates to embodied carbon. In response to these disparities within the structural engineering industry, the Structural Engineers 2050 Commitment Program (SE 2050) by the Structural Engineering Institute (SEI) of the American Society of Civil Engineers (ASCE) was created. Modeled after the AIA 2030 Commitment, this program is the only national embodied carbon tracking and reduction program focused on structural framing systems. The SE 2050 Committee Program has operated for nearly two years with remarkable growth. This paper's first focus is an overview of SE 2050's history and actions since its establishment in 2020. The second focus is to update the structural engineering community on SE 2050's progress since its launch, including reviewing submitted Embodied Carbon Action Plans (ECAPs) by firms and*

*discussing the SE 2050's newly launched database. Finally, this paper will explore SE 2050's future goals.*

## Introduction

The Structural Engineers (SE) 2050 Commitment Program is a national program with the goal of reducing the embodied carbon of structural systems to net zero by 2050 through education, engagement, tracking of embodied carbon, and establishing reduction targets over time. Modeled after the American Institute of Architects (AIA) 2030 Commitment, this program focuses on tracking and reducing embodied carbon in structural systems through volunteered firm engagement. SE 2050 is the first North American embodied carbon reduction program focused on structural systems.

SE 2050 was established as a subcommittee under the Structural Engineering Institute (SEI) Sustainability Committee and has operated for nearly two years with remarkable growth. This paper's first focus is an overview of SE 2050's history and actions since its establishment in 2020. The second focus is to update the structural engineering community on SE 2050's progress since its launch, including reviewing submitted Embodied Carbon Action Plans (ECAPs) by firms and discussing SE 2050's newly launched database. Finally, this paper will explore SE 2050's future goals.

## Timeline of SE 2050

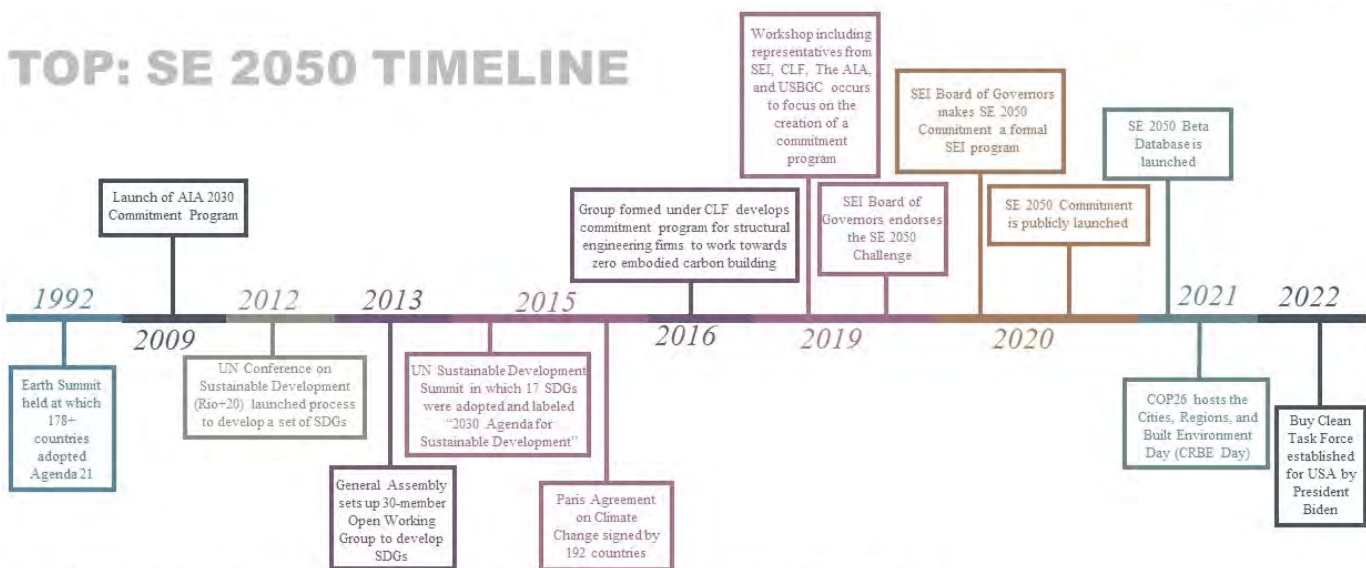
The SE 2050 Commitment Program originated in grassroots style from structural engineers who recognized the necessity of the structural engineering profession to engage more actively in conversations surrounding sustainability. Upon the announcement of the AIA 2030 Commitment Program in 2009, several structural engineers began to formulate a program that would specifically address the embodied carbon of structures. These early conversations occurred predominantly within the Carbon Leadership Forum (CLF) community. After several notable workshops, including a 2019 workshop in which representatives from SEI, CLF, AIA, and U.S. Green Building Council (USGBC) met to create a commitment program focused on embodied carbon reduction, the SE 2050 Challenge was presented and endorsed by the SEI Board of Governors.

After endorsing the SE 2050 Challenge, SEI officially launched the SE 2050 Commitment as a subcommittee of the SEI Sustainability Committee in 2020. The SE 2050 subcommittee has rallied over 30 dedicated members as well gained nearly 100 signatory engineering firms across North America. In mid-2021, SE 2050 launched the SE 2050 Database to which firms submit life cycle assessment (LCA) data on their projects. Still in the developmental stages of its existence, SE 2050 continues its focus on advocacy for sustainable structural design, growth of firm commitments, and refinement of the database. Figure 1 (TOP) highlights key moments of SE 2050 to this point.

It is important to recognize how SE 2050 fits into the broader landscape of sustainability-focused movements. To illustrate, Figure 1 (BOTTOM) additionally presents notable conferences and governmental commitments related to the international cooperation on addressing the climate crisis.

This timeline shows how international declarations can provide impetus to spur on conversations within industry. Ten years of international work on developing the United Nations (UN) Sustainable Development Goals (SDGs) took place between the Launch of AIA 2030 and the SE 2050 Challenge. These SDGs are widely considered the most comprehensive assessment on the meaning of sustainability and they act as goal posts for both governments and the private sector. Indeed, the United Nations SDGs are referenced within several of the ECAPs submitted to SE 2050 (read more in Section: ECAPS). The Figure 1 timeline signals that within five years of governments signing the Paris Agreement on Climate Change, the recognized importance of establishing sustainability within the built environment grew significantly. This is additionally exemplified by UN Climate Change Conference in Glasgow (COP26) at which an entire day was dedicated to the built environment (GlobalABC, 2021). The Cities, Regions, and Built Environment Day (CRBE Day) was used to study the built environment in a way that expands impact and resilience; a key component of which is setting goals surrounding the operational and embodied carbon of buildings and to put specific items on the international agenda as they relate to the emissions of buildings. Last on the timeline is the 2022

### TOP: SE 2050 TIMELINE



### BOTTOM: INTERNATIONAL EVENTS

Figure 1: Timelines for Sustainability Movements – TOP: SE 2050 Timeline, Bottom: International Events (United Nations, 2020 & Carbon Leadership Forum, 2021)

announcement by the Biden administration on the creation of the Buy Clean Task Force. Amongst other agenda items, the Buy Clean Task Force is to develop recommendations on construction materials and increase/enhance transparency of embodied carbon emissions through reporting (The White House, 2022).

### SE 2050 Engagement: Advocacy & Education

As sustainability movements related to structural systems continue to grow, SE 2050 seeks to use the momentum of international movements as well as its own recent history of influence and transform them into education and action across the structural engineering industry. Since officially launching at the Greenbuild International Conference & Expo in November 2020, SE 2050 has sought to increase industry engagement in the embodied carbon conversation through education and advocacy.

Over the past two years, subcommittee members of SE 2050 have presented at building conferences and conventions across North America. Members have presented at notable building conferences such as Greenbuild International Conference & Expo (2020, 2021), Structures Congress (2020), the International Association for Bridge and Structural Engineering (IABSE, 2021), the Structural Engineering Association of California (SEAOC, 2021), and the Net Zero Conference (NZE, 2022).

In addition to speaking at major conventions, SE 2050 has targeted smaller audiences through presentations at local CLF meetings, seminars for students at high schools and colleges, and by providing presentations to firms who are interested in joining the SE 2050 program and/or are new to the embodied carbon conversation and have questions.

The members of SE 2050 recognize that moving forward in the realm of sustainability requires a feedback loop. Therefore, in addition to presentations and seminars, SE 2050 regularly hosts meetings at which firms and engineers can voice their perspectives, concerns, and ideas related to sustainability of structural systems. These meetings take the form of Signatory Calls and Executive Firm Calls, each of which takes place multiple times per year.

More recently, SE 2050 has been called upon to develop seminar series to provide guidance in performing life cycle assessments (LCAs) on structural systems. SE 2050 members have developed several documents on best practice methodologies for specific structural systems, which can be found at the SE 2050 website. Developing educational tools is particularly helpful for, while the definitions and methodologies for such practices continue to take new form, establishing common principles amongst practitioners is

crucial to validation. Therefore, SE 2050 acting as a common thread amongst firm sustainability education is an important new phase of the program.

Taken together, these advocacy and education actions highlight the reach that SE 2050 has attained since its launch. Dedicated SE 2050 members have spoken and advocated data-driven sustainability goals to hundreds, if not thousands, of structural engineers. It is now common for subcommittee members to be attendees at seminars at which SE 2050 is referenced as a key industry movement. Presenting to industry professionals has been crucial to SE 2050's growth and these presentations continue as a key aspect of the program's net zero strategy.

### SE 2050 Committed Firms

The SE 2050 program is premised on volunteered firm engagement. As such, both the level of engagement and the number of committed firms are primary attributes of the

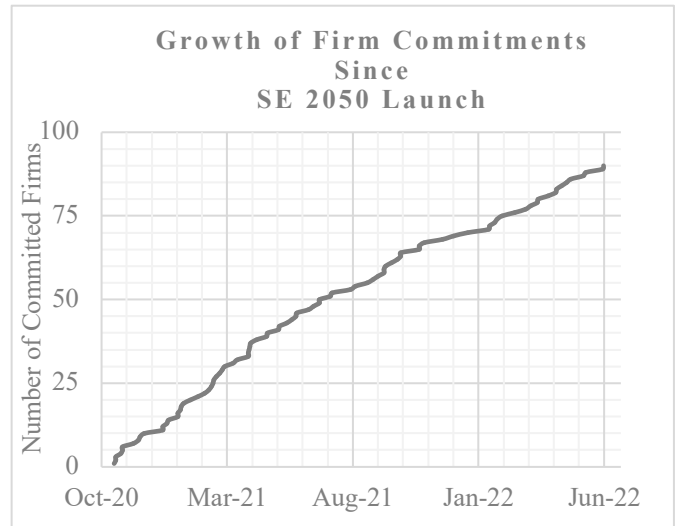


Figure 2: Growth in Firm Commitments Since SE 2050 Launch

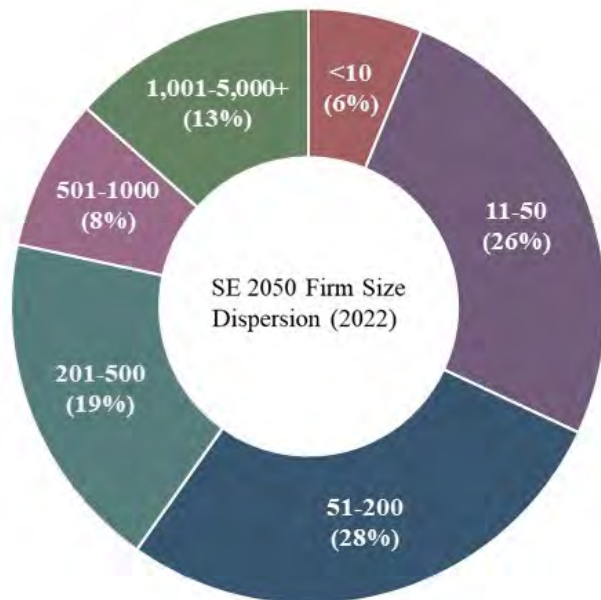


**Figure 3: Locations of SE 2050 Committed Firms (Google Earth Graphic)**

program’s achievements. SE 2050 is proud of the steady growth in firm commitments over the past 2 years. Through advocacy of the program and education on the cause, SE 2050 has successfully garnered the commitment of over 90 firms within less than two years. While acknowledging these successes, the program recognizes the need to continue to grow the movement and increase engagement.

Additional to the remarkable speed at which structural engineering firms have committed to the SE 2050 program, is the geographic range of these firms. As shown in Figure 3, firms are committed across all Northern America. It is worth noting, that pegged locations represent the location of the firm’s sustainability champion (aka the primary liaison between a firm and the SE 2050 Program). With this mind, firms with multiple offices are represented with only one peg. Therefore, Figure 3 conservatively visualizes the office locations that are working to achieve the SE 2050 stated program goals. As a note, multiple offices are captured in the SE 2050 program requirements—for example, a multi-office firm is currently required to submit two LCAs per office (though not *required* to submit more than five LCAs across offices).

In addition to office location, the number of employees of committed firms ranges considerably. Firm size is an important aspect of how the SE 2050 Subcommittee continues to discuss and formulate future program requirements. As a program, inclusivity and representation across the full range of structural engineering firms is considered critically important to achieving carbon reduction goals.



**Figure 4: SE 2050 Firm Size Dispersion as Number of Employees Range (2022)**

## Embodied Carbon Action Plans

Embodied Carbon Action Plans (ECAPs) are central to firm engagement with SE 2050 and the path to net zero embodied carbon structures. The ECAP articulates how a firm will *educate, advocate, report, and reduce* the embodied carbon of building structures. When firms engage with SE 2050, they are referred to the [SE 2050 Program Requirements Guidance Document](#). In addition to other program requirements, this document provides details on ECAP deliverables, which can be summarized in the following actions:

- Provide an outline of your firm’s strategy to *educate* employees about embodied carbon and *advocate* for net zero embodied carbon structures
- Provide an outline of your firm’s commitment to *report* project embodied carbon data to the SE 2050 Database
- Specify measurable goals to assess your firm’s progress in *reducing* embodied carbon in project work

ECAPs are to be submitted yearly and published on the SE 2050 website. Furthermore, firm ECAPs are to be updated each year with a “lessons learned” section. Currently, 65 firm have published their ECAP. Several firms have already submitted an updated ECAP for their second committed year.

The collection of ECAPs that SE 2050 has compiled is a unique and encompassing dataset in and of itself. For this paper, all submitted ECAPs were assessed. The outcomes of this study reveal common goals, actions, and statements of firms as they relate to sustainability. Additionally, this study shows the general status of LCA data collection capabilities as well as embodied carbon reduction strategies.

### *Educate and Advocate:*

From the 65 unique firm ECAPs, it is apparent that the structural engineering industry acknowledges their role in the management of embodied carbon and supports the SE 2050 mission to achieve net zero embodied carbon for structures by 2050. The ECAPs reveal an array of strategies firms are using to educate employees and advocate for net zero embodied carbon structures.

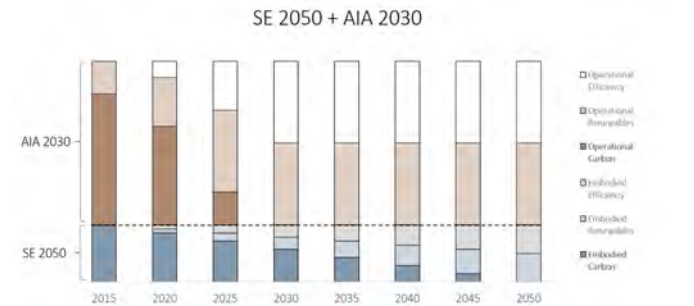
In the ECAPs, all firms list at least one repeating educational event for sustainability. These events come in the form of monthly meetings, internal seminar series, or young engineer on-boarding methods. 60% of ECAPs showed the creation of an internal working group for embodied carbon reduction as *unique* from a general sustainability team.

A common set of statements exists within ECAPs surrounding education and advocacy of processes that would better facilitate sustainable design. As a percentage of ECAPs: 65% stated the need to onboard and educate the client as an initial or highly important step; 60% referenced the benefit of greater access to product specific EPDs and/or their desire to use them in specifications; and 46% stated a high benefit in engaging across disciplines and stakeholders early in the design process to achieve sustainability goals.

Collectively, the submitted ECAPs show that most firms advocate for several sustainability-related organizations and movements beyond SE 2050. In fact, 65% of ECAPs list their partnerships with other “green” organizations (e.g., CLF, AIA 2030, USGBC, LEED, NCSEA, Green Globes, IStructE, etc.). SE 2050 is itself explicitly partnered with CLF, IStructE, and NCSEA and believes that the combined influence of like-minded organizations is important to achieving net zero.

Less common, but of interest, is that 23% of firm ECAPs state the firm’s interest in driving policy and/or code requirements as related to the sustainability of structural systems. This is a key change in mindset for both firms and sustainability-related organizations. In addition to better design and materials, it is clear that policy will be critical in achieving net zero structures.

Notably, the majority of ECAPs refer to the AIA 2030 Commitment and several go on to explain the relationship between operational carbon versus embodied carbon. Noted in Figure 5 is the in-step relationship proposed for carbon reductions for both operational and embodied carbon (SEI Sustainability Committee, 2018).



**Figure 5: SE 2050 + AIA 2030 – Chart to Demonstrate Timeline to Net Zero of Operational vs. Embodied Carbon (SEI Sustainability Committee, 2018)**



### Report:

As stated, firm reporting is integral to the success of SE 2050. Therefore, ECAPs are required to explain how firms will collect and report their LCA data. As such, 72% of firms explicitly identified the LCA tool they are using. Most firms are using external tools like Tally, OneClick, or Athena, but 22% of firms reported that they are developing internal tools to conduct LCAs. Currently, it is widely known that LCA tools can produce different GWP results for a similar set of material inputs. As stated in the SE 2050 Database Section, one input parameter for the SE 2050 database is the LCA tool used. Understanding how outcomes differ across tools will be important in refining the LCA process.

With the need for refinement in mind, it is unsurprising that 72% of firm ECAPs called for more data prior to establishing reduction targets. This signals a clear need for the database that SE 2050 is developing. While SE 2050 works to establish progressing program requirements related to year-by-year reductions in embodied carbon, 11% of firms studied have already established their own internal reduction targets. These stated targets range 5% - 30% reduction in embodied carbon. Conversely, 14% of firms state limited resource availability to conduct life cycle assessments making reduction targets difficult to establish.

As mentioned, SE 2050 recognizes the current limited guidance as related to conducting LCAs. To aid in establishing common knowledge across firms, the SE 2050 LCA Methodology Guide is currently under development to be published on the SE 2050 website.

### Reduce:

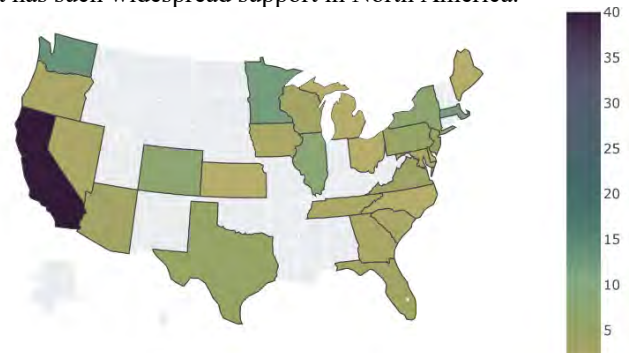
While reporting and setting clear reduction goals is important to achieving net zero, there are many actions firms can take now to reduce the embodied carbon of their designs. Many firms recognize this and list actions for reduction in their ECAP. The most common action is modifying General Notes/Specifications. 60% of firms state they will implement requirements limiting GWP values and/or require product-specific EPDs. These contractual requirements will (1) serve to reduce a project's total GWP via materials selection and (2) spur on manufacturers to produce products more sustainably and document the outcome via creating product-specific EPDs.

Other means of reducing embodied carbon relate to stated goals of designing with materials known as being more sustainable and/or to incorporate sustainable methodologies into design outcomes. For example, 38% of firms stated they aim to increase designs featuring biogenic construction materials. Additionally, 12% of firms stated their goal to design for adaptive reuse and/or regenerative design.

## SE 2050 Database

A primary limitation to setting embodied carbon reduction targets for structural systems is the current lack of sufficient baseline data for the embodied carbon of structural systems. As such, the SE 2050 Database will be a powerful tool for embodied carbon reduction. While still in its beta stage, SE 2050 is focused on ensuring smooth processes of data collection as well as increasing the quantity of data submitted to the database.

The SE 2050 Database anonymizes and aggregates firm-submitted LCA data for structural systems. To date, firms have collectively submitted embodied carbon data for 160+ projects. As shown in Figure 5, submitted embodied carbon data represents projects across many demographic regions. There exists no other cross-firm database for embodied carbon that has such widespread support in North America.



**Figure 5. Number of SE 2050 Project Submissions by State**

The following types of data inputs are collected:

- General Project Information
  - o Location, primary building use, area, height, etc. project zip code
- Structural System Information
  - o Typical column grid spacing, gravity and lateral structural systems & materials, gravity and lateral design criteria
- Global Warming Potential (GWP) Data
  - o Total GWP, LCA tool used, LCA stages included
- Structural Material Quantities (optional)

The above is a partial list. A complete list of inputs and user guidance is published on the SE 2050 website.

As outlined in the SE 2050 Program Requirements Guide, firms are currently required to submit data for two projects per year to the database. For firms with multiple office locations, the requirement states that two projects are to be submitted per



office, but that a firm is not required to submit more than five project LCAs in total per year. This data is not public and only signatory firms can access the database viewer.

New project LCAs are being added to the SE 2050 database each week. To date, the database represents approximately 1.2 million metric tons of CO<sub>2</sub> equivalents across more than 40 million gross square feet of buildings. For reference, the United States emitted 5,222 million metric tons CO<sub>2</sub> equivalents in 2020 (Our World Data, 2020). Additionally, the generally accepted percentage of total emissions attributed to building materials and construction (i.e. embodied carbon) is ~11% (WorldGBC).

Detailed analysis of this quantity of data will provide new insights into GWP baselines for a variety of structural designs. SE 2050 is currently working to analyze this collection of data in a meaningful way for the engineering community.

### Future Goals of SE 2050

After nearly two years of establishing a strong foundation, the SE 2050 Commitment Program is focused on growth over the next five. Our ability to provide our signatories appropriate and accurate structural system and structural embodied carbon information is directly tied to the number of signatories we have. Because quantifiable sustainability goals require the best quality aggregate data to measure against, we need to increase the number and diversity of the structural systems and building types in our database. We can achieve this by increasing the number of signatory firms and the number of projects per firm over the next several years. Therefore, the most immediate goal of the program is increasing the following:

1. Committed signatory firms and ECAPs
2. Submitted projects to SE 2050 Database
3. Guidance documents published on SE 2050 website

The growth of these three primary areas will enhance the influence of the program. More committed firms will allow better understanding of industry attitudes and capabilities. Increased project submission to the SE 2050 Database will enhance the fidelity of the analyzed data. Finally, guidance documents (e.g. LCA guidelines, educational documents on embodied carbon) will aid in creating common understanding of sustainability needs across firms.

While SE 2050 is currently in its developmental stages, the subcommittee has begun to formulate several mid- and long-term goals. These goals largely take on the form of deliverables to the structural engineering community. This can only be done via firm action and, consequently, SE 2050's main responsibility is providing the tools, guidance, and motivation

to achieve net zero as a reality. Therefore, the following constitutes several of SE 2050's mid- and long-term goals (intended to evolve over time as new data is collected and analyzed):

- Maintain the SE 2050 website as a database for ECAPs of firms across North America
- Yearly report of the data collected in the SE 2050 Database (e.g. baseline GWP for structures, tracking reported values against reduction goals, etc.)
- Enhanced program requirements that drive firms towards net zero embodied carbon structural systems
- Creating benchmark recommendations for policy

SE 2050 sees achieving these goals as most helpful to firms as the structural engineering industry works towards becoming net zero embodied carbon. These goals are currently being pursued through a multitude of actions by the SE 2050 subcommittee, largely described throughout this paper. As is evident in the development of SE 2050 alongside international events (Figure 1), there is a positive feedback loop between high-level goals and real-world implementation. SE 2050 continues to listen and rapidly envision a net zero carbon future. The subcommittee aims to take international, national, and localized conversations and create the information necessary for action.

### Conclusions

The primary focus of this paper has been to provide the engineering community with a status update of the SE 2050 Commitment Program. It is hoped that showing the progress and discussing the details of firm commitments will encourage new firms to commit as well as galvanize more action from already committed firms.

The subcommittee is proud of its achievements over the past two years. The program has over 90 firms committed, 30 subcommittee members, a website with a variety of best-practice guides and that houses 65+ ECAPs for public view, and a beta database with 160+ project entries. This accumulation of information has acted as a critical first step in getting structural systems to net zero.

While acknowledging the achievements of SE 2050, it is equally important to recognize that the work to reach net zero structural systems remains in its infancy. The subcommittee members of SE 2050 are working to provide information and achieve results that will transform the structural engineering landscape for the benefit of our planet. To do this, engagement and action from your firm is necessary.

*Are you ready to join the movement?*  
Email: [contact@se2050.org](mailto:contact@se2050.org)

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