Toward Zero Carbon: Developing a Roadmap for the Structural Engineering Profession and the Structural Engineering Institute, ASCE

Final Report on the Workshop Held

July 22–24, 2024

Northeastern University

Boston, Massachusetts, USA

Structural Engineering Institute

American Society of Civil Engineers

Reston, Virginia, USA

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About the American Society of Civil Engineers and the Structural Engineering Institute

Founded in 1852, ASCE is the nation's oldest civil engineering society. The American Society of Civil Engineers represents more than 160,000 members of the civil engineering profession in 177 countries. ASCE stands at the forefront of a profession that plans, designs, constructs, and operates society's economic and social engine—the built environment—while protecting and restoring the natural environment. Through the expertise of its active membership, ASCE is a leading provider of technical and professional conferences and continuing education; the world's largest publisher of civil engineering content; and an authoritative source for codes and standards that protect the health, safety, and welfare of the public. The society advances civil engineering technical specialties through nine discipline-specific institutes, including the Structural Engineering Institute, and leads the industry with its many professional- and public-focused programs.

The Structural Engineering Institute represents more than 30,000 members internationally and works to improve every aspect of the structural engineering profession. The Structural Engineering Institute supports a unique, fully engaged profession with a strong identity, recognized for the contribution it makes to public safety and risk management, economic and sustainable use of resources, the use of innovative technologies, the creation of inspiring structures, and stewardship of the built environment. Members of the Structural Engineering Institute are leaders and innovators in their fields and collectively advance the state of the practice of structural engineering through publication of journals and technical reports, manuals of practice, and design standards that are adopted into national codes.

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Executive Summary

The structural engineering profession regularly embraces new strategies for sustainable design and operation of structures and infrastructure. Embodied carbon and operational carbon within the built environment are prime targets for innovative approaches related to structural design; construction materials, product development, and fabrication; transportation of construction materials; and construction processes. As part of the broader community of the American Society of Civil Engineers, the Structural Engineering Institute (SEI) is well positioned within the United States and internationally to take a leadership role in establishing a new paradigm for sustainable design within structural engineering.

On July 22–24, 2024, SEI held a workshop on the campus of Northeastern University in Boston, Massachusetts, entitled “Toward Zero Carbon: Developing a Roadmap for the Structural Engineering Profession and the Structural Engineering Institute, ASCE.” The workshop addressed the current state of the art and future needs to bring the structural engineering profession—and the architecture, engineering, and construction industry in the buildings sector in general—toward zero carbon designs for the built environment.

This workshop assembled experts with a broad range of expertise within the architecture, engineering, and construction industries related to embodied and operational carbon in buildings and other structures so that the profession may chart a roadmap to progress toward zero embodied and operational carbon in the built environment and establish priority initiatives for SEI to continue to lead the drive toward embodied carbon reductions in structures over the next 25 years approaching 2050.

By addressing issues related to extraction, production, fabrication, and distribution of construction materials; architectural and structural engineering design of the built environment; life-cycle assessment tools and databases related to sustainable design in construction; construction and deconstruction processes; and policy, advocacy, and education related to the built environment, the workshop participants prioritized key opportunities and initiatives needed to drive the structural engineering profession toward zero embodied and operational carbon in the built environment. The following are key highlights from these prioritized initiatives:

- Develop a roadmap to enable the structural engineering profession to realize its goals around zero carbon designs;
- Develop a performance standard using data collected through the SEI SE 2050 Commitment Program;
- Develop standards to ensure consistent methodology, data transparency, and robustness of embodied carbon calculations;
- Develop approaches to de-risk adoption of new and innovative materials, components, and systems through published protocols, demonstration platforms, and training for certifiers;
- Develop a guide or standard for evaluating adaptive reuse potential in existing buildings, including salvaged material opportunities for existing building portfolios ("reuse audit");
- Develop design guides and other resources that aid practicing structural engineers in reducing the embodied carbon of structural systems;
- Reassess national standards to optimize reliability in reducing embodied carbon (e.g., reassess loading and target reliabilities);
- Develop processes to work with federal agencies to inform the development of their industry-leading sustainable design standards and guides;
- Develop approaches for incorporating sustainability as a core design responsibility to disseminate across the profession;
- Define the "embodied carbon literacy" that is recommended as a requirement of the graduate structural engineer; and
- Develop an education and awareness campaign targeting professional structural engineers to ensure the practice is qualified to deliver results.

This report summarizes the workshop organization, discussions, conclusions, and proposed initiatives.

This workshop was supported in part through generous sponsorships received from the SEI Futures Fund, the Department of Civil and Environmental Engineering at Northeastern University, the Charles Pankow Foundation, Magnusson Klemencic Associates, Simpson Gumpertz and Heger, Walter P. Moore, and LeMessurier.

1. Introduction

On July 22–24, 2024, the Structural Engineering Institute (SEI) of the American Society of Civil Engineers and Northeastern University hosted a workshop on the Northeastern University campus in Boston, Massachusetts, entitled “Toward Zero Carbon: Developing a Roadmap for the Structural Engineering Profession and the Structural Engineering Institute, ASCE.” The workshop addressed the current state of the art and future needs to lead the structural engineering profession and the architecture, engineering, construction (AEC) industry in the buildings sector toward zero carbon designs for the built environment. The workshop convened participants from a wide range of fields and expertise, including extraction, production, fabrication, and distribution of construction materials; architectural and structural engineering design of the built environment; life-cycle assessment tools and databases related to sustainable design in construction; construction and deconstruction processes; and policy, advocacy, and education related to the built environment. This report summarizes the conclusions and proposed initiatives from the workshop.

1.1. Workshop Scope and Purpose

The structural engineering profession is increasingly embracing new strategies for sustainable design and operation of structures and infrastructure. Embodied carbon and operational carbon within the built environment are prime targets for innovative approaches related to structural design; construction materials, product development, and fabrication; transportation of construction materials; and construction processes. As part of the broader community of the American Society of Civil Engineers, SEI is well positioned within the United States and internationally to take a leadership role in establishing a new paradigm for sustainable design within structural engineering. This workshop convened experts with a broad range of expertise within the AEC industries related to embodied and operational carbon in buildings and other structures so that the profession may chart a roadmap toward zero embodied and operational carbon in the built environment and establish priority initiatives for SEI to continue to lead the drive toward embodied carbon reductions in structures over the next 25 years approaching 2050.

This workshop had three objectives:

1. To understand the current state of the art in the profession for mitigating embodied carbon through structural designs for building construction;

2. To define what success related to sustainable design and construction of buildings and infrastructure looks like; and
3. To establish priority initiatives for SEI that define the path toward successfully reducing carbon for the structural engineering profession over the next 25 years.

While the workshop had a broad scope related to sustainable design and construction in the built environment, its primary focus was reductions in embodied carbon for building structures.

1.2. Workshop Framework and Vision

The two-day workshop included guest speakers and participants to set the stage and then advance the dialogue. Appendix A summarizes the workshop agenda, and Appendix B presents the workshop invitation and participant list. The workshop began with a series of presentations by experts in the AEC industry to highlight the state of the art and propose bold initiatives aiming to bring the industry toward zero carbon. Appendix C includes biographies of the speakers.

Workshop co-chairs Jerome F. Hajjar and Jennifer Goupil initiated the workshop, highlighting the critical opportunity for the structural engineering profession in addressing the issues surrounding climate change. Approximately forty percent of all energy use, greenhouse gas emissions, material flow, and waste are from construction and use of buildings.

Structural Engineering As Leaders Addressing Climate Change:
"Approximately forty percent of all energy use, greenhouse gas emissions, material flow, and waste are from construction and use of buildings."

Despite this statistic, as recently as a decade ago, many in the structural engineering community did not understand how they could contribute and did not feel the structural engineering profession should take a lead in mitigating the impacts of climate change. A key goal of this workshop was to encourage structural engineers to discuss ideas intended to drive the industry toward zero carbon, working with other professions and leaders as integral partners and as fundamental drivers to meet these carbon-reduction goals. The ideas put forward at this workshop are intended to spur a broad and deep culture shift in the profession. Structural engineers are in a position to have sustainability and resilience as premier design objectives, underpinned by current design objectives of strength, stability, reliability, serviceability, aesthetics, and economy. Hajjar emphasized that performance goals should include being executed in a cost-neutral manner while embracing these objectives and that the choices made by the structural engineering community can drive markets.

Hajjar asked the workshop participants to consider what whole new industries, materials, supply chains, structural systems, policies, standards, codes, design guides, and regulations are needed to achieve these objectives. What should structural engineers be doing now that they are not doing adequately?

Goupil highlighted the unique position of the SEI in continuing to lead sustainability efforts within the structural engineering profession. Anchored by the numerous activities and initiatives of the SEI Technical Committee on Sustainability; the SEI SE 2050 Commitment Program; the ASCE Committee on Sustainability; and other sustainability-related initiatives and activities at ASCE, SEI, and other ASCE institutes, SEI is well positioned to consider bold initiatives for driving the profession toward zero carbon.

The workshop keynote speakers included the Honorable Brendan Owens from the U.S. Department of Defense and Lance Davis from another federal agency, who together oversee hundreds of thousands of federally owned buildings. These speakers highlighted the opportunity and potential for significant advancement toward zero carbon that partnering on the ongoing sustainability initiatives and design code development within their respective agencies could achieve.

Jude Abel from Deloitte LLP provided a unique perspective that highlighted the place of the AEC industry within the broader economy as it relates to achieving sustainability objectives across industries to achieve a net-zero emissions economy. She highlighted the importance of incentives, market forces, and government-industry partnerships to achieve significant progress.

Torey Brooks from the U.S. Environmental Protection Agency highlighted recent agency initiatives to foster sustainable materials, design, and construction. Matthew Eckelman from Northeastern University summarized the state of the art and recommended future initiatives related to material extraction and processing for the construction industry. Kena David from Consigli Construction Co., Inc., highlighted sustainability initiatives of contractors.

Benjamin W. Schafer of Johns Hopkins University moderated a discussion among three panelists representing different sectors of the industry related to construction materials.

Brandon Williams from Sublime Systems highlighted innovations in sustainable concrete materials. Max Puchtel from the American Institute of Steel Construction summarized several initiatives related to sustainability of structural steel. Jennifer Shakun from the New England Forestry Foundation highlighted the important interplay of forestry stewardship and timber design to provide sustainable solutions for construction.

The remainder of the workshop consisted of breakout sessions representing six industry sectors to focus on the following two key questions:

1. What are the key initiatives required to drive the profession toward zero carbon in structural engineering: research, practice, and education?
2. How are professional organizations such as SEI best able to advance toward zero carbon in structural engineering?

The six breakout groups included the following topics, moderators, and recorders:

A. Resource extraction, materials processing, and fabrication

- Moderator: Benjamin W. Schafer, Willard and Lillian Hackerman Professor of Civil and Systems Engineering, Department of Civil and Systems Engineering, Johns Hopkins University
- Recorder: Emily Lorenz, Principal Engineer, Independent Consultant

B. Architectural and engineering design

- Moderator: Michael Gryniuk, Founder and Principal, CORA Structural
- Recorder: Suzanne Robinson, Associate Principal, LeMessurier Associates

C. Life-cycle assessment, databases, and software

- Moderator: Matthew Eckelman, Associate Professor, Department of Civil and Environmental Engineering, Northeastern University
- Recorder: Demi Fang, Assistant Professor, School of Architecture, Northeastern University

D. Construction and deconstruction

- Moderator: Mark Webster, Senior Consulting Engineer, Simpson Gumpertz & Heger, Inc.
- Recorder: Erika Winters-Downey, Associate Principal and Director–Sustainable Structures, Lamar Johnson Collaborative

E. Policy, advocacy, and the public

- Moderator: Elaina Sutley, Associate Dean for Diversity, Equity, Inclusion and Belonging, School of Engineering, and Associate Professor, Department of Civil, Environmental, and Architectural Engineering, University of Kansas
- Recorder: Luke Lombardi, Senior Sustainability Consultant, Buro Happold

F. Education

- Moderator: Jay Arehart, Assistant Teaching Professor and Director of Architectural Engineering, Department of Civil, Environmental, and Architectural Engineering, University of Colorado Boulder
- Recorder: Andrew Myers, Professor and Associate Chair for Graduate Studies, Department of Civil and Environmental Engineering, Northeastern University

Each breakout session discussed the two key questions in relation to the breakout topic. Then, during the final workshop sessions, the workshop participants voted to prioritize and highlight the key initiatives for the profession and for SEI moving forward, which are summarized in Section 2. Appendix D includes all these key initiatives in priority order.

Section 2 of this report summarizes key discussion points and initiatives put forward in the six breakout sessions. Section 3 presents conclusions and identifies recommendations and future initiatives.

2. Breakout Session Summaries and Priorities

The following six sections summarize the discussions and key recommendations resulting from discussing these two questions:

1. What are the key initiatives required to drive the profession toward zero carbon in structural engineering: research, practice, and education?
2. How are professional organizations such as SEI best able to advance toward zero carbon in structural engineering?

2.1. Breakout Session A: Resource Extraction, Materials Processing, and Fabrication

The breakout session on resource extraction, materials processing, and fabrication focused on the key initiatives required for zero carbon in structural engineering infrastructure. In addition, the participants were tasked with considering specifically how professional organizations such as SEI can best achieve these goals. Broadly, the participants considered initiatives in research, practice, and education to meet the stated goals.

2.1.1. Summary

The breakout session had experts on infrastructure materials, including professionals involved in resource extraction, materials processing, and fabrication for traditional civil engineering materials: timber, concrete, and steel. The session included commercial and research innovators working in these domains and those looking more broadly at the role of sustainability and embodied carbon in resource extraction, materials processing, and fabrication.

The breakout session reviewed a traditional life-cycle assessment (LCA) framework and identified its scope as the production stage, which includes module A1: raw material supply, module A2: transport, and module A3: manufacturing. Participants also spent some time clarifying the meaning and implications of “resource extraction,” “materials processing,” and “fabrication.” A key takeaway was that embracing a circular economy way of thinking could help prevent this linear idea of starting with resource extraction, which could be the most critical takeaway from considering the production stage: that is, can the profession avoid much of it more often than previously recognized?

Participants highlighted critical issues that would ultimately lead to the breakout session priorities. Focusing first on resource extraction, participants discussed the overarching need to decarbonize; a consistent need for transparency, accounting, and targets; the current lack of reward or incentive for reuse and the need for market mechanisms; and the lack of knowledge of many structural engineers on the impact of resource extraction on LCA of the materials used in construction.

In discussing materials processing, the participants identified an overarching need for electrification; the importance of incentivizing and de-risking the best new practices; the slowness of standards and existing methods for the current time and need; and the need for political advocacy to unleash technical innovation.

Finally, in discussing fabrication, the breakout session participants considered rethinking risk, noting that risk in the time of climate change is much more than just life-safety structural risk and needs to be considered. They also talked about demonstration buildings and platforms and tax credits to explore new technology in infrastructure at pace. They noted the need to address how civil innovation needs more commodity solutions vs. the proprietary path of other aspects of renewable energy. How does the profession get funding for innovation in civil structural spaces in this situation? Other topics discussed included increasing the connection between materials suppliers and specifying engineers, recognizing and leveraging the fact that more engineering dollars and more engineering time equates to less carbon and less cost, rebalancing construction inefficiencies vs. carbon inefficiencies to make the carbon inefficiencies matter more, focusing on fabrication for reuse, moving infrastructure thinking more to 3D in fabrication, and providing education at all levels for all parties.

The participants summarized the overall discussion with two key points: the participants advocate for and support the circular economy for buildings and structural engineers should lead in requesting materials and fabrication processes that support net-zero carbon designs.

2.1.2. Priorities

The participants in the resource extraction, materials processing, and fabrication group winnowed their ideas down to the following six priorities (in order):

1. **De-risk adoption of new materials innovations** through published protocols, demonstration platforms (even demonstration buildings), and training for certifiers and others. The participants were particularly keen on any effort that de-risks

materials innovation in buildings and infrastructure. They noted an imbalance between the need for materials innovation to reach net-zero goals and the risks that structural engineers become liable for when sourcing or specifying new solutions in their designs.

2. Create **transparency and accounting in materials sourcing** directed toward an end state of 2035 carbon targets and raw material (sourcing) certification through draft specifications, advocacy, and so on. Participants were keen to see SEI align itself with meaningful raw material (sourcing) certification. This level of advocacy is critical to adoption with a level playing field.
3. Create **education**al series to bring materials "resource to fabrication" knowledge to structural engineers across all materials. Structural engineering education, at all levels, tends to make assumptions about the materials involved and provides little in the way of frameworks and knowledge for structural engineers to consider questions related to the carbon and energy inherent in going from resource to fabrication.

> **"Structural engineering education, at all levels, tends to make assumptions about the materials involved and provides little in the way of frameworks and knowledge for structural engineers to consider questions related to the carbon and energy inherent in going from resource to fabrication."**

4. Structural engineers need to understand the basic tradeoffs and questions at this level to advocate for better solutions.
5. Promote-advocate-educate for **reuse** and avoidance of resource extraction (circular economy materials ecosystems). Participants were enthusiastic about reuse instead of raw material extraction, and all steps leading to a more circular economy for infrastructure materials need to be a priority for structural engineers.

> **"Re-use, instead of raw material extraction, and all steps leading to a more circular economy for infrastructure materials needs to be a priority for structural engineers."**

6. Promote-advocate-educate for appropriate **engineering time** directed toward sustainability goals (efficiency, lower carbon). The participants agreed that the current balance of engineering time in a project is out of balance and leads to less efficient infrastructure with a higher level of embodied carbon. Improvements only happen with more time per project.
7. Promote required **regulations for embodied carbon calculation** for resource extraction, materials processing, and fabrication. A level playing field demands consistency in key calculations such as embodied carbon. Promoting the SEI "Prestandard for Assessing the Embodied Carbon of Structural Systems for Buildings" and advocating for clear regulations in this space is a high priority.

2.2. Breakout Session B: Architectural and Engineering Design

The breakout session on architectural and engineering design underscored the urgency of establishing a unified framework for addressing carbon in structural engineering while enabling flexibility for firms and engineers to adopt and innovate within a set of guidelines.

2.2.1. Summary

This breakout session explored and defined initiatives critical to advancing the structural engineering profession toward zero carbon and how SEI can support and lead this transition. The session focused on creating a practical roadmap, fostering interprofessional partnerships, advocating for policy changes, and building awareness within the profession and among clients. It sought to answer key questions about how research, practice, and education in structural engineering can contribute to the toward-zero carbon goal and how SEI can effectively drive these efforts.

2.2.2. Priorities

The following priorities stemmed from the breakout session on architectural and engineering design:

1. **Develop a roadmap for zero carbon in structural engineering:**
   a) Create a structured roadmap with intermediate targets (5, 10, 15 years) for the profession;

   b) Align with other professional roadmaps—such as for materials, including concrete, steel, and timber—and with professional organizations, such as the Institution of Structural Engineering in the United Kingdom (IStructE);
   c) Include resources, guidelines, and toolkits to support easy wins and stretch goals; and
   d) Address roadblocks and ensure inclusivity for all engineers.
2. **Promote early structural engineer involvement:**
   a) Form strategic partnerships with organizations such as the American Institute of Architects to advocate for early involvement of structural engineers;
   b) Equip engineers with skills to proactively address nontechnical challenges; and
   c) Encourage cross-disciplinary collaboration to optimize project outcomes.
3. **Develop prestandards and code advocacy:**

> **"Develop prestandards and standards for embodied carbon within structures."**

   a) Develop prestandards and standards for embodied carbon within structures that can be referenced prior to full code adoption;
   b) Reassess national standards to optimize reliability of reduced embodied carbon (e.g., reassess loading and target reliabilities);
   c) Use precedents, such as ASCE/SEI's "Prestandard for Performance-based Wind Design," to fast-track development of embodied carbon measures; and
   d) Create frameworks and recommendations for performance-based carbon caps and baseline designs.
4. **Develop an education and awareness campaign:**
   a) Launch a deliberate marketing campaign to raise awareness of embodied carbon;
   b) Reframe embodied carbon as a life-safety issue to accelerate adoption; and
   c) Integrate sustainability into all SEI committees and create continuing education materials, including PDH and CEU programs.
5. **De-risk embodied carbon strategies:**
   a) Vet new materials, environmental product declarations (EPDs), and LCAs to build confidence in embodied carbon reduction strategies and
   b) Create standards of care and validation processes for emerging embodied carbon practices.
6. **Vet and curate resources:**

a) Enable SEI to act as a resource hub, curating best-in-class information from various industries, such as materials including steel, timber, and concrete and
b) Address industry fragmentation by harmonizing resources and avoiding contradictory information.

7. **Expand SEI's organizational capacity:**
   a) Restructure SEI to expedite the development of resources, potentially through hiring additional staff, and
   b) Move beyond volunteer-based efforts to accelerate the creation of tools and guidelines.
8. **Make advocacy and regulatory efforts:**
   a) Advocate for regulatory measures to mandate embodied carbon consideration, starting with measurement and moving toward carbon caps;
   b) Push for embodied carbon to be a part of the building code and licensure exams, including the Fundamentals of Engineering, Professional Engineer (PE), and Structural Engineer (SE) licensure exams; and
   c) Educate the public on the role of structural engineers in solving the climate crisis.
9. **Develop baseline building and carbon cap definitions:**
   a) Develop and standardize baseline building definitions for low-carbon design, similar to American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 and 189.1 for energy performance;
   b) Introduce benchmarks for reducing structural elements with high embodied carbon, such as transfers and cantilevers; and
   c) Introduce recommendations for incorporating performance-based embodied carbon caps.
10. **Encourage reuse and adaptive reuse:**
   a) Advocate for building codes that incentivize reuse rather than penalizes it and
   b) Provide guidance on designing for deconstruction and long-term adaptability.
11. **Create long-term goals for carbon reduction:**
   a) Move SEI to establish a roadmap for embodied carbon reduction strategies to become common practice by 2030 and
   b) Set a target for zero-carbon materials and products by 2050.

2.3. Breakout Session C: Life-Cycle Assessment, Databases, and Software

The breakout session on life-cycle assessment, databases, and software identified challenges and opportunities related to LCA strategies within structural engineering and use of databases and software to enhance sustainable design and construction of structures.

2.3.1. Summary

Discussion of challenges and proposed solutions in this breakout session fell into four major categories: overcoming data limitations, improving LCA software tools and their data transparency, identifying SEI opportunities to improve the role of LCA within design, and improving structural engineers' training and literacy.

Overcoming data limitations

Participants discussed several challenges in transparency and availability of data and proposed related solutions. They highlighted the lack of data for use as an intermediary between industry-wide averages and product-level EPDs. Participants expressed interest in having SEI provide guidance to fill this gap. Some suggested guidance included data-informed regional averages (recent Carbon Leadership Forum Material Baseline reports address this need) and a tool that provides parametrized LCA values (refined by geography or scope).

Participants were also interested in additional quality criteria for EPDs and were skeptical of EPD reviews that were not conducted independently. Options to address this included an SEI-approved pool of reviewers and/or certifiers for EPDs. A suggested criterion to include in future product category rules is an SEI-branded "EPD+" stamp of approval on EPDs that pass a review via appropriate committees within SEI. A forthcoming labeling program from the U.S. Environmental Protection Agency may address this interest.

Participants desired better data around the following life-cycle modules beyond A1–A3: real-time environmental tracking of specific materials, e.g., concrete mixes; fire-proofing and post-tensioning strands; and new materials. Participants stated that data limitations for new materials are a barrier to bringing them to market.

Improving LCA software tools and their data transparency

Most participants interacted with data through LCA tools and highlighted challenges around data transparency. The breakout session proposed the following solutions: creating pressure and incentives for LCA software tools to keep EPD values up to date and/or publishing inventories and sources to give users greater confidence in the data, incentivizing LCA software developers to provide more explanatory guidance during use to help cut user error and inconsistencies, and incentivizing improvement of visualizations and exports along with data transparency.

Identifying SEI opportunities to improve the role of LCA within design

Participants identified several data-related opportunities for SEI to improve the deployment of LCA during design, including an SEI stance on who evaluates EPDs and/or performs LCA in project teams, advocacy for a parametric tool allowing users to estimate carbon intensity factors as an intermediate between EPD values and industry-wide averages (see also the previous section on overcoming data limitations), and incentives for a software system that ensures LCA inputs and assumptions are shared across disciplines on a given project. Participants identified the need for SEI clarification on which tools (and data) are best suited for different stages of design.

For the near term, the SEI "Prestandard for Assessing the Embodied Carbon of Structural Systems for Buildings" addresses this latter opportunity. Other opportunities for improving LCA in design include developing SEI-driven incentives for improved data structures and open-source inventories that enable data transparency and allow third-party tools to focus on enhancing the user interface and visualization development; codifying LCA or EPD guidelines into core structural engineering practice, such as into ASCE 7; educating clients (and/or the general public) on the importance of whole building life-cycle assessment and embodied carbon; and leading efforts to coordinate with the U.S. Green Building Council (USGBC) on incorporating higher-weight Leadership in Energy and Environmental Design (LEED) incentives on embodied carbon, especially those specific to structures, such as an "on track for SEI SE 2050 Commitment Program" LEED category. Participants also discussed SEI-established benchmarks and/or baselines, including precedent design tools, such as picking multipliers from a map, or ASHRAE 240P reference buildings. They noted that the desire for benchmarks could be addressed by data analysis results to be released by the SEI SE 2050 Commitment Program within the next year.

The participants valued the distinction between the use of benchmarks and baselines. For example, benchmarks might be important for calibrating orders of magnitude but less useful for measuring reductions in a given project. Benchmarks are also useful for giving orders of magnitude of "better" or "worse" to clients and the public.

Improving structural engineers' training and literacy

Recognizing the relationship between data transparency and literacy, participants also identified the following opportunities to boost the structural engineering profession's literacy in data and LCA, including education on limitations and uncertainty in EPDs and more explicit training and incentives for structural engineers to perform LCA. These incentives could take the form of micro-credentialing and/or certificates, while others suggested embedding LCA and data literacy directly into structural engineering curricula. The participants also noted the need for more education around impact categories outside of global warming potential. For example, they expressed concern around a "carbon myopia" in addressing the climate impacts of the profession and suggested pursuing models that incorporate and consider economics and social benefits, such as labor. Participants indicated the importance of putting numbers behind the actual costs of emissions reductions. While cost may be more sensitive for data disclosure purposes, participants suggested an opportunity to engage with contractors' organizations such as Contractor's Commitment.

2.3.2. Priorities

The following recommendations emerged from the discussion as high-impact opportunities for SEI, ranging from immediate short-term actions to long-term aspirations where intermediate steps are less immediately clear.

1. Participants recommended SEI coordinate with USGBC on incorporating higher-weight LEED incentives on embodied carbon, especially specific to structures.
2. Data transparency and LCA quality are contingent on user proficiency in terms of understanding and using material values in EPDs and inventories. Participants recommended that SEI promote more education for the structural engineering profession around understanding the uncertainty and limitations of EPDs. This literacy can lead to higher profession-wide expectations around data quality and greater ability to interpret LCA results and identify potential issues with published EPDs.
3. In considering LCA-related data quality needs, participants identified material values beyond modules A1–A3 as an important data gap to prioritize filling. In light of data gaps between product-level EPDs and industry-wide averages, participants also recommended SEI advocate for parametric tools to estimate carbon intensity factors by region or scope.
4. Participants also identified many meaningful opportunities for improving the user experience of LCA software. Participants recommended that SEI create incentives for LCA software tools to improve recency and transparency of data inventories,

"Create incentives for LCA software tools to improve recency and transparency of data inventories."

such as by keeping EPD values up to date and/or by publishing inventories and sources, to give users greater confidence in the data. Considering the multidisciplinary procedure of LCA, participants also called on SEI to advocate for software that ensures LCA inputs and assumptions are shared across disciplines on a given project. They identified SEI-approved benchmarks as a priority recommendation, or at least baselines to calibrate orders of magnitude of whole building life-cycle assessment, to enable meaningful communication of emissions reductions to team members including clients and owners.

5. The participants recommended codifying LCA guidelines, such as within ASCE 7. Participants also expressed interest in the profession starting to expand literacy and model analysis beyond emissions to consider other life-cycle impacts, economics, and social dimensions, to prevent a profession-wide "carbon myopia" in addressing the environmental impacts of structural systems.

2.4. Breakout Session D: Construction and Deconstruction

The breakout session on construction and deconstruction addressed construction-phase carbon emissions, deconstruction, and material reuse within structural engineering.

2.4.1. Summary

Construction

Construction activities contribute significantly to climate emissions and are increasingly under scrutiny. For the United Kingdom, the Royal Institution of Chartered Surveyors recommends default values of 35 $kgCO_2e/m^2$ for demolition of an existing building and 40 $kgCO_2e/m^2$ for on-site construction activities.

Examples of emission sources during construction include diesel-powered generators providing on-site power; heating in cold weather, especially for concrete and masonry activities; transportation of materials to the site; and water usage (indirectly contributing to emissions).

Discussion highlights included insufficient available information about construction-phase emissions, high cost of alternative energy sources and construction practices, and association of emissions with on-site formwork.

The participants discussed strategies for reducing construction-related emissions such as prefabrication, automation, project delivery/collaboration, and shifting of project timelines to allow more time to incorporate reuse.

Deconstruction and reuse

Deconstruction provides materials that can be reused in new construction with a small fraction of the embodied carbon associated with new materials. Participants highlighted the following concerns and opportunities: little information is available about the process, costs, and benefits of deconstruction; perceived risks are associated with using salvaged materials due to lack of professional and code guidance; perceived additional costs are associated with deconstruction compared with traditional demolition; and supply chains for salvaged materials are not well-established, so concerns surround availability and cost of materials.

The participants discussed strategies for making deconstruction/salvage/reuse more routine, including gaining a better understanding of the true costs of deconstruction once better methods are developed and workers are trained, conducting pre-demolition building surveys to identify salvageable materials, writing a design guide for salvaged materials, conducting surveys on the practices of deconstruction contractors, being flexible with structural design and tailoring it to available materials, developing stable and reliable supply chains for salvaged materials, and developing EPDs for salvaged materials.

Building reuse is also an excellent strategy to reduce embodied carbon. Participants highlighted the following concerns and opportunities: when pricing reuse vs. new construction, the greater unknowns associated with reuse can raise cost estimates, and reuse often entails costly energy upgrades. A strategy to encourage building reuse involves creating policy incentives encouraging building reuse.

2.4.2. Priorities

The participants selected five key initiatives for moving toward zero-carbon structural systems and divided them into two categories: those driven by professional organizations such as SEI and those driven by the larger community.

Two key SEI initiatives:

1. **Guide to evaluating buildings for reuse and deconstruction.** Building reuse is often cited as the second-best strategy for reducing embodied carbon after "do nothing." Deconstruction is the best approach to removing a building as a last resort so that the embodied carbon of those existing materials can be used productively in new construction instead of new materials.

   "Deconstruction is the best approach to removing a building as a last resort so that the embodied carbon of those existing materials can be used productively in new construction in place of new materials."

   But reuse and deconstruction have associated risks and costs. One way to reduce these risks and reveal the potential for these strategies is to identify the potential of a building for reuse and deconstruction. With this information, building and building portfolio owners could better understand the value of their properties as candidates for adaptive reuse and for deconstruction. Armed with this information, they would be more likely to implement such strategies in place of the less risky but more environmentally harmful choice of demolish and build new.

   The participants recommended preparing a guideline or standard to evaluate existing buildings for reuse and deconstruction potential. Such an evaluation could build upon existing ASCE guidelines for condition assessment and building retrofit. The methodology would evaluate the existing structural system for reuse potential, including assessing deterioration, safe live loads, adaptability, and code requirements for the gravity and lateral systems in adaptive reuse scenarios. To evaluate deconstruction potential, deconstructable materials would be identified and cataloged. Potential market value of such materials could be addressed.

   An SEI guideline would focus on structural materials. The authors would collaborate with architects and deconstruction contractors to develop effective measures of adaptability and deconstructability, respectively.

2. **Guide to material reuse.** Designers perceive risk associated with designing for and specifying reused materials. The participants recommended preparing a guideline or standard for designing with salvaged materials. The document could address material provenance and likely properties based on age and source, evaluation (including testing), and applicable safety factors. It could cover typical deterioration mechanisms for structural materials, such as creep, corrosion, and fatigue, and how to address such conditions if present. Once procedures are established, they could eventually be incorporated into building codes, removing another obstacle to material reuse.

Three key industry-wide initiatives:

3. **Demystifying deconstruction**. The participants noted that deconstruction is perceived as time-consuming and costly and therefore often dismissed as an option. The participants recommended a comprehensive study of deconstruction addressing these questions of cost, time, and risk. The study would identify the real barriers to deconstruction rather than demolition through surveys and fact-finding with deconstruction contractors and project teams that have deconstructed buildings successfully. This study would engage contractors, designers, academics, and policymakers who have worked in this arena.
4. **A national salvaged material exchange.** One major impediment to advancing deconstruction and reuse is a weak supply chain. Although some regional reused material centers exist, they are local and generally do not stock structural materials. The storage and supply of structural materials such as timber and steel framing requires space and distribution mechanisms. Development of such supply chains requires markets. A national salvaged material exchange would expand the reach of regional and local reused material operations, encouraging them to expand their stock of bulkier materials that could be shipped long distances.

"A national salvaged material exchange would expand the reach of regional and local reused material operations, encouraging them to expand their stock of bulkier materials that could be shipped long distances."

Those seeking salvaged materials would have ready access to a national supply and potentially source materials from multiple origins.

A coalition of local and regional salvaged material suppliers, including potential structural material distribution operations such as steel service centers and lumberyards, with support provided by grants from nonprofit and/or government sources, could lead the establishment of such a national exchange. Structural engineers should help decide what type of information to include in the database, such as wood species and steel grades where known.

5. **Designer role in reducing construction impacts.** The participants raised a concern that designers may not always understand how their choices affect construction-phase carbon emissions. In general, design guidance for reducing embodied carbon calls for material optimization, but designers need to be aware of the limitations of that approach by accounting for construction impacts.

   The participants recommended conducting studies of these tradeoffs to provide actionable guidance for designers. Such studies would look at the full A1–A5 life-cycle stages of alternate design choices and offer guidance as to which are preferable with respect to climate emissions.

Other recommendations and ideas that did not make the top five but that have value and should be included in the conversation follow.

Construction:

- Research into automated construction (e.g., robotics) that can be used to make optimized designs less labor intensive. Historically when materials were more expensive relative to labor, highly efficient structures such as built-up trussed structural members were possible. Automated construction techniques could potentially revive these sorts of structural elements.
- Prefabricated elements and other design strategies can reduce construction phase emissions.
- Guidance and incentives are needed for deconstruction plans for new construction. Development of “material passports” to label structural elements in new construction could be part of these approaches.
- Case studies of projects that successfully reduce construction-phase emissions would be beneficial.
- Construction-phase emissions must be more accurately captured in LCA tools. Additional research is needed to categorize and document these emissions.
- Education of students and working professionals about construction-phase emissions is needed.

- SEI should engage with construction-related professional organizations to research construction-phase emissions and document and disseminate the findings.
- Prefabrication can reduce construction-phase emissions and reduce material waste. A guide to prefabricated construction techniques that reduce emissions relative to conventional site-constructed structures could help move the industry in this direction.

Deconstruction and reuse:

- Recommend code changes that are needed to facilitate material reuse. Work with material professional groups to develop recommended code language.
- Develop a database of case studies of projects successfully incorporating material reuse.
- Advocate for policies at all levels of government that incentivize deconstruction instead of demolition.
- Publish a guide to design for deconstruction.
- Determine whether existing SEI committees can address deconstruction and reuse or whether SEI needs to consider one or more new committees.

2.5. Breakout Session E: Policy, Advocacy, and the Public

The breakout session on policy, advocacy, and the public focused on the need for structural engineers to engage the public and advocate for increasing ambition on embodied carbon policy as a key driver of meeting global climate targets.

2.5.1. Summary

Public policy and building codes—the legal rules and requirements to build in society—are the most influential levers for widespread action. Discussion around climate action and embodied carbon often calls for incentives, primarily financial. Policy supersedes financial and other considerations with the recognition that action is necessary for the public good. With this also comes the heavy weight of collateral impacts of such policies.

This breakout discussion and resulting recommended actions were categorized as pertaining to industry collaboration, equitable engagement, building codes, and circularity.

Foster and maintain industry collaboration

The participants addressed the need to advance and expand industry collaboration by bolstering existing policy activities and expanding public communication. The recommendation is for these efforts to begin by publishing a concise policy statement and sharing a transparent roadmap to 2050, creating an annual sustainability report card, advocating for carbon reduction, developing policy templates and resources, supporting tax breaks for early adopters, and actively tracking federal agency regulations through a dedicated committee. SEI should aim to accomplish these goals by formalizing and supporting existing volunteer efforts such as the SE Sustainable Policy Collaboration and ASCE Legislative Action Group.

Prioritize equitable engagement with the public

Social and equitable public engagement serves as an important mechanism to further recognize the valuable role of structural engineers in society and expand their perceived value in the realm of sustainability. Discussions proposed promoting the standing of structural engineers via educational media campaigns about sustainable buildings, incentivizing SEI SE 2050 Commitment Program adoption, and elevating program recognition. Additionally, the participants stressed the importance of advocating for integrating the social cost of carbon into building costs, clarifying ethical responsibilities related to environmental impacts, pushing for improvements to LEED, presenting at the annual conference of mayors, and engaging in daily conversations with the public to raise awareness about sustainable engineering practices. These aspirations need to leverage an equitable lens and aim to reach a broad audience on the grounds that sustainable action is only successful if everyone is successful.

Integrate sustainability goals into building codes and professional practice

Building codes are the ultimate purview of structural engineers and technical practices, and the profession has a critical role to play amid efforts to incorporate embodied carbon into codes. SEI should aim to establish or support the establishment of performance standards using data from the SEI SE 2050 Commitment Program to define minimum performance levels, e.g., embodied carbon intensity limits ($kgCO_2e/m^2$). These standards must be transparent and incorporated into the SEI roadmap to facilitate adoption. Limits should be dynamic and ultimately aim for reconciliation with Science-Based Targets Initiative limits by 2050. Initially, voluntary adoption is anticipated with the goal of incorporating the limits into building codes by 2030. Additionally, building code goals apply to design loading and serviceability criteria (ASCE 7), advocacy for performance-based specification language for concrete, verification requirements (e.g., EPDs), and fundraising to support pilot projects that aggressively target carbon reduction while mitigating risk and creating experiential learning opportunities for the public. Importantly, the workforce cannot be left behind code advancements, and thus SEI can work with the National Council of Examiners for Engineering and Surveying and LEED to mandate and produce continuing education on embodied carbon for licensed structural engineers and professional engineers.

Promote and enable circularity

> **"In parallel with efforts to raise minimum performance with existing standard practices, the profession also needs to support early adopters and the cutting edge of innovation, such as circularity, that radically mitigates resource consumption and environmental degradation."**

In parallel with efforts to raise minimum performance with existing standard practices, the profession also needs to support early adopters and the cutting edge of innovation, such as circularity, that radically mitigate resource consumption and environmental degradation. Circularity will play a critical long-term role in building decarbonization, and though it has gained some momentum in parts of Europe, it remains in the nascent stages of adoption in the United States. To be the leader SEI aims to be, the institute should consider goals requiring salvage assessments for structural reuse on existing projects, partnering with academia to incentivize adaptive reuse, mandating design for deconstruction and decommission plans in new projects, publishing research on aggregating structural data pertaining to reuse, and ensuring LCA comparisons for new projects involving existing buildings. Circularity also extends into biobased materials that have a natural and more regenerative end of life.

Policy sits at the intersection of private leaders, public practice standards, and legislative requirements. Private practice often serves as a test bed for innovation. The public sector can complement the scale of adoption of industry best practices as a large builder and buyer in the industry by including the additional needs of public health, safety, and welfare beyond market cost implications. Only after the viability of scalable action has been established, either by public or private entities, can broad policy adoption be established that raises the standard of all actors. SEI should embrace an active role in this nexus rather than the current more passive or reactive one to advance the profession into the future.

2.5.2. Priorities

The top five priorities from discussions were as follows:

1. **Publish policy statements and action plans** that serve as a consistent, concise platform of issues that SEI proactively supports and join ASCE legislative action on reducing carbon.
2. **Set performance standards** using data and resources from the SEI SE 2050 Commitment Program with clear intermediate milestones.
3. **Reclaim ownership of building codes** to performance-based criteria (with explicit sustainability criteria) to elevate the profession rather than designing for the worst engineers.
4. **Establish a public marketing campaign** (social media and educational marketing) to educate the public and shift market demand to sustainable buildings while elevating the positive role of structural engineers.
5. **Partner with business professionals** to develop programs that establish a business case for building sustainability innovation, such as adaptive reuse, and engage publicly, e.g., by presenting to the annual conference of mayors.

Additional goals related to policy, advocacy, and the public include the following:

Raising public awareness:

- Develop an annual report card similar to the infrastructure report card;
- Provide education about the code of ethics, clarifying that engineers must discuss the environmental impacts of project design choices;
- Develop policy templates and industry engagement resources to facilitate local policy and avoid communication breakdowns on projects; and
- Formally advocate for changes and improvements to LEED.

Raising profession minimum performance:

- Incentivize SEI SE 2050 Commitment Program adoption;
- Mandate continuing education on embodied carbon for membership;
- Revisit ASCE 7 design loading and serviceability criteria in response to changes due to climate change;
- Require LCA comparison for new projects when a building already exists; and
- Advocate for financial organizations—banks and research funding agencies—to require considerations of carbon reductions in review criteria for grants/loan requests/proposals.

Leading on innovation:

- Set voluntary performance targets and work to get required limits into building code by 2030 and make dynamic LCA limits that align with Science-Based Targets Initiative targets by 2050;
- Require salvage assessment for structural reuse on all existing projects;
- Partner with academic business programs to develop programs that incentivize adaptive reuse and present to the annual conference of mayors;
- Require design for deconstruction drawings and decommission plan in all new projects; and
- Fundraise for pilot projects that hit aggressive carbon reduction targets, mitigate risk, and create experiential learning for the public.

2.6. Breakout Session F: Education

The breakout session on education addressed education of stakeholders included within the scope of this workshop.

2.6.1. Summary

This breakout session discussed the pivotal role of education in steering the structural engineering profession toward zero carbon. Education cuts across all other focus areas. The discussion during the workshop focused on formal academic education; however, education of professionals and the public were also identified as key areas.

To summarize the discussion, education is divided into three categories: providing formal academic education, educating the practicing engineer, and educating other stakeholders. The following priorities section will explore these areas further and summarize initiatives and priorities that will help drive the structural engineering profession toward zero carbon.

2.6.2. Priorities

1. Formal academic education

Colleges and universities are responsible for educating emerging structural engineers. Moving toward zero carbon by 2050 will require that all graduate structural engineers are well-versed in low-carbon structural design. The following three initiatives were identified as priorities to support colleges and universities.

Education Initiative 1: Define the "embodied carbon literacy" that is required of the graduate structural engineer.

What a graduating structural engineer must know about embodied carbon needs to be defined. An industry-academic partnership is recommended to clearly define the basic embodied carbon literacy that is expected of structural engineering graduates. This literacy may include, among others, core concepts of sustainability science, LCA fundamentals, industrial engineering of construction materials, retrofit of existing systems, timber design, and low-carbon design strategies.

By defining embodied carbon literacy, civil, architectural, and structural engineering programs can determine how best to incorporate the core competencies into their respective curricula.

"By defining embodied carbon literacy, civil, architectural, and structural engineering programs can determine how best to implement the core competencies into their respective curricula."

To enable the development of this literacy, the profession must define the standard of practice around embodied carbon. The development of basic "embodied carbon literacy" relies upon the profession having clearly defined a standard of practice (see Education Initiative 5).

Education Initiative 2: Incorporate sustainability as a core design constraint across the profession.

A larger requirement in moving toward zero carbon is the collective recognition of the structural engineering profession that sustainability, specifically addressing the climate crisis, is a core tenet. While cultural shifts require a change in leadership and those with power, academic institutions can support this shift by including sustainability as a core element of undergraduate and graduate curricula.

Education Initiative 3: Integrate sustainability across the structural engineering curriculum to inspire future engineers.

Sustainability topics are typically considered separately from core structural engineering topics. To shift the mindset of the engineer toward viewing sustainability and structural engineering as interlinked, topics of sustainability must be infused into the curriculum. By doing so, the profession can engage more students who have an interest in sustainability but do not view structural engineering as a home for their interest.

Professional organizations can help academic instructors achieve this initiative by supporting the development of teaching materials across all curriculum levels. For example, SEI is well-equipped to develop content and examples that are material agnostic to avoid the bias that may be introduced from material-specific trade organizations that may not want to highlight the downsides of a given construction material.

2. **Education for the practicing engineer**

In addition to training graduate engineers in low-carbon structural design, upscaling the entire profession to move it toward zero carbon is also imperative. The following two priority initiatives are related to the practicing engineer.

Education Initiative 4: Develop continuing education resources incentivized by questions on the PE and SE licensure exams.

To engage engineers across the profession, the recommendation is to develop and incentivize educational resources for professionals through embodied carbon-related questions on the PE and SE licensure exams. For example, aligned organizations such as iStructE include sustainability topics in their licensure exam and can be considered a precedent.

Education Initiative 5: Develop the standard of practice around embodied carbon.

> **"The profession relies heavily upon standards to guide the practice. Professional organizations should lead the development of standards and design guides that enable professionals to consistently assess the embodied carbon of structural systems."**

The profession relies heavily on standards to guide practice. Professional organizations should lead the development of standards and design guides that enable professionals to consistently assess the embodied carbon of structural systems.

Additionally, the development of a carbon reduction roadmap, benchmarks, and targets will aid practicing engineers in understanding how the systems that they design perform against what is needed to move toward zero carbon.

3. Education for stakeholders

Education Initiative 6: Support workforce development in new construction methods, such as deconstruction, retrofit of historic structures, mass timber, and new innovations in materials and systems.

To realize the shift to zero carbon structural systems, the construction workforce must be able to implement these low carbon systems. While structural engineering professional organizations are often limited to the design side, they should also play a role in supporting the education of other industries. This support can help realize collective action.

3. Conclusions and Future Initiatives

The workshop “Toward Zero Carbon: Developing a Roadmap for the Structural Engineering Profession and the Structural Engineering Institute, ASCE,” hosted by the Structural Engineering Institute of the American Society of Civil Engineers and Northeastern University, established the commitment and excitement of the structural engineering community to lead the industry toward zero carbon for the built environment. By addressing issues related to extraction, production, fabrication, and distribution of construction materials; architectural and structural engineering design of the built environment; life-cycle assessment tools and databases related to sustainable design in construction; construction and deconstruction processes; and policy, advocacy, and education related to the built environment, the workshop participants prioritized key opportunities and initiatives needed to drive the structural engineering profession toward zero embodied and operational carbon in the built environment.

The following are key highlights from these prioritized initiatives:

- Develop a roadmap to drive the structural engineering profession toward zero carbon;
- Develop a performance standard using data collected through the SEI SE 2050 Commitment Program;
- Develop standards to ensure consistent methodology, data transparency, and robustness of embodied carbon calculations;
- Develop approaches to de-risk adoption of new and innovative materials, components, and systems through published protocols, demonstration platforms, and training for certifiers;
- Develop a guide or standard for evaluating adaptive reuse potential in existing buildings, including salvaged material opportunities for existing building portfolios (“reuse audit”);
- Develop design guides and other resources that aid practicing structural engineers in reducing the embodied carbon of structural systems;
- Reassess national standards to optimize reliability to reduced embodied carbon (e.g., reassess loading and target reliabilities);
- Work with federal agencies and partner and allied organizations to inform the development of their industry-leading sustainable design standards and guides;
- Develop approaches for incorporating sustainability as a core design responsibility to disseminate across the profession;

- Define the “embodied carbon literacy” that is recommended as a requirement of the graduate structural engineer;
- Develop an education and awareness campaign targeting professional structural engineers to ensure the practice is qualified to deliver results; and
- Develop a roadmap to enable the structural engineering profession to realize its goals related to zero-carbon designs.

Appendix D lists priorities established by the workshop participants. The Structural Engineering Institute will continue to lead in addressing initiatives such as these to drive the profession toward zero carbon.

4. References

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Appendices

Appendix A. Workshop Agenda

Toward Zero Carbon: Developing a Roadmap for the Structural Engineering Profession and the Structural Engineering Institute, ASCE

Northeastern University, Boston, Massachusetts

July 22–24, 2024

Monday, July 22, 2024

5:30 p.m.	**Opening Reception**
	17th Floor, East Village

Tuesday, July 23, 2024

7:30 a.m.	**Morning Networking and Breakfast**
	Interdisciplinary Science and Engineering Complex (ISEC), Lobby
8:30 a.m.	**Opening Remarks**
	Room 102 ISEC Auditorium
	Jerome F. Hajjar
	CDM Smith Professor, University Distinguished Professor, and Department Chair, Department of Civil and Environmental Engineering, Northeastern University, and President, Structural Engineering Institute
	Jennifer Goupil
	Managing Director, Structural Engineering Institute
8:45 a.m.	**The Honorable Brendan Owens**

Assistant Secretary of Defense for Energy, Installations, and Environment Chief Sustainability Officer, U.S. Department of Defense

9:10 a.m. **Jude Abel**

Senior Manager, Sustainability and Innovation, Deloitte LLP

9:30 a.m. **Lance Davis**

Sustainability Architect and Standards Expert, Federal Agency

9:50 a.m. **Torey Brooks**

Embodied Carbon Expert, U.S. Environmental Protection Agency

10:10 a.m. **Matthew Eckelman**

Associate Professor, Department of Civil and Environmental Engineering, Northeastern University

10:30 a.m. ***Break and Photo***

11:00 a.m. **Kena David**

Director of Sustainability, Consigli Construction Co., Inc.

11:20 a.m. **Panel Discussion**

Moderator: **Benjamin W. Schafer**, *Willard and Lillian Hackerman Professor of Civil and Systems Engineering, Department of Civil and Systems Engineering, Johns Hopkins University*

Brandon Williams

Product Success Manager, Sublime Systems

Max Puchtel

Director of Sustainability and Governmental Relations, American Institute of Steel Construction

Jennifer Shakun

Bioeconomy Initiative Director, New England Forestry Foundation

12:30 p.m. **Lunch**

1:30 p.m. **Breakout Sessions**

Interdisciplinary Science and Engineering Complex, Room 102 ISEC Auditorium

Jerome F. Hajjar: Charge the Breakouts

CDM Smith Professor, University Distinguished Professor, and Department Chair, Department of Civil and Environmental Engineering, Northeastern University, and President, Structural Engineering Institute

1:45 p.m. **Breakout Sessions**

Interdisciplinary Science and Engineering Complex and EXP

A. **Resource Extraction, Materials Processing, and Fabrication** - *Room 136 ISEC*

Moderator: Benjamin W. Schafer, *Willard and Lillian Hackerman Professor of Civil and Systems Engineering, Department of Civil and Systems Engineering, Johns Hopkins University*

Recorder: Emily Lorenz, *Principal Engineer, Independent Consultant*

B. **Architectural and Engineering Design** - *Room 102 ISEC*

Moderator: Michael Gryniuk, *Founder and Principal, CORA Structural*

Recorder: Suzanne Robinson, *Associate Principal, LeMessurier Associates*

C. **Life-Cycle Assessment, Databases, and Software** - *Room 138 ISEC*

Moderator: Matthew Eckelman, Associate Professor*, Department of Civil and Environmental Engineering, Northeastern University*

Recorder: Demi Fang, *Assistant Professor, School of Architecture, Northeastern University*

D. **Construction and Deconstruction** - *Room 140 ISEC*

Moderator: Mark Webster, *Senior Consulting Engineer, Simpson Gumpertz & Heger, Inc.*

Recorder: Erika Winters-Downey, *Associate Principal and Director–Sustainable Structures, Lamar Johnson Collaborative*

E. **Policy, Advocacy, and the Public** - *Room 142 ISEC*

Moderator: Elaina Sutley, *Associate Dean for Diversity, Equity, Inclusion and Belonging, School of Engineering, and Associate Professor, Department of Civil, Environmental, and Architectural Engineering, University of Kansas*

Recorder: Luke Lombardi, *Senior Sustainability Consultant, Buro Happold*

F. **Education** - *Room 610A EXP*

Moderator: Jay Arehart, *Assistant Teaching Professor and* Director of Architectural Engineering*, Department of Civil, Environmental, and Architectural Engineering, University of Colorado Boulder*

Recorder: Andrew Myers, *Professor and Associate Chair for Graduate Studies, Department of Civil and Environmental Engineering, Northeastern University*

Breakout Session Questions:

1. What are the key initiatives required to drive the profession toward zero carbon in structural engineering: research, practice, and education?

2. How are professional organizations such as SEI best able to advance toward zero carbon in structural engineering?

3:15 p.m. **Break**

3:45 p.m. **Breakout Session Reports**

Interdisciplinary Science and Engineering Complex, Room 102 ISEC Auditorium

4:15 p.m. **Discussion**

5:00 p.m. **Adjourn**

6:00 p.m. **Reception**

17th Floor, East Village

7:00 p.m. **Banquet**

17th Floor, East Village

<u>Wednesday, July 24, 2024</u>

7:30 a.m. **Morning Networking and Breakfast**

Interdisciplinary Science and Engineering Complex (ISEC), Lobby

8:00 a.m. **Breakout Sessions**

Interdisciplinary Science and Engineering Complex, Room 102 ISEC Auditorium

Jerome F. Hajjar: Charge the Breakouts

CDM Smith Professor, University Distinguished Professor, and Department Chair, Department of Civil and Environmental Engineering, Northeastern University, and President, Structural Engineering Institute

8:15 a.m. **Breakout Sessions: Prioritizing Session**

Interdisciplinary Science and Engineering Complex and EXP

A. **Resource Extraction, Materials Processing, and Fabrication** - *Room 136 ISEC*

B. **Architectural and Engineering Design** - *Room 102 ISEC Auditorium*

C. **Life-Cycle Assessment, Databases, and Software** - *Room 138 ISEC*

D. **Construction and Deconstruction** - *Room 140 ISEC*

E. **Policy, Advocacy, and the Public** - *Room 142 ISEC*

F. **Education** - *Room 610A EXP*

9:15 a.m. **Break**

9:45 a.m. **Breakout Session Reports**

Interdisciplinary Science and Engineering Complex, Room 102 ISEC Auditorium

10:15 a.m. **Prioritization (Voting)**

10:30 a.m. **Break**

10:45 a.m. **Moderated Discussion with Breakout Session Moderators and Recorders**

11:45 a.m. **Closing Remarks**

Jennifer Goupil

Managing Director, Structural Engineering Institute

Jerome F. Hajjar

CDM Smith Professor, University Distinguished Professor, and Department Chair, Department of Civil and Environmental

Engineering, Northeastern University, and President, Structural Engineering Institute

12:00 p.m. **Adjourn**

Appendix B. Workshop Invitation and Participant List

The following is the list of professionals who were invited to and/or participated in the workshop:

Jude	Abel	Deloitte LLP
Ebiji	Akah	SMBH, Inc.
Sergio	Alcocer	National Autonomous University of Mexico, UNAM
Don	Allen	Association of the Wall and Ceiling Industry
Bassem	Almuti	CannonDesign
Jay	Arehart	University of Colorado Boulder
Sanjay	Arwade	University of Massachusetts Amherst
Hessam	AzariJafari	Massachusetts Institute of Technology
Andre	Barbosa	Oregon State University
Juliana	Berglund-Brown	Massachusetts Institute of Technology
Sujit	Bhandari	Northeastern University
Daniella	Blyakhman	Walter P Moore
Kevin	Borth	HGA
Jared	Brewe	Precast/Prestressed Concrete Institute
Torey	Brooks	U.S. Environmental Protection Agency
Ivey	Bueno	IBI Development Advisors
Jim	Burke	CBT Architects

Brandon	Byers	ETH Zurich
Sangeeta	Chachadi	SOBHA, Ltd.
Baiyu	Chen	Northeastern University
Jim	D'Aloisio	Klepper, Hahn & Hyatt
Hossein	Daneshvar	University of Alberta
Mohammad Adil	Dar	University of Sheffield
Kena	David	Consigli Construction Co.
Don	Davies	Davies-Crooks Associates
Lance	Davis	Federal Agency
Joseph	De Larauze	Tufts University
Jessica	DeJoie	VHB
Jeffrey	Diguette	Clark Construction Group
Matt	Eckelman	Northeastern University
Allison	Evin	Northeastern University
Demi	Fang	Northeastern University
Kiley	Feickert	Massachusetts Institute of Technology
Lori	Ferriss	Built Buildings Lab
James	Ferullo	Isgenuity Architects
Catarina	Figueiredo Mendes	VHB
Kristen	Fritsch	Elkus Manfredi Architects

Antonio	Garcia	Northeastern University
Jennifer	Goupil	Structural Engineering Institute, ASCE
Michael	Gryniuk	CORA Structural
Jerome	Hajjar	Northeastern University
Stuart	Harrison	The Charles Pankow Foundation
Olivia	Healy	Fast+Epp
Thomas	Hennessy	Clayco
Gordana	Herning	Wesleyan University
Victoria	Herrero-Garcia	Mead & Hunt
Nathan	Holt	Meyer Borgman Johnson
Olivia	Humphrey	Payette
Heidi	Jandris	Jandris Block
Andrew	Jin	U.S. Army Corp of Engineers
Masha	Karameadeh	Northeastern University
Swarna	Karuppiah	Datum Engineers, Inc.
Dirk	Kestner	Walter P Moore
Ron	Klemencic	Magnusson Klemencic Associates
Maria	Koliou	Texas A&M University
Michelle	Laboy	Northeastern University
Michelle	Lambert	Carbon Leadership Forum

Nicholas	Lang	Concrete Masonry & Hardscapes Association
Dylan	Lee	BALA Consulting Engineers Inc.
Daniel	Linzell	National Science Foundation
Jamie	Littlefield	SLAM Collaborative
Ruipeng	Liu	Northeastern University
Luke	Lombardi	Buro Happold
Emily	Lorenz	Principal Engineer, Independent Consultant
Marco	Lo Ricco	USDA Forest Service–Forest Products Laboratory
Michael	Lyons	Martin/Martin, Inc.
Brenna	Marcoux	Forell/Elsesser Engineers, Inc.
Dominic	Mattman	RJC Engineers
Ian	McFarlane	Magnusson Klemencic Associates
Angela	Menichino	Stantec
Rodney	Meyers	Structural Engineering Institute, Maryland Chapter
Saurabh	Mhatre	Northeastern University
Reed	Miller	University at Maine
Russ	Miller-Johnson	Engineering Ventures, PC

Natasha	Mundis	LeMessurier Associates
Andrew	Myers	Northeastern University
Alison	Nash	Sasaki Associates, Inc.
Charles	Nmai	Master Builders Solutions
Alex	Nothnagel	John A. Martin & Associates, Inc.
Claire	Nowasell	Heidelberg Materials
John	Ochsendorf	Massachusetts Institute of Technology
David	Odeh	WSP Building Structures
Raven	Odian	John A. Martin & Associates, Inc.
Michael	Orbank	STO Building Group
Brandan	Owens	U.S. Department of Defense
Pradeep	Parde	Northeastern University
Brian	Parsons	American Society of Civil Engineers
Bill	Parsons	WoodWorks
Kara	Peterman	University of Massachusetts Amherst
Oliver	Pires	Lemessurier Associates
Max	Puchtel	American Institute of Steel Construction
Sheila	Puffer	Northeastern University
Patience	Raby	Dekker Perich Sabatini

Brian	Raff	American Institute of Steel Construction
Douglas	Rammer	USDA Forest Service–Forest Products Laboratory
Tiffany	Reed-Villarreal	National Ready Mixed Concrete Association
Andrea	Reynolds	SmithGroup
Kelly	Roberts	Walter P Moore
Suzanne	Robinson	LeMessurier Associates
Steve	Rys	Nucor
Nima	Sakhaee	Northeastern University
Shaina	Saporta	SEI Sustainability Committee
Michael	Scancarello	Odeh Engineers / WSP
Benjamin	Schafer	Johns Hopkins University
Don	Scott	Don Scott Consulting, PLLC
Jennifer	Shakun	New England Forestry Foundation
Julie	Shaw	CannonDesign
Scott	Shell	Climateworks Foundation
Yilei	Shi	Syracuse University
Petros	Sideris	Texas A&M University
Arijit	Sinha	Oregon State University

Harish	Sivakumar	Indian Institute of Technology, Hyderabad
Aubrey	Smading	Portland Cement Association
Jodi	Smits Anderson	New Buildings Institute
Mohit	Srivastava	Britt, Peters and Associates
Katie	Stueckle	Structural Engineering Institute, ASCE
MIlani Sureka	Sumanasooriya	NEU/ACI Center of Excellence
Elaina	Sutley	University of Kansas
Rose	Tabassi	Aspect Structural Engineers
Jonathan	Tavarez	American Institute of Steel Construction
Kathleen	Teer	McNamara-Salvia Structural Engineers
Ashley	Thrall	University of Notre Dame
Judy	Too	University of Melbourne
John	Tracy	McNamara Salvia Structural Engineers
Yelda	Turkan	Oregon State University
N. Jonathan	Unaka	Wentworth Institute of Technology
Nancy	Varney	Northeastern University
James	Wacker	USDA Forest Service–Forest Products Laboratory
Mark	Webster	Simpson Gumpertz & Heger, Inc.
Bethany	Whitehurst	Clark Nexsen, Inc.

Brandon	Williams	Sublime Systems
Erin	Winston	HKS, Inc.
Erika	Winters-Downey	Lamar Johnson Collaborative / Clayco Construction
Pitipat	Wongsittikan	Massachusetts Institute of Technology
Ryan	Woodward	COWI
Shun Lei	Yee	Northeastern University
Dustin	Young	American Society of Civil Engineers
Aghil	Zamani	Architecture Consultant
Khalid	Zuiater	Civil Engineer

Appendix C. Workshop Co-Chair and Speaker Biographies

Workshop Co-Chairs

Jerome F. Hajjar

Jerome F. Hajjar, Ph.D., P.E., NAE, F.SEI, F.ASCE, is the CDM Smith Professor, University Distinguished Professor, and Department Chair in the Department of Civil and Environmental Engineering at Northeastern University. His research and teaching interests include analysis, experimental testing, and design of steel and composite steel/concrete building and bridge structures; regional modeling of infrastructure systems; and earthquake engineering, and he has published more than 300 papers and authored or edited five books on these topics. He is the President of the Structural Engineering Institute of the American Society of Civil Engineers and is a member of the American Institute of Steel Construction Committee on Specifications. He was elected as a member of the National Academy of Engineering in 2022 and has received several honors and awards. He is a registered professional engineer in Illinois and Minnesota.

Jennifer Goupil

Jennifer Goupil, P.E., F.SEI, F.ASCE, is the Chief Resilience Officer for ASCE and Managing Director of SEI. With deep knowledge and experience in the buildings industry, Goupil is a passionate leader with more than three decades of experience in advancing the profession of structural and civil engineering through standards development and adoptions, educational program creation and growth, and advocacy. Goupil's reputation for collaboration and consensus building, transparency, and effectiveness makes her a strong advocate and sought-after industry partner. Goupil works tirelessly to advance resilient, sustainable, and performance-based design and is passionate about education and developing future leaders.

Workshop Speakers

Honorable Brendan Owens

The Honorable Brendan Owens was sworn in as Assistant Secretary of Defense for Energy, Installations, and Environment on January 26, 2023. In this role, he is the principal advisor to the Under Secretary of Defense for Acquisition and Sustainment for all matters relating to operational and facility energy; installations real property planning, operations, and sustainment; environmental protection, compliance, and restoration; natural, historical, and cultural resources; and accompanied and unaccompanied military housing. He oversees the U.S. Department of Defense's real property portfolio encompassing millions of acres and more than 500,000 buildings and structures at more than 500 installations. He also serves as the Chief Sustainability Officer and Chief Housing Officer for the U.S. Department of Defense. Prior to his appointment, Mr. Owens served as Principal of Black Vest Strategy, a consultancy focused on the intersection of health, equity, and climate issues in the built environment. He was also a co-founder of ecountabl, Inc., a technology platform seeking to democratize access to corporate environmental, social, and governance information. Previously, Mr. Owens had a 19-year career with the USGBC. He is a Virginia-registered Professional Engineer and was honored as a LEED Fellow in 2012.

Jude Abel

Jude Abel is the Senior Manager for Sustainability and Innovation at Deloitte LLP. As a member of Deloitte LLP's Sustainability, Climate, and Equity practice, Abel serves as the sustainability subject matter advisor for a team dedicated to developing innovative solutions to support clients' net-zero, nature-positive pathways. She has held senior strategy, management, and consulting roles for 20 years in the international conservation, environmental services, and carbon markets sectors in the United States, Hong Kong, and New Zealand. Abel is particularly passionate about scaling conservation and climate finance and greening the built environment. She holds a B.A. in Politics from Princeton University and a master's degree in Environmental Management from the Yale School of the Environment.

Lance Davis

Lance Davis is the sustainability architect for a federal agency in Washington, DC, where he leads the development of sustainable policy, performance, and tools. He has a Bachelors of Architecture from Mississippi State University where he is a Fellow. He is also a Fellow of the American Institute of Architects and USGBC. He chaired the LEED Steering Committee for the development of LEED v5 and was on the ASHRAE Decarbonization Task Force focusing on carbon sequestration. He was appointed to President Biden's Climate Smart Infrastructure Working Group; co-authored Sustainability Matters; and is featured in the book, The Rise of Living Architecture.

Torey Brooks

Torey Brooks is a structural engineer who started her career working on public and private projects throughout the Northeast. As a designer and sustainability coordinator she focused on meaningful embodied carbon reductions on projects, whole building LCA, and corporate greenhouse gas accounting initiatives. Brooks has been at the U.S.

Environmental Protection Agency for more than a year working to implement the embodied carbon provisions under the Inflation Reduction Act. This work focuses on construction materials and products and includes launching a grant program to improve EPDs, developing a carbon label program, and working alongside GSA and FHWA to use low-carbon materials on federally funded projects. Brooks is a member of the USGBC LEED Technical Advisory Group and the NCSEA sustainability committee and teaches Green Building design as an adjunct professor at the University of New Hampshire. When Brooks is not working on embodied carbon, she can be found enjoying the mountains, lakes, and oceans in her home state of New Hampshire.

Matthew Eckelman

Matthew Eckelman is an Associate Professor of Civil and Environmental Engineering at Northeastern University. His research group uses life-cycle assessment, process simulation, and energy system modeling to understand large-scale environmental impacts of materials and the built environment. Dr. Eckelman worked previously for the Massachusetts State Executive Office of Environmental Affairs and in the manufacturing and construction sectors. He received the international Laudise Prize in Industrial Ecology in 2013 and the Clemens Herschel research award from the Boston Society of Civil Engineers in 2017 and holds a doctorate in Chemical and Environmental Engineering from Yale University.

Kena David

Kena David serves as Director of Sustainability at Consigli Construction Co., Inc., a leading construction manager in the Northeast and Mid-Atlantic. She leads the development and implementation of comprehensive sustainability strategies on Consigli's projects, building on the firm's proven track record of delivering innovative green building solutions for clients across market sectors. With more than a decade of diverse sustainable building experience, David has successfully led sustainability efforts for large, complex projects and has wide-ranging expertise in Environmental, Social , and Governance (ESG) initiatives. The recipient of various industry awards, she is a LEED AP, ID+C WELL AP, and Fitwel Ambassador and WELL Faculty.

Benjamin W. Schafer

Benjamin W. Schafer, Ph.D., P.E., F.SEI, is the Willard and Lillian Hackerman Professor of Civil and Systems Engineering and the Director of the Ralph O'Connor Sustainable Energy Institute at Johns Hopkins University. He is an active volunteer and leader on multiple national committees related to engineering and design of steel structures.

Brandon Williams

As Product Success Manager at Sublime Systems, Williams collaborates closely with designers and builders to validate technology and educate and build trust in Sublime materials across the construction value chain. Williams has more than 10 years of experience working in the concrete industry as a Lab Technician, Project Manager, Plant Manager, Quality Assurance Supervisor, and Senior Project Engineer for several leading companies in California and Hawaii.

Max Puchtel

Max Puchtel is the Director of Sustainability and Government Relations for the American Institute of Steel Construction, and he works to see a world in which the United States is a global leader in decarbonized structural steel. Puchtel often represents the structural steel community on state and federal government affairs, including Buy American policies, trade, transportation funding, and Buy Clean legislation. He leads many of the American Institute of Steel Construction's sustainability efforts, including the development and publication of three industry-wide EPDs for structural steel. He is active in many professional, standards, and industry groups, including the Structural Engineering Institute; the National Council of Structural Engineering Associations; the Association for Iron and Steel Technology; the American Society of Heating, Refrigerating and Air-Conditioning Engineers; and Green Globes Consensus Bodies. Puchtel holds degrees from the University of Michigan and Illinois Tech, and he is a licensed structural and professional engineer.

Jennifer Shakun

Jennifer Shakun's areas of expertise include the science of climate change impacts on forest ecosystems, climate-smart approaches to forest management, and the use of wood for lower-carbon building construction. She leads the New England Forestry Foundation's work to develop a regional forest bioeconomy that benefits communities, climate, and forests. This includes deep engagement with partners in the architecture, engineering, and construction industry, particularly around the development of sustainably sourced mass timber construction. Shakun has dual master's degrees in Forestry and Environmental Management from Duke's Nicholas School of the Environment, and she is an SAF Certified Forester.

Workshop Steering Committee Members and Breakout Session Leaders

Jay Arehart

Jay Arehart is an Assistant Teaching Professor and Director of Architectural Engineering in the Civil, Environmental, and Architectural Engineering department at the University of Colorado Boulder and Co-Founder and Chief Product Officer of Preoptima, a software company that manages and mitigates the embodied carbon of buildings. Trained as an architectural engineer, Arehart worked as a structural designer prior to completing his Ph.D. investigating the carbon storage potential of materials and buildings. Arehart currently teaches courses with a focus on architectural design, structural engineering, building science, and sustainability. He is a co-chair of the Structural Engineering Institute Sustainability Committee and representative of the Academic Council of the Architectural Engineering Institute.

Don Davies

Don Davies, P.E., S.E., is the Co-Founder and Principal at Davies-Crooks Associates. An industry champion for the promotion of urban density and lower-carbon construction and a 2023 *Engineering News Record* top 25 news maker, Davies helped found the Carbon Leadership Forum, Building Transparency, and the MKA Foundation. He is a Senior Fellow of the Design Futures Council and has been inducted into the UC Berkeley Academy of Distinguished Alumni. The past president of Magnusson Klemencic Associates, his structurally designed projects are in 18 countries and more than 50 major metropolitan centers. More than 25 are performance-based seismic design towers.

Michael Gryniuk

Michael Gryniuk is the Founder and Principal of CORA Structural, a full-service structural engineering firm based in Boston. With more than 23 years of industry experience, his firm aims to design cost-effective solutions with a focus on design outcomes and structural systems that minimize material usage and reduce embodied carbon. Renowned for his passion and leadership in the structural engineering profession, he co-founded and serves as Chair of the SEI SE 2050 Commitment Program and recently advised the White House Office Climate Policy Office on Embodied Carbon. In 2024, Gryniuk received the Structural Engineering Institute's President's Award for his leadership in advocating for sustainability and net-zero embodied carbon construction in the structural engineering profession.

Dirk Kestner

Dirk Kestner is a Senior Principal and corporate Director of Sustainable Design for Walter P Moore, a global structural and enclosure engineering firm. His current practice includes structural design with a focus on whole building life-cycle assessment to minimize embodied impacts. He was the founding chairman of the Sustainability Committee for the Structural Engineering Institute and served as an editor of the committee's book

Sustainability Guidelines for the Structural Engineer. He is a current advisory board member of the Carbon Leadership Forum and a past chair of the USGBC Materials and Resources Technical Advisory Group. Kestner is a licensed Professional and Structural Engineer and is a LEED AP BD+C and Envision SP.

Elaina Sutley

Elaina Sutley is the Associate Dean for Diversity, Equity, Inclusion, and Belonging, and an Associate Professor in Structural Engineering at the University of Kansas. Her research uses field-based, experimental, and computational approaches to advance equity during and after disasters. Dr. Sutley has received early career awards from the National Science Foundation and from the National Academies supporting her research. Dr. Sutley currently serves on the American Society of Civil Engineer's Infrastructure Resilience Division Executive Committee, the Structural Engineering Institute's Board of Governors, and the Applied Technology Council's Board of Direction. Dr. Sutley is a licensed Professional Engineer in Kansas and a LEED AP Homes.

Mark D. Webster

Mark D. Webster is a Structural Engineer at Simpson Gumpertz & Heger Inc.'s Boston area office. He is a Founder and past Co-Chair of the Structural Engineering Institute's Sustainability Committee. He is part of the leadership team for the SEI SE 2050 Commitment Program and co-leads the SE 2050 Resources Group. He edited and co-authored the SEI Sustainability Committee's technical report addressing the climate impacts of structural materials, *Structural Materials and Global Climate,* and the committee's white paper entitled "*Achieving Net Zero Embodied Carbon in Structural Materials by 2050.*" His structural consulting practice encompasses new design, renovation, and investigation work, with an emphasis on historic buildings.

Appendix D. Workshop Priority Initiatives

The six breakout sessions each put forward several initiatives, which the workshop participants then voted on to prioritize them. The following is the list of initiatives in priority order.

1. Develop a roadmap to achieve zero carbon and beyond for the structural engineering profession.
2. Incorporate sustainability as a core design constraint across the profession.
3. Hire a dedicated SEI staff member to lead and guide the profession toward zero carbon, supporting education and embodied carbon-related initiatives.
4. Create a national salvaged material exchange with tracking mechanism for salvaged materials and develop software for tracking and reporting on material properties.
5. Set performance standard using SEI SE 2050 Commitment Program data with clear intermediate milestones.
6. De-risk adoption of new materials innovations through published protocols, demonstration platforms, training for certifiers, and so forth.
7. Get ahead of the code with prestandards and other measures.
8. Develop a guide/standard for evaluating adaptive reuse potential in existing buildings and salvaged material opportunities/potential for existing buildings and building portfolios ("reuse audit").
9. Foster interprofessional partnerships to advocate for early involvement of structural engineers.
10. Reclaim ownership of building code as performance based (with explicit sustainability criteria) rather than design for the worst engineers.
11. Partner with business professionals to develop programs that incentivize adaptive reuse. Present to the annual conference of mayors.
12. Define the "embodied carbon literacy" that is required of the graduate structural engineer.
13. Promote-advocate-educate reuse and avoidance of resource extraction (circular economy materials ecosystems).
14. Develop guide/standard for evaluating and designing with salvaged materials (could turn into code recommendations) (including testing recommendations).
15. Promote education and awareness through a marketing campaign targeting professional structural engineers (SEI to hire sustainability staff).

16. Create transparency and accounting in materials sourcing directed toward specific carbon targets by 2035 and raw material (sourcing) certification through draft specifications, advocacy, and so forth.
17. Develop SEI structural system prototypes and parametric models for materials, with benchmarks and regional adjustments (ASHRAE 240P-like references), and coordinate timely benchmarks with code.
18. Publish a policy statement and action plan that serves as a consistent, concise platform of issues that SEI proactively supports and join ASCE legislative action on reducing carbon.
19. Determine cost/risk barriers to deconstruction instead of demolition (e.g., through surveys and fact-finding with demolition contractors), including dialog/partnerships between designers and contractors.
20. Take tangible steps toward de-risking new embodied carbon strategies (materials, LCAs, and design).
21. Request software providers include improved guidance and transparency for LCA inputs and/or SEI-sponsored overlay/plugin.
22. Promote-advocate-educate increased engineering time directed toward sustainability goals (efficiency and lower carbon).
23. Orchestrate and sponsor the development of teaching materials across all curriculum levels that are material agnostic, while integrating sustainability across the structural engineering curriculum.
24. Develop an SEI-approved EPD+ program to incentivize higher-quality, transparent EPDs.
25. Supplement prestandard with guidance, such as guidance to designers on what EPDs to use in absence of a perfect fit (like the National Ready Mixed Concrete Association) and appropriate tools/data to use at different design stages.
26. Develop continuing education resources incentivized by questions on the PE and SE licensure exams or other embodied carbon credential.
27. Create educational series to bring materials “resource to fabrication” knowledge to structural engineers across all materials.
28. Prepare studies on design optimization/tradeoffs with respect to material use and construction phase impacts (A1–A5) (e.g., design decisions around formwork, shored construction, etc.).
29. Develop TV ads and media campaign to educate the public and shift market demand to sustainable buildings while elevating the positive role of structural engineers.
30. Establish an SEI-hosted listserv/forum for community questions.