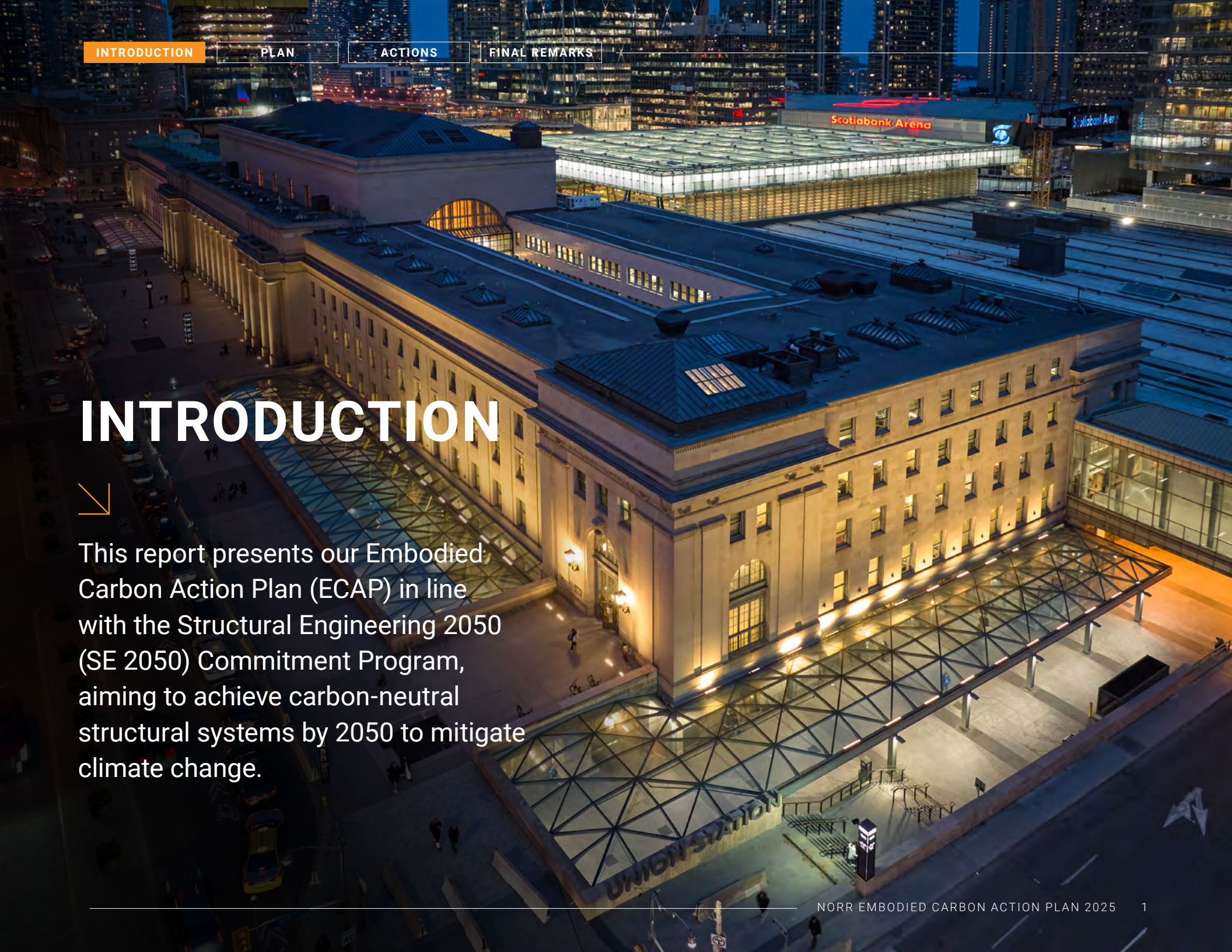
NORR

EMBODIED CARBON ACTION PLAN 2025

SE 2050 COMMITMENT PROGRAM
YEAR 4 REPORTING UPDATE



INTRODUCTION

This report presents our Embodied Carbon Action Plan (ECAP) in line with the Structural Engineering 2050 (SE 2050) Commitment Program, aiming to achieve carbon-neutral structural systems by 2050 to mitigate climate change.

OUR COMMITMENT

As part of our steadfast commitment to sustainability, we are dedicated to not only meeting but leading the industry in reducing the embodied carbon (EC) associated with our structural design practices. This initiative aligns closely with the SE 2050 Commitment, reflecting our aspiration to drive innovation and excellence in sustainable engineering.

Recognizing the significant role the construction industry plays in global greenhouse gas (GHG) emissions, we are deeply engaged in efforts within the SE 2050 Commitment Program. We work alongside other organizations to disseminate essential tools, methodologies and data, fostering a collaborative approach towards reducing embodied carbon and mitigating the climatic impact of construction.

Our vision extends beyond the immediate program period, as we aim to establish NORR as a trailblazer in sustainable structural design practices. This involves designing to achieve short-term goals, as well as continuously improving and innovating for long-lasting impact.

We understand the importance of our sustainability efforts on stakeholders, including clients, partners and communities. Therefore, we are motivated and enthusiastic about driving positive change through our actions. This updated Embodied Carbon Action Plan (ECAP) provides a comprehensive overview of our objectives for reducing embodied carbon throughout the 2025-2026 period while reflecting on the progress made in the previous period. It also outlines the internal resources and protocols developed to support our sustainability initiatives.

As we reflect on our progress and reaffirm our commitment to the SE 2050 program requirements, we invite our employees and stakeholders to join us in championing sustainable engineering practices for a brighter, more resilient future.

We aim to establish NORR as a trailblazer in sustainable structural design practices.

ABOUT US

NORR is an employee-owned, fully integrated A&E firm. Our professional team of 750 architects, engineers, planners and interior designers work collaboratively across 12 market sectors in Canada, the US and UK.

Our mission is to create socially aware, environmentally responsible and financially viable architecture and engineering design solutions to ensure our clients achieve their business goals while contributing to healthier and sustainable spaces and places across the globe.

A CARBON CONSCIOUS COMMITMENT

We are committed to supporting the transformation of the built environment from a major source of carbon emissions to an important contributor to combating the climate emergency. We embrace the climate change mitigation strategy put forth in the COP28 Agreement and accept the urgent challenge to make carbon-neutral buildings a standard practice, rather than the exception.

SECTORS

- Commercial
- Education
- Health Sciences
- Hospitality
- Industrial
- Justice
- Public Buildings
- Residential
- Restaurants
- Retail
- Science & Research
- Transportation

SERVICES

- Architecture
- Interior Design
- Master Planning and Urban Design
- Structural Engineering
- MEP Engineering
- Sustainability

EMBODIED CARBON TEAM

SMIT PATEL P.Eng., M.Eng.
Structural Engineer
SE 2050 Embodied Carbon Champion

Smit is a Professional Engineer with over eight years of experience in executing structural engineering projects. Passionate about integrating low-carbon solutions into the built environment, he has led projects across commercial, residential and institutional sectors. His knowledge in mass timber structures supports the industry's shift toward more sustainable construction, aligning with global climate goals.

HASSAN SAFFARINI, P.Eng., Ph.D., PMP, LEED® AP, CAHP
Principal, Structural Engineering, North America

Hassan heads NORR's structural engineering team in Canada. With 35+ years of professional experience and a Ph.D. from UC Berkeley, he has been particularly aware of the potential impact of architecture and engineering projects on the environment. He became a LEED AP in 2007 and is a board member of the Ontario Association of Heritage Professionals. He promptly bought into the SE 2050 commitment in 2021.

ALI HUSAIN, P.Eng., M.Eng., ing.
Associate
Studio Manager, Structural Engineering

As the Studio Manager of Structural Engineering with more than a decade of experience, Ali has a proven track record of success in a wide variety of projects in Canada and abroad. With a passion for sustainable design and a deep commitment to finding new and innovative solutions, Ali is skilled in creating structures that meet the highest standards of environmental responsibility.

BLAKE JACKSON, AIA, LEED® Fellow, WELL Faculty, Fitwel Amb., CPHC
Director, Sustainability

As Director, Sustainability at NORR, Blake supports project delivery, CSR and leads the firm's global program to achieve both the AIA 2030 and SE 2050 Commitments. For over 20 years, Blake has been working at the nexus of sustainability, wellness, resiliency and equity, promoting positive, measurable outcomes for built environment projects worldwide.

NORR EMBODIED CARBON ACTION PLAN

Our goals are presented in four categories and will be achieved through the identified actionable steps. These outcomes form the base doctrine of our environmental commitment and serve to direct this Action Plan.

THE FOUR AREAS OF FOCUS OF THE SE 2050 COMMITMENT PROGRAM

EDUCATION
Educating employees and enhancing professional development on topics related to reducing embodied carbon in design.

REPORTING
Measuring, tracking and reporting embodied carbon data and comparing determined embodied carbon values to predefined targets.

EMBODIED CARBON REDUCTION STRATEGIES
Reduce embodied carbon, document lessons learned in pursuing reduced-carbon designs and set embodied carbon goals for projects in design.

ADVOCACY
Share the goals of the SE 2050 Commitment Program and enhance outreach on the important topic of embodied carbon.

ECAP

VISION: To establish NORR as an industry leader in embodied carbon best practices in structural engineering and ultimately assist in achieving industry carbon neutrality.

MISSION: These four missions lay the foundation for NORR's vision to become a central hub for embodied carbon research, education, dissemination and execution.

1. MEET AND EXCEED REQUIREMENTS

The SE 2050 Commitment Program requirements will be met and exceeded through unique solutions that develop our experience in the field. While the SE 2050 guidelines provide a minimum standard to be met, in order to develop excellence in sustainable design and play a significant role in the health of the environment, this standard will be met and surpassed to achieve the objective by, or before, 2050.

2. IMPLEMENT NEW DESIGN STRATEGIES

New structural design strategies will be implemented to enable better assessment and reduction of embodied carbon. As the consideration of embodied carbon is growing, new tools and methodologies will be adopted to effectively achieve the overall vision.

3. FACILITATE CARBON REDUCTION GOALS

Property owners' own carbon reduction goals will be facilitated through our proficiency. To elicit the greatest consideration of embodied carbon, the carbon goals of property owners will be achievable to encourage further carbon reduction and to promote industry-wide change.

4. CARBON REDUCTION EDUCATION

Technical staff will be inspired and educated in carbon reduction strategies as those are developed internally. One of NORR's greatest strengths is in its multidisciplinary, in-house design teams, which exist alongside and integrate with the structural engineering discipline. The other disciplines will be engaged through company-wide knowledge dissemination.

GOALS

The following list of goals addresses the critical topics of education, reporting, embodied carbon reduction and advocacy that are essential to an effective carbon reduction plan.

1. Identify and refine structural design processes within the scope of NORR's current procedures that can yield improvements to embodied carbon totals.
   Action: EC comparative studies are now integrated into our design process, with standardized internal benchmarks developed for different structural systems.

2. Establish embodied carbon as an additional criterion to monitor, on all major structural design projects.
   Action: EC tracking is embedded into project workflows, with milestone checklists and quarterly reviews ensuring consistency. QA/QC now includes EC assessments, with enhanced reduction efforts for high-impact projects.

3. Work with clients to set embodied carbon reduction targets for significant projects.
   Action: Reduction targets are set at project kickoffs through EC workshops, with early contractor involvement to ensure feasible low-carbon solutions.

4. Influence other disciplines' consideration of embodied carbon through advocacy and resource sharing.
   Action: NORR promotes EC collaboration through multi-disciplinary design charrettes, shared guidelines and case studies with its architectural teams committed to AIA 2030.

5. Advocate multi-disciplinary sustainability studies of embodied and operational carbon to arrive at the most environmentally conscious solutions.
   Action: Select projects now undergo integrated carbon studies, with results documented in project scorecards and shared group-wide.

6. Ensure NORR applies state-of-the-art tools and methods to achieve a reduction in embodied carbon annually.
   Action: One Click LCA has been vetted and implemented company-wide, with annual training sessions planned to ensure staff maximizes its capabilities.

7. Improve upon available embodied carbon reduction tools for structural designs and identify knowledge gaps following their adoption. Action: Structured training is provided to ensure staff stay informed on low-carbon solutions, new technologies and tools.

8. Engage NORR's multi-disciplinary technical staff to encourage feedback and facilitate discussion towards embodied carbon goals on a semi-annual basis.
   Action: A semi-annual EC task force with the EC champion to capture lessons learned, and a database to document best practices. Guest speaker sessions for industry insights, and staff incentives are employed.

STRATEGIES

The following strategies outline the means through which the goals will be achieved and inform the actionable tasks.

1. Examine in-house tools for potential add-ins to facilitate embodied carbon consideration.

Actions: EDUCATION REPORTING

2. Develop procedures for optimizing embodied carbon reduction over the course of a project.

Actions: EDUCATION EC REDUCTIONS

3. Conduct estimates of embodied carbon in ongoing projects using Life Cycle Assessments (LCAs) of building materials.

Actions: EC REDUCTIONS

4. Engage clients and architects to optimize the use of structural materials and suggest lower-carbon alternatives when available.

Actions: ADVOCACY

5. Host discussions with other disciplinary teams to increase engagement and assist in determining areas of potential embodied carbon reduction.

Actions: EDUCATION ADVOCACY

6. Identify and acquire necessary software for monitoring embodied carbon throughout a project.

Actions: EDUCATION EC REDUCTIONS

7. Review available embodied carbon data analysis tools and develop a standardized method of reporting project data.

Actions: EC REDUCTIONS REPORTING

8. Schedule semi-annual meetings to update the firm on the EC reduction implementation progress and ongoing tasks.

Actions: EDUCATION

9. Engage our Global Marketing and HR departments to help establish the SE 2050 campaign and build awareness of the initiative.

Actions: EDUCATION ADVOCACY

ACTIONS

This section presents the actionable steps to be taken to ultimately meet our carbon reduction vision and goals. The tasks are divided into the five critical components identified by the SE 2050: education & knowledge sharing, reporting, embodied carbon reduction, advocacy and lessons learned.

In this report we reaffirm our commitment to the SE 2050, provide an update about our actions and our plan to continue on this trajectory.

EDUCATION

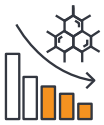
SE 2050 COMMITMENT ITEM		TARGET ACTION 2024	STATUS	TARGET ACTION 2025	COMMENT/REFERENCE
1.01	Annually distribute firm-wide announcement of firm's commitment to SE 2050.	Announcement is made and reports are distributed annually.	Announcement is completed, reports to be distributed annually.	ECAP report to be distributed annually before Earth Day.	Document Map: Annual ECAP
1.02	Provide a narrative describing how NORR is promoting firm-wide education for EC & the SE 2050 Commitment Program.	Action Plan to be continually updated and redistributed to all disciplines.	Action plan shared and presented company-wide, typically during Earth Week and in conjunction with dissemination of our AIA 2030 Commitment results.	Action plan will be continually updated and redistributed to all disciplines. Share on LinkedIn to external stakeholders.	Click to view NORR's Commitment to Sustainable Design Document Map: EC Education Plan
1.03	Nominate an EC Reduction Champion. Include profile in ECAP.	EC Champion is selected.	EC Champion has been changed.	EC Champion to continue development of internal and external documents and procedures.	Click to view our EC Champion profile
1.04	Select a date to present an EC 101 Webinar to the firm. Can use own or existing.	New webinars on EC topics to be shared regularly as outlined in the internal Education Plan.	EC 101 presented annually and new topics shared with Canadian and US Structural group.	Refine presentation and present to the larger US and Canadian group.	Document Map: EC Education Plan
1.05	Have a representative attend quarterly external education programs via SE 2050.	External programs continue to be attended quarterly.	Achieved.	External programs continue to be attended quarterly.	External learning opportunities are continually sought after and shared with structural engineering team members.

EDUCATION (CONTINUED)

SE 2050 COMMITMENT ITEM		TARGET ACTION 2024	STATUS	TARGET ACTION 2025	COMMENT/REFERENCE
1.06	Share the SE 2050 resources library with staff.	SE 2050 resources shared with staff.	SE 2050 resources shared with staff.	NORR internal EC library continues to be developed and regularly shared with new and existing staff. Organize information and ensure it is up to date.	Updates to the EC resource library are shared with structural team members. New members are onboarded with the latest EC resources. Document Map: EC Education Plan
1.07	Provide outlining plans for a minimum of one firm-wide presentation per year on EC.	Create EC presentation outline plans for an annual presentation to be held on April 22, 2024.	Firm-wide EC presentation held on April 22, 2024	Present a structural focused case study during the annual EC presentation on April 22, 2025	NORR's multi-disciplinary Earth Day presentation was held on April 22, 2024

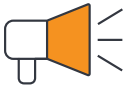
REPORTING

SE 2050 COMMITMENT ITEM		TARGET ACTION 2024	STATUS	TARGET ACTION 2025	COMMENT/REFERENCE
2.01	Provide a narrative describing plans to measure, track and report EC.	Outlining plans are made for EC calculations, EPD access, LCA methodologies and material data extraction.	EC procedures document has been developed and presented to structural engineering staff. Templates for data collection are under development.	Procedures for EC calculations, including EPD access, LCA methodologies, and material quantification are included in Internal EC Training Document for user reference.	Document Map: EC Reporting Plan
2.02	Describe the internal training procedure for EC you will provide.	Internal training procedure for EC is presented.	The internal training procedure has been outlined in the Internal EC Training Document which has been presented to structural engineering staff.	The Internal EC Training Document continues to be developed, with updates being distributed to structural engineering staff quarterly.	Document Map: EC Reporting Plan
2.03	Submit two or more projects annually to the SE 2050 database.	Submit two or more projects targeted for EC data recording.	Two projects were submitted.	Continue to submit two or more projects for 2025.	Click for a sample case study of a project submitted to the SE 2050 database.
2.04	Discuss sustainability goals with the owner and architect for projects to be submitted.	EC kickoff meetings held throughout project duration and notes are reported.	EC kickoff meetings have been held for select projects to engage architects.	Architects and clients continue to be engaged near project kickoff for more selected projects.	The EC impact of design decisions is discussed to inform project direction.



EC REDUCTION STRATEGIES

SE 2050 COMMITMENT ITEM		TARGET ACTION 2024	STATUS	TARGET ACTION 2025	COMMENT/REFERENCE
3.01	Meet your target EC reduction from the previous year.	EC reduction goal for 2024 was set to be 10% for our project work.	A total of 10% of all active projects achieved the reduction target.	Five year EC reduction goal is set to be 30%. Reduction strategy is innovation that prioritizes sustainability without compromising structural performance.	Document Map: EC Reduction Outcomes
3.02	Provide lessons learned and feedback to the program by submitting a case study.	Lessons-learned case studies to be developed for each EC project selected for data collection. Case studies to be collected and summarized for 2025 ECAP and beyond.	Case studies submitted in 2024 along with ECAP.	Formalize lessons learned and track for each project. Submit via case studies to SE 2050 database.	Click for a sample case study of a project submitted to the SE 2050 database. Document Map: EC Reduction Outcomes
3.03	Update specifications to incorporate embodied carbon performance.	Update all division 3 and division 5 structural specifications to include embodied carbon performance and reduction opportunities.	Cast-in-place concrete reinforcement and structural steel specifications were updated.	Continue updating other applicable structural specifications as well as drawing notes to include low carbon alternatives.	Click for a sample case study of a project submitted to the SE 2050 database. Document Map: EC Reduction Outcomes
3.04	Create a project-specific EC reduction plan.	Project-specific EC reduction plan is developed and submitted.	EC reduction plan has been developed for selected EC projects.	EC reduction plan developed into a standardized EC reduction workflow for future EC projects.	Click for a sample case study of a project submitted to the SE 2050 database. Document Map: EC Reduction Outcomes
3.05	Complete an EC comparison project in project conception phase.	EC comparison to be a part of standard EC calculation protocol for every EC project.	EC comparison was done for select project where applicable.	EC comparisons to be a part of standard EC calculation protocol for every EC project.	Click for a sample case study of a project submitted to the SE 2050 database.



ADVOCACY

SE 2050 COMMITMENT ITEM		TARGET ACTION 2024	STATUS	TARGET ACTION 2025	COMMENT/REFERENCE
4.01	Engage with structural material suppliers in your region to communicate the importance of Environmental Product Declarations (EPDs) and low-carbon material options.	Connect with material suppliers and inform them of changes to structural specifications and the requirement of submitting EPDs along with other submittals.	Made contact with concrete, reinforcement, steel and waterproofing suppliers and discussed the importance of EPDs.	Continue informing suppliers of new changes made to specifications. Organize meetings with suppliers to learn more about their progress on attaining EPDs for their products.	Click for a sample case study of a project submitted to the SE 2050 database.
4.02	Describe the value of SE 2050 to clients (Including marketing materials).	Informational materials are developed and presented to clients to discuss EC goals.	NORR Marketing has been engaged to disseminate EC Goals through SE 2050.	Informational materials continue to be developed for client reference. Collaborate with marketing team and review material to ensure it is up to date with SE 2050 and the latest industry research.	Document Map: EC Advocacy Plan
4.03	Declare SE 2050 membership on boilerplate proposal language.	SE 2050 membership included on NORR proposals and other boilerplate deliverables.	SE 2050 Membership information to be included in boilerplate text for applicable projects where EC targets are established.	Declare SE 2050 membership on boilerplate proposals for all proposals advocating for lower carbon design methods and service offerings.	Document Map: EC Advocacy Plan
4.04	Share SE 2050 details on company website.	SE 2050 Commitment Program shared on website.	SE 2050 Commitment Program shared on website.	Update website with the latest ECAP and share SE 2050 updates on a semi-annual basis.	Document Map: EC Advocacy Plan
4.05	Share education opportunities with clients.	EC education opportunities are forwarded to clients.	Some clients welcome EC education opportunities and work with NORR to establish reduction targets.	Clients to be engaged to join EC education opportunities.	Document Map: EC Advocacy Plan Click for a sample case study of a project submitted to the SE 2050 database.

EDUCATION PLAN

We recognize that education plays a crucial role in driving internal action toward embodied carbon reduction. Our strategy focuses on empowering employees with the knowledge and skills necessary to contribute effectively to our sustainability goals.

EDUCATION

Our SE 2050 Champion is tasked with leading efforts to embed embodied carbon reduction practices into our daily practice. The champion serves as an ambassador for sustainability, facilitating educational initiatives and fostering a culture of awareness and action.

We are committed to raising awareness about embodied carbon across all levels of our organization. To achieve this, we host monthly webinars focused on embodied carbon (accessible to all employees) and integrate recorded sessions into our onboarding process. This ensures that every new team member is equipped with foundational knowledge about embodied carbon and its significance in our work.

Recognizing the pivotal role of structural engineers in driving embodied carbon reduction, we conduct recurring workshops on core concepts and skills related to measuring, reducing and reporting embodied carbon. Through these workshops, we empower our engineers to incorporate sustainability principles into their design decisions effectively.

To facilitate ongoing learning and collaboration, we have established an Embodied Carbon Committee within our practice. This committee, while broadly addressing sustainability topics, prioritizes embodied carbon reduction initiatives. In collaboration with our Sustainability team, this committee promotes interdisciplinary dialogue and knowledge sharing and enhances the collective understanding and commitment to sustainable engineering practices.

We actively engage with the Carbon Leadership Forum (CLF) Regional Hubs to stay abreast of the latest developments and best practices in embodied carbon reduction. Our participation includes attending presentations, working sessions and reporting back to the firm. By leveraging regional networks, we strengthen our knowledge base and enhance our capacity to drive meaningful change.

In addition to these initiatives, we continually explore new avenues for promoting embodied carbon education within our firm. Through ongoing evaluation and feedback, we refine our educational strategies to ensure maximum impact and engagement across our organization.

KNOWLEDGE SHARING

Effective knowledge sharing is essential for driving external awareness and understanding of embodied carbon reduction efforts. We are committed to transparently communicating our initiatives, successes and lessons learned with clients, the design community and the public at large.

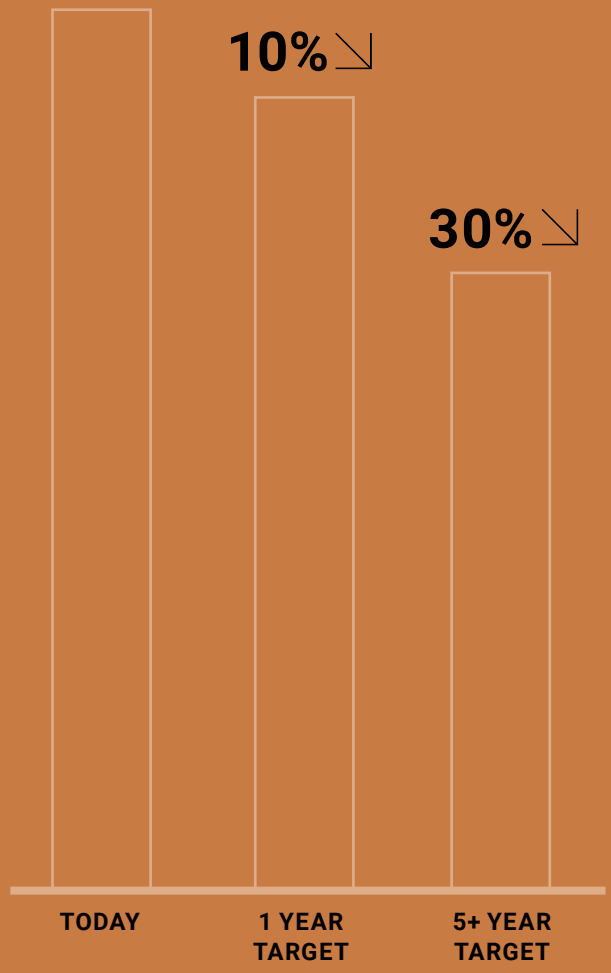
We are employing a multifaceted approach to external communication, leveraging various channels to share information about our embodied carbon reduction work. This includes regular updates on our website, social media platforms and industry publications to reach a broad audience and foster engagement.

We actively engage with professional networks and associations to share our embodied carbon reduction journey and exchange insights with peers. Through participation in industry events, panel discussions and webinars, we contribute to advancing the discourse on sustainability in structural design.

Through these initiatives, we aim to catalyze broader awareness and action on embodied carbon reduction, fostering a culture of sustainability within the design community and beyond.

EMBODIED CARBON REDUCTION OUTCOMES

We are committed to implementing specific and measurable strategies to reduce embodied carbon in our project work both in the short term and the long term. Our reduction outcomes is grounded in innovative approaches that prioritize sustainability without compromising design integrity or structural performance.



NORR has established reduction targets for embodied carbon: 10% in the short term (less than one year) and 30% in the long term (five or more years). These targets serve as guiding principles for our design teams, driving innovation and encouraging the adoption of sustainable practices across all projects.

We are implementing a workflow that facilitates early design decisions based on embodied carbon considerations. By integrating embodied carbon analysis tools into our design process, we empower our teams to identify low-carbon alternatives and optimize material selections from the outset.

We have updated our specifications to incorporate embodied carbon performance criteria, ensuring that sustainability considerations are integrated into all aspects of our project documentation. By specifying low-carbon materials and construction methods, we drive demand for environmentally responsible practices within the industry.

We compare different design options using embodied carbon as a performance metric during the project concept phase. By evaluating the environmental impact of various design alternatives, we identify opportunities for optimization and refinement that minimize embodied carbon emissions while maximizing project value. We communicate embodied carbon impacts of different design options to clients using effective data visualization techniques. Through visually engaging presentations and reports, we empower clients to make informed decisions that prioritize sustainability without sacrificing project goals or objectives.

We empower clients to make informed decisions that prioritize sustainability without sacrificing project goals or objectives.

REPORTING PLAN

Transparent and accurate reporting is fundamental to our commitment to embodied carbon reduction. Our reporting plan outlines how we will measure, track and report embodied carbon data, ensuring accountability and facilitating informed decision-making throughout our projects.

We utilize a robust methodology to calculate embodied carbon for structural materials. This methodology encompasses Life Cycle Assessment (LCA) principles and considers the environmental impacts associated with material extraction and manufacturing. When calculating embodied carbon or specifying materials on our projects, we employ a systematic approach to finding, selecting or requesting Environmental Product Declaration (EPD) data. Our methodology prioritizes EPDs from reputable sources and ensures that data quality and reliability are thoroughly vetted.

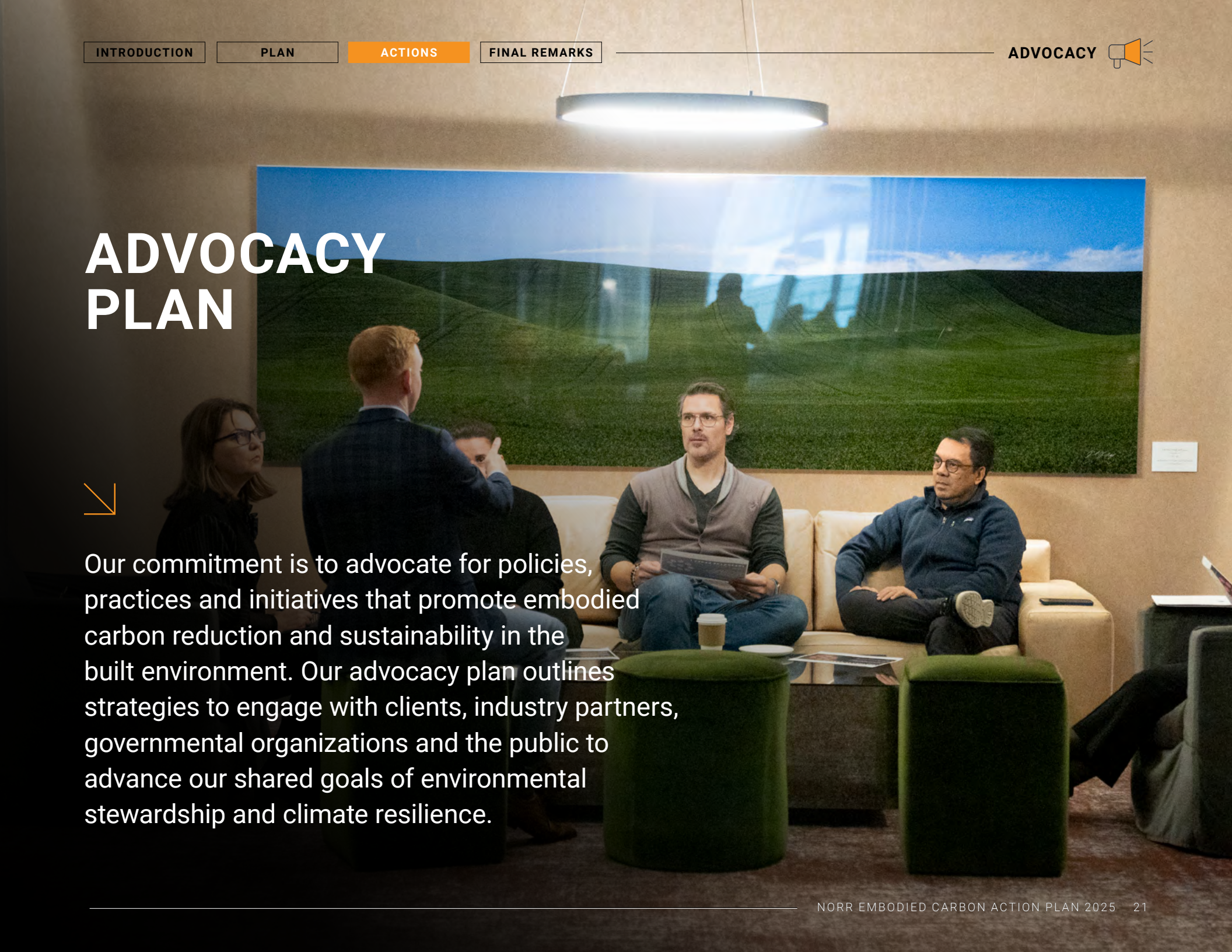
In addition to the internally developed Carbon Calculator, we utilize industry-leading LCA software, such as One Click LCA and Beacon, to quantify embodied carbon in our projects accurately. The scope of our LCA encompasses relevant life-cycle stages, including A1-A3 (cradle-to-gate), A1-A5 (cradle-to-grave), or other specified boundaries as required by project goals and objectives.

We employ standardized procedures for calculating material quantities at various project stages, ensuring consistency and accuracy in our reporting. Whether at the conceptual design phase or during construction administration, our reporting methodology accounts for material usage throughout the project lifecycle.

Our reporting plan encompasses a comprehensive scope of embodied carbon data, covering all structural materials used in our projects. We strive to capture data from a representative sample of projects across our portfolio, providing insights into trends and performance metrics at both the project and firm levels. We commit to submitting a minimum of two projects, annually.

Our reporting plan encompasses a comprehensive scope of embodied carbon data, covering all structural materials used in our projects.

ADVOCACY PLAN



Our commitment is to advocate for policies, practices and initiatives that promote embodied carbon reduction and sustainability in the built environment. Our advocacy plan outlines strategies to engage with clients, industry partners, governmental organizations and the public to advance our shared goals of environmental stewardship and climate resilience.

We actively communicate the value of the SE 2050 Commitment to our clients, highlighting how our participation in the program aligns with their sustainability objectives and contributes to positive environmental outcomes. By showcasing the benefits of embodied carbon reduction, we foster collaboration and alignment with clients who share our commitment to sustainability.

We publicly declare our firm as a member of the SE 2050 Commitment, reinforcing our dedication to reducing embodied carbon and promoting transparency in our sustainability efforts. We showcase our commitment on our website, social media platforms and other relevant channels to demonstrate leadership and inspire others to join us in this important initiative.

We engage with structural material suppliers in our regions to communicate the importance of Environmental Product Declarations (EPDs) and low-carbon material options. By advocating for greater transparency and sustainability in the supply chain, we drive market demand for environmentally responsible materials and encourage suppliers to prioritize embodied carbon reduction.

Through these advocacy initiatives, we demonstrate our commitment to driving positive change and advancing sustainability in the built environment. We leverage our experience, partnerships and influence to advocate for policies and practices that prioritize environmental stewardship and contribute to a more resilient and sustainable future.

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LESSONS LEARNED

Our review of the Cast-in-Place Concrete specification provided valuable lessons learned on reducing embodied carbon while aligning with industry capabilities. By refining specifications and engaging stakeholders, we can enable practical low-carbon solutions in future government projects. As concrete technology evolves, ongoing collaboration will drive innovation and support SE 2050 goals.

Through the comprehensive review and survey feedback for the Cast-in-Place Concrete (03 30 00) specification, we gained invaluable insights into the current practices and opportunities for reducing embodied carbon in concrete. While this case study focused on concrete, similar evaluations were conducted across many other structural specifications, ensuring a holistic approach to sustainability. By engaging with industry stakeholders and analyzing their responses, we were able to make targeted, prescriptive changes to the specifications, enabling suppliers and contractors to prioritize low-carbon solutions in future government projects. This case study exemplifies how sustainability goals set by agencies, like the Toronto Green Standard, can be effectively aligned with industry capabilities, ensuring that ambitious targets are not only achievable but practical.

The rapidly evolving landscape of concrete technology presents both challenges and opportunities. As innovations such as nanotechnology and Optimized Combined Aggregate Gradation (OCAG) continue to advance, we must remain agile and adapt our approaches accordingly. This process of continuous improvement is essential for driving meaningful change. Moving forward, we will continue collaborating with stakeholders, including suppliers, contractors, and industry partners, to foster innovation and reduce embodied carbon. Ultimately, our collective efforts contribute to the broader goal of achieving carbon neutrality by 2050 (SE 2050), helping to shape a more sustainable future for the construction industry.

CASE STUDY #1

BALANCING COST AND SUSTAINABILITY: FROM MASS TIMBER TO LOW-CARBON CONCRETE

NORR's integrated Engineering and Architecture services were commissioned to design a durable, resilient facility supporting essential police and forensics operations. The three-story structure, currently in the design phase, is targeting a 10% reduction in embodied carbon, guided by CaGBC's Zero Carbon Building (ZCB) Design Standard. Strategies include low-carbon concrete solutions, structural optimization and material efficiency, ensuring reduced environmental impact without compromising performance or constructability.

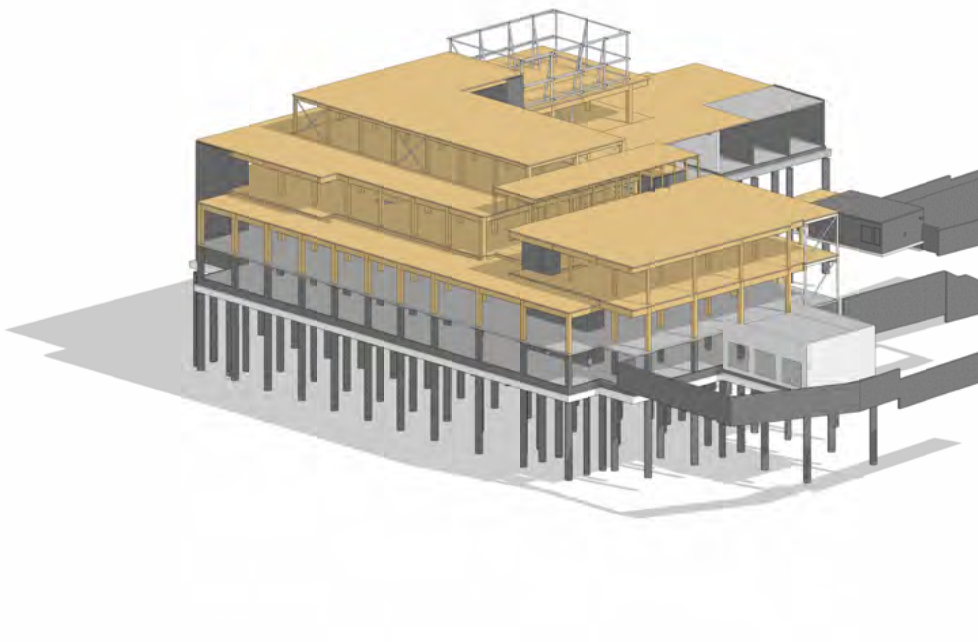
The hybrid mass timber and concrete design reduced embodied carbon by 57% compared to conventional concrete construction, reducing CO^2 emissions from ~7,000 to 3,000 tonnes with biogenic carbon storage. Initially, the hybrid design reduced emissions to 5,500 tonnes, already surpassing sustainability targets. The additional carbon sequestration of mass timber further lowered net emissions to 3,000 tonnes. This highlights mass timber's potential to drive sustainable design while maintaining structural integrity.

The building was classified as a post-disaster facility, requiring significantly higher loading capacities. Additional challenges arose from snow drift across multiple roof areas and a dedicated storage space, adding complexity to the design and necessitating a robust structural system.

To enhance sustainability and reduce embodied carbon, we developed a mass timber design that balances aesthetics, efficiency, and environmental responsibility, providing a lower-carbon alternative to conventional materials. This hybrid structure integrates a reinforced concrete substructure with a mass timber superstructure.

The superstructure features a post-and-beam system optimized with an 8m x 6m bay size and a CLT slab, ensuring superior structural integrity, fire resistance, and acoustic performance.

Due to weak native soil, the foundation relies on deep concrete caissons. Below grade, a 200mm-thick concrete slab-on-grade supports the holding cells, transitioning to a 250mm reinforced flat slab supported by concrete columns at Level 1.



CHALLENGE: NAVIGATING ELEVATED INSURANCE COSTS IN MASS TIMBER CONSTRUCTION

After a comprehensive evaluation of the Class C cost estimate, it became evident that, while the initial design surpassed embodied carbon reduction targets, the mass timber component incurred unexpectedly high costs. Upon closer examination, it was revealed that the elevated expenses were not due to the construction of mass timber itself but were primarily attributed to the substantial insurance premiums associated with such structures.

Several factors contributed to these elevated costs:

1. Perceived Fire Risks
Despite mass timber's demonstrated fire resistance, including the ability of structures to withstand conflagrations for extended periods, insurers often categorize these buildings similarly to traditional wood-frame constructions. This classification leads to higher premiums due to concerns about fire susceptibility.

2. Limited Historical Data
The relative novelty of mass timber in large-scale applications means there's a scarcity of historical claims data. This lack of empirical evidence makes it challenging for insurers to accurately assess risks, prompting them to set higher premiums as a precaution.

3. Repair and Rehabilitation Uncertainty
Insurers express concerns regarding the costs and processes involved in repairing mass timber buildings after events like fires or water damage. The unfamiliarity with these procedures contributes to the increased insurance rates.

Following extensive value engineering and stakeholder consultations, it was determined that to align with the client's budget, transitioning the superstructure design from mass timber to concrete was necessary. This shift introduced a new challenge: finding alternative strategies to achieve the original embodied carbon reduction targets while working within the limitations of a concrete structure.

STRATEGIES IMPLEMENTED TO REDUCE EMBODIED CARBON IN THE CONCRETE DESIGN

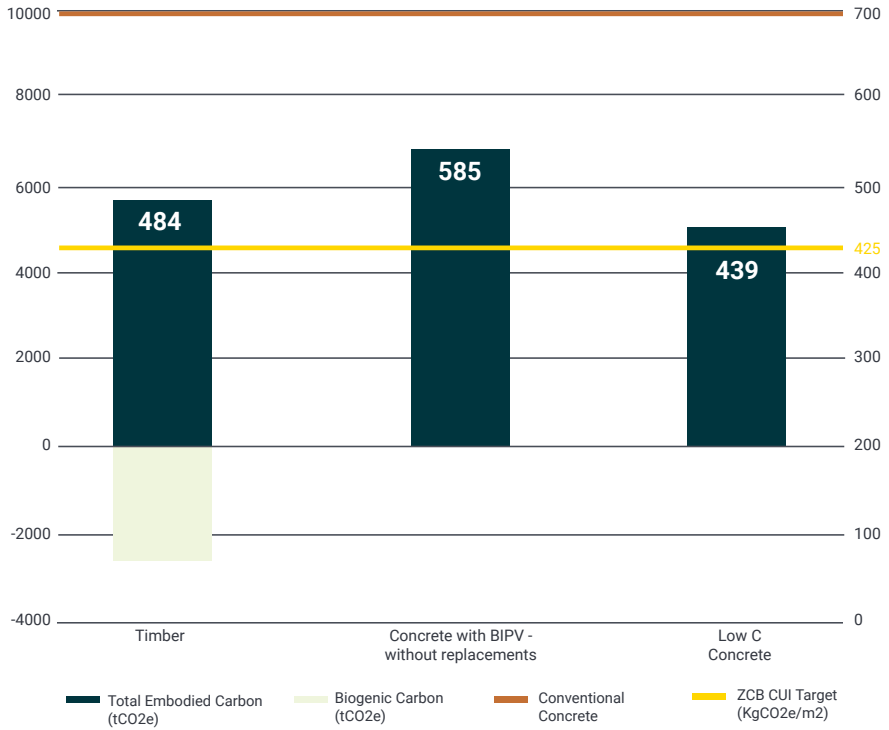
1. Low-Carbon Concrete Initiatives

- **Utilization of Supplementary Cementitious Materials (SCMs):** By incorporating by-products such as fly ash and slag into the concrete mix, the reliance on traditional Portland cement was reduced. This substitution not only decreased greenhouse gas emissions but also enhanced the durability and longevity of the concrete.
- **High-SCM Concrete Mix Designs:** Implementing mixes with elevated SCM content effectively lowered the carbon footprint of the concrete, aligning with sustainability goals.
- **Transition to Portland-Limestone Cement (GUL) from General Use Cement (GU):** Adopting GUL cement, which incorporates fine limestone, resulted in reduced clinker content and associated emissions, contributing to a lower EC profile.

2. Optimized Structural Design

- **Efficient Concrete Utilization:** Through meticulous structural analysis, concrete usage was minimized without compromising structural integrity, thereby reducing material consumption and associated emissions.
- **Selective Application of Exposure Classes:** By limiting the use of high-EC concrete exposure classes (e.g., C-1 and F-1) to areas where they were absolutely necessary, the overall EC was effectively managed.
- **Reduction of Hollow Structural Sections (HSS) in Steel Design:** Recognizing the higher EC associated with HSS sections, their usage was minimized in favor of alternative steel configurations that maintained structural performance while lowering EC.

Comparative Analysis of All Options



By implementing sustainable strategies such as high-SCM concrete mixes, efficient structural design, and material optimizations, the total embodied carbon of the concrete version was reduced to approximately 5,000 tonnes of CO^2e—a significant improvement over the 7,000 tonnes of CO^2e in a conventional concrete design. This represents a 29% reduction in EC. While this exceeds the 10% reduction goal, ongoing design refinements are being explored to further minimize EC and bring the concrete design as close as possible to the carbon efficiency of the timber alternative.

CASE STUDY #2

ADVANCING SUSTAINABLE STRUCTURAL SPECIFICATIONS FOR GOVERNMENT PROJECTS

NORR was engaged by a municipal organization to review key structural specifications to align with evolving sustainability standards, including the Toronto Green Standard and net zero carbon goals. The assessment identified opportunities to reduce embodied carbon while ensuring structural integrity. By integrating low-carbon technologies, NORR helped modernize material standards and promote greener construction in future government projects.

METHODOLOGY

NORR's approach to reviewing the specifications followed a comprehensive, multi-stage process aimed at evaluating and enhancing sustainability measures, specifically focusing on embodied carbon and GHG reduction opportunities. The methodology consisted of three key stages:

1. Specification Review
NORR conducted a detailed review of the specifications and identified clauses addressing embodied carbon reduction and assessed the potential for further GHG reduction measures. Specifications were compared against NORR's internal standards and other industry benchmarks to ensure completeness and alignment with best practices. Emphasis was placed on ensuring clarity and consistency in the language and intent of the specifications. The most critical sustainability-related clauses were then extracted for subsequent analysis.

2. Research and Survey
To validate the approach and ensure alignment with industry capabilities, NORR supplemented the specification review with targeted research and a comprehensive survey. Key sustainability standards and guidelines were reviewed, including:

- Toronto Green Standard Version 4
- Zero Carbon Building (ZCB) Design Standard Version 4
- Canada Green Building Council - Zero Carbon Building Design Guidelines

A tailored questionnaire was developed to capture insights regarding the adequacy, feasibility, and acceptability of the proposed carbon reduction measures. The survey targeted a diverse group of stakeholders—ranging from material suppliers and structural engineers to general contractors and sustainability consultants—to gather a comprehensive range of industry perspectives. The resulting data was organized and analyzed to extract key trends and to assess the specifications' alignment with current sustainability mandates.

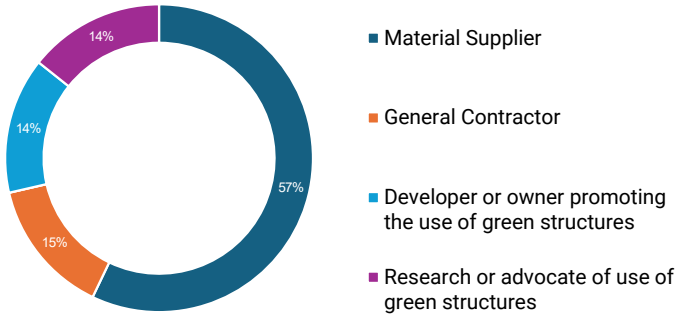
3. Comparative Analysis and Recommendations
The final stage involved a comparative analysis that integrated the survey findings and research insights with the specifications. NORR identified areas where the specifications were already aligned with industry practices for carbon reduction and sustainability, as well as potential challenges in the practical application of these measures. Based on these insights, detailed recommendations were provided to enhance the overall effectiveness of the sustainability measures, ensuring they met long-term environmental goals.

SURVEY FEEDBACK: CAST-IN-PLACE CONCRETE SPECIFICATIONS

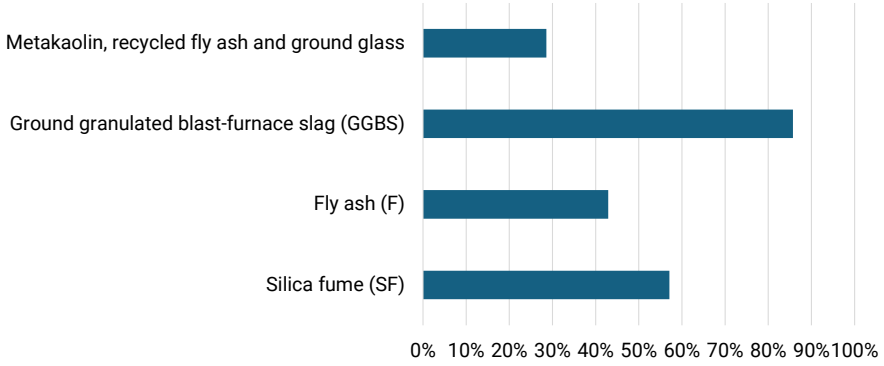
For this case study, we present the survey feedback specifically related to the Cast-in-Place Concrete (03 30 00) specification, which is a key component of the overall review.

The following results highlight key insights gathered from industry stakeholders through the questionnaire, showcasing perspectives on sustainability and low-carbon strategies.

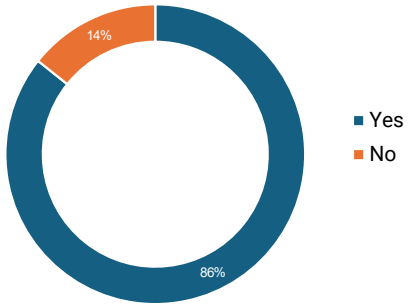
Please select the title that best describes your role, as these questions are relevant to your involvement in the industry.



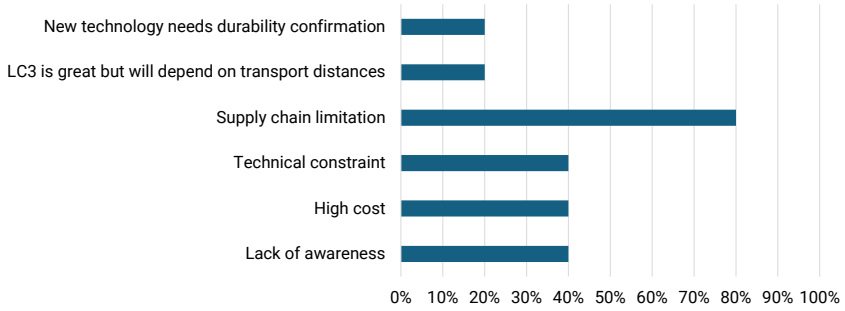
Which of the following SCMs are commonly used in concrete mix in order to meet GWP limits?



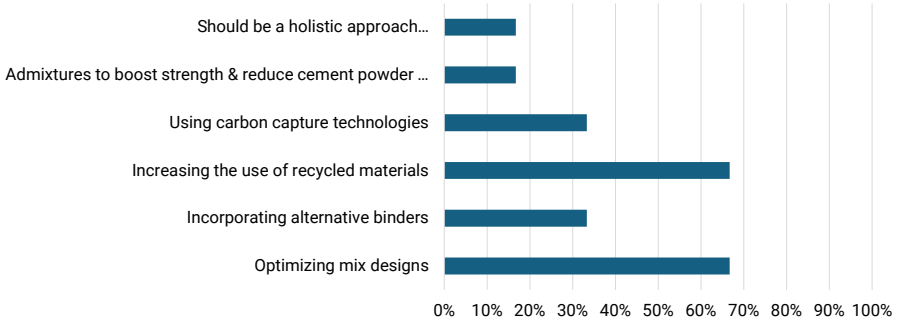
From your experience, would limitations on percentage of above SCMs in the concrete mix limit the impact on the overall carbon reduction in the concrete mix?



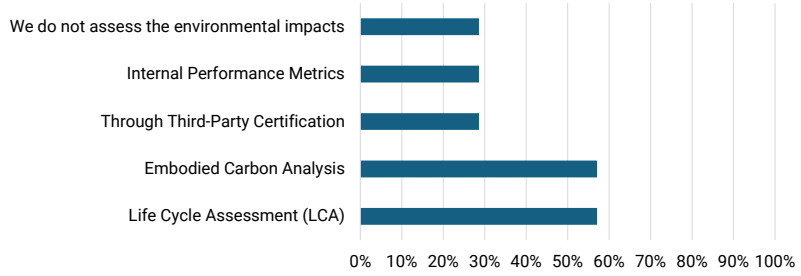
What challenges, if any, prevent you from using Limestone Calcined Clay Cement (LC3)?



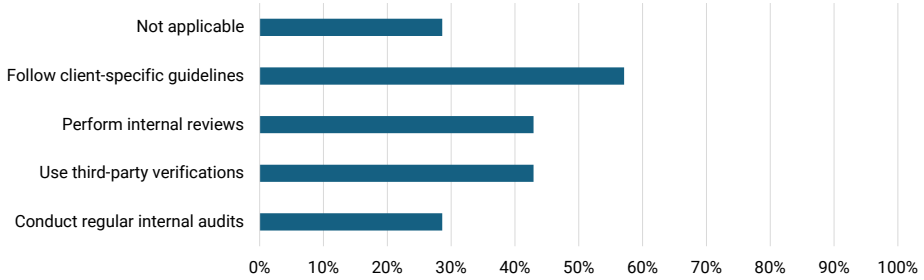
What strategies do you employ to reduce the carbon footprint of concrete used in projects?



How do you currently assess the environmental impact of concrete?



How do you ensure compliance with low-carbon specifications in your contracts?



KEY INSIGHTS FROM CAST-IN-PLACE CONCRETE SURVEY

The survey feedback provided valuable insights into how the Cast-in-Place Concrete specification can contribute to reducing embodied carbon while maintaining performance standards. The following key takeaways emerged from the survey responses:

1. Concrete Mixes and Carbon Footprint:
Responses varied regarding whether concrete mixes fall below the average Global Warming Potential (GWP) of industry standards. Some suppliers reported mixes with more than a 10% reduction in GWP, while others met only the minimum reduction. NORR's analysis indicates that a 10% reduction in GWP is achievable and should be targeted in future specifications.

2. Environmental Product Declarations (EPDs):
One supplier confirmed that facility-specific EPDs could be provided, although additional costs were involved. NORR believes that EPDs should be part of the documentation to ensure transparency and accountability, but no immediate action is required as compliance is possible.

3. Supplementary Cementitious Materials (SCMs):
Common SCMs like Ground Granulated Blast Furnace Slag (GGBS), Silica Fume (SF) and Fly Ash (F) were identified as effective in reducing carbon emissions. However, limitations on SCM percentages were noted to potentially hinder carbon reduction efforts. NORR suggests considering more flexibility in SCM limits to maximize carbon reduction potential.

4. Limestone Calcined Clay Cement (LC3):
The implementation of LC3 was noted to be limited due to supply chain constraints. NORR recognizes these challenges and recommends no immediate action but suggests monitoring for future opportunities as the supply chain improves.

5. Recycled Concrete Aggregates (RCA):
The restriction of RCA in concrete mixes can negatively affect the ability to meet low-carbon goals, particularly for high-RCA users. NORR suggests maintaining the restriction for structural elements but considering allowing RCA for non-structural elements to enhance sustainability without compromising safety.

6. Innovative Technologies:
Industry leaders highlighted promising innovations for reducing carbon in cast-in-place concrete. Notably, nanotechnology and OCAG were identified as effective methods for reducing cement content.

- Nanotechnology uses nanoparticles (e.g., nano-silica) to improve concrete's strength and durability, reducing the amount of cement required.
- OCAG optimizes the particle size distribution of aggregates, reducing the need for cement paste by improving aggregate packing efficiency. These approaches can significantly lower embodied carbon by reducing cement demand.

FINAL REMARKS

This report represents our fourth annual Embodied Carbon Action Plan as inspired by the SE 2050 Commitment Program as well as our dedication to environmental stewardship.

The framework presented in this report outlines the company's vision, goals, strategies and immediate tasks to implement the means to create a reduction in embodied carbon through structural design. Action items are divided into education & knowledge sharing, embodied carbon reduction, reporting and advocacy subtasks which will form the structure for our embodied carbon response for the next 26 years and beyond. This Action Plan will enable us to emerge as a front runner in sustainable structural engineering practice through internal embodied carbon education, advanced carbon-conscious design procedures, superior sustainability coordination with clients and a uniquely inspired employee environment. Together, these components will develop continuously in the future and ultimately contribute to achieving net zero structural engineering practices by 2050. We are committed to reducing embodied carbon in our projects and incorporating this important metric across all of its actions.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