

# LCRES Appendix-E

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## A Directed Approach to Embodied Carbon in Health Care New Construction and Major Renovation

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# EXECUTIVE SUMMARY

BC health care organizations have a mandate to reduce emissions contributing to global warming. Construction materials and activities emit greenhouse gases through their extraction, manufacturing, transportation, use and disposal, which is referred to as embodied carbon. In construction, including health care, embodied carbon emissions can be comparable to a facility’s operational carbon emissions over several decades.

The construction industry is evolving to respond to this urgent challenge by improving material selection and design practices. However, major capital project teams require a practical way to coordinate decision-making and identify the most effective embodied carbon reductions within project constraints.

*A Directed Approach to Embodied Carbon in Health Care New Construction and Major Renovation* serves as a guide under the Low Carbon Resilience and Environmental Sustainability (LCRES) framework for teams seeking a practical pathway to set, manage and verify embodied carbon reductions. The approach directs project resources toward achieving the highest carbon reductions at the least cost and effort. This guide is an appendix to the LCRES Guidelines for Health Care New Construction. The directed approach emphasizes early collaboration on high-impact materials and uses Life-Cycle Assessment intentionally for target-setting and verification.

## OVERVIEW

As part of a directed approach to embodied carbon reduction, this guide covers:

- Roles and responsibilities
- Target setting and verification
- Scope and prioritization
- Use of Whole-Building Life-Cycle Assessment (wbLCA)
- Actions across each phase from early planning through design and construction

Who should read it:

- **Owner-side:** Project Manager
- **Consultants and Delivery team:** Sustainability Consultant, Prime Consultant

How to use this guide:

- **SUMMARY OF KEY ACTIONS AND COLLABORATORS** serves as a quick navigation key to the relevant sections and summarizes the most important actions and collaborations.
- **PART-1 – TARGETS, ROLES & SCOPE** defines roles and accountability, target-setting, recommended scope, and use of wbLCA. These are the general rules behind the directed approach.
- **PART-2 – PHASE-BY-PHASE CHECKLIST** outlines recommended actions across each project phase to embed targets into business plans and contracts, coordinate design-stage actions and confirm specification compliance through construction, aligned with LCRES.

## KEY DEFINITIONS

**Baseline:** A reference material or building used for comparison when evaluating embodied carbon performance.

**Embodied Carbon:** The greenhouse gas (GHG) emissions associated with extraction, manufacturing, transportation, installation, maintenance and disposal of construction materials, reported in kilograms of carbon dioxide equivalent (kgCO<sub>2e</sub>)

**Environmental Product Declaration (EPD):** A document that reports the environmental impacts of a product over its life cycle.

**Global Warming Potential (GWP):** A measure used to compare heat trapping ability of different greenhouse gases (GHGs) relative to carbon dioxide.

**Greenhouse Gas (GHG):** A measure used to compare the climate impact of different greenhouse gases relative to carbon dioxide.











**Gross Floor Area (GFA):** The total floor area of a building measured to the outer perimeter of the exterior walls. For embodied carbon calculations, this should include all floors above as well as below grade spaces (parking, service spaces, and mechanical areas).

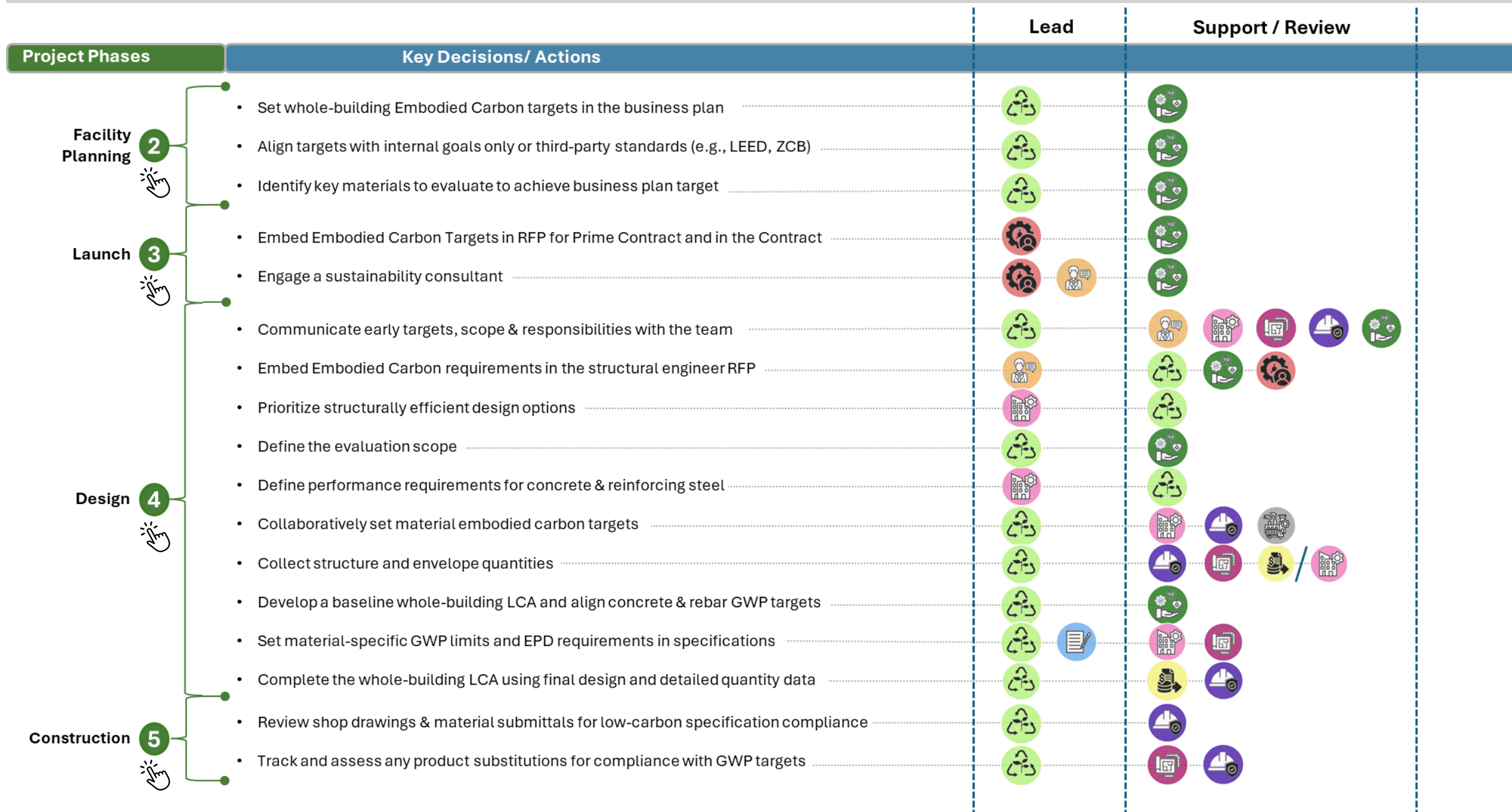
**Life-Cycle Assessment or Analysis (LCA):** A method used to assess the environmental impacts, including embodied carbon, of a material, product or building across its life cycle. When this assessment is applied collectively to all major materials in a building (such as significant structural and envelope materials), it is referred to as a whole-building Life-Cycle Assessment (wbLCA).

**Sustainability Consultant:** An external consultant, as defined in the LCRES guide, responsible for implementing the Directed Embodied Carbon Approach on the project. This consultant typically has accreditation to support green building certification programs and conducts whole-building Life-Cycle Assessments (LCA) as per this Appendix.

# SUMMARY OF KEY ACTIONS AND COLLABORATORS

## Legend

 EES Representative	 Prime Consultant	 Cost Consultant	 Architect (Design Team)	 Specification Writer
 Project Manager	 Sustainability Consultant	 Structural Engineer (Design Team)	 Contractor	 Material Supplier



# PART-1 – TARGETS, ROLES & SCOPE

## Embodied Carbon Targets for New Health Care Facility Construction

As the construction industry evolves to produce materials with lower global warming impacts, targeting selected high embodied carbon materials such as concrete and rebar can realistically achieve a 10% to 20% reduction in overall embodied carbon at little to no additional cost. This reduction is measured against a baseline design using conventional materials. Using this directed approach, a new health care facility can reasonably target a 10% to 20% reduction in embodied carbon.

Significant embodied carbon reductions are an important part of the design approach and can be achieved through architectural and structural design choices. Opportunities for substantially greater reductions may be available at minimal cost, depending on factors such as project location and material availability. Greater reductions may be pursued, where appropriate, through defined and costed stretch targets.

Part 1 outlines how embodied carbon targets are established, updated and verified. The section clarifies use of whole-building life-cycle assessment (wbLCA), roles and scope.

### **Steps to Target-setting and Verification**

- Whole-building embodied carbon targets are established in the business plan, with a minimum reduction of 10–20%. Optional stretch targets may be set where aligned with project goals and constraints.
- Material-specific targets are defined through early engagement with the design team, contractor and suppliers.
- Targets are updated as design information and supplier feedback become available.
- Target achievement is verified through whole-building life-cycle assessment (wbLCA) using designed materials and quantities during Contract Documentation or Construction, as outlined in Part 2.

## The Directed Approach and the Role of wbLCA

The directed Embodied Carbon approach focuses on evaluating the embodied carbon of key structural and material choices to inform early design and procurement decisions, along with verification of target achievement during construction. This differs from conventional approaches, which typically rely on multiple full-scope whole-building life-cycle assessments.

However, a whole-building Life-Cycle Assessment (wbLCA) is an important activity to account for the impact of material choices, across the life cycle of the building. Under the directed approach, a wbLCA is used at specific milestones, later in the project, to set whole building baselines, refine target-setting and to verify achievement of embodied carbon reductions. It is not intended to be used as a continuous or iterative design optimisation tool.

The LCA is to be carried out intentionally at specific milestones as described in the *Design* subsection of this document.

### **Required use of wbLCA:**

- Establish a baseline GWP for the building.
- Update whole-building target GWP once key material GWP inputs and quantities are available.

- Verify achievement of whole-building and material GWP at appropriate project stages.

### **Setting the wbLCA boundary:**

The LCA boundary defines which life-cycle stages are included in the assessment (e.g., A1–A3 or A1–C4). These stages represent different parts of the life cycle, such as manufacturing (A1–A3), transportation to site (A4), construction (A5), use and maintenance (B stages), and end-of-life (C stages).

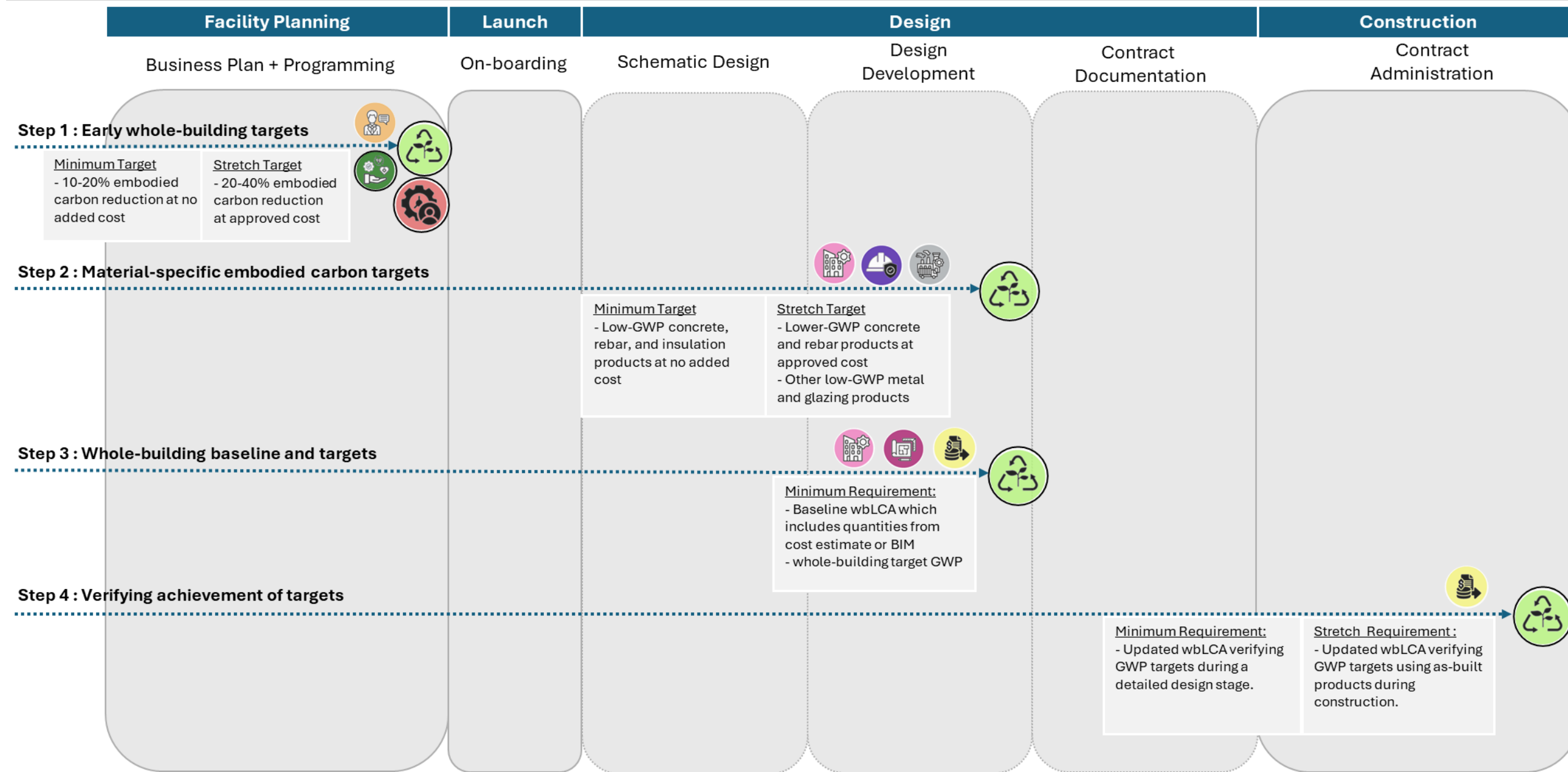
Depending on project goals and third-party target requirements, apply one of the following approaches. Assumptions and parameters should remain consistent between the baseline and proposed models, regardless of the approach.

- **Limited wbLCA (A1-A3):** Used when the project is pursuing internal embodied carbon targets only. This approach assesses cradle-to-gate emissions (A1–A3) using local industry-average EPDs for the baseline building and product- or plant-specific EPDs for the proposed design, supported by a controlled quantity table (e.g., Excel).
- **Full-boundary wbLCA (A1-C4):** Uses software-based wbLCA modelling to assess cradle-to-grave emissions (A1–C4), following methodology consistent with [NRC National guidelines for whole-building life cycle assessment](#), ISO 14044 and/or other standards required to project-specific internal or external objectives.

Update the assessment if significant inputs change (e.g., new concrete mixes, added or removed storeys, or envelope design changes), or if the project undergoes a major redesign affecting the structural or envelope systems

# Timeline for Target-setting and Verification

## Legend



# Directed Embodied Carbon Approach: Material Scope and Priorities

Under a conventional approach, whole-building LCA is conducted early using an indicative design to establish a baseline and later repeated on the proposed design to assess compliance or improvement. The process typically produces modelling-based reduction recommendations but does not ensure that reductions are achieved through coordinated material decisions.

Under the Directed Embodied Carbon Approach, projects initially target a minimum 10–20% embodied carbon reductions through focused material decisions, typically at no additional cost.

The assessment scope below focuses on key structural and envelope materials that should be prioritised for embodied carbon reduction ranked based on their impact.

- Tier 1 materials define the minimum required scope for embodied carbon evaluation.
- Tier 2-3 materials define optional stretch scope, to be addressed in order of priority.

The section aims to identify the key materials that are targeted for embodied carbon reduction. A wbLCA includes all major structural and envelope materials to quantify the whole-building embodied carbon reductions achieved by targeting the key materials.

**Structure:**

Tier (priority)	Material/ Systems
1 (minimum)	Concrete, Rebar
2 (stretch)	Concrete masonry units (CMU), Steel Deck, High-strength steel (HSS) sections, Cold-formed steel (e.g. metal studs), Mass timber

**Envelope:**

Tier (priority)	Material/ Systems
1 (minimum)	Thermal insulation (including XPS, polyisocyanurate, EPS, mineral wool and fiberglass insulation materials)
2 (stretch)	Aluminium and Metal cladding systems, Windows and Curtainwall systems
3 (stretch)	Non-metal cladding systems (e.g. cementitious, precast concrete, terra cotta), Roofing membranes, Gypsum sheathing, Plywood sheathing, Roof screens

**Embodied Carbon Stretch Opportunities:**

The following items represent selected industry stretch pathways and are not exhaustive. These opportunities are separate from the tiered material scope above. They are intended for projects seeking additional embodied carbon reductions, improved assessment accuracy beyond minimum requirements, or advancement of industry knowledge.

Additional project-specific stretch actions may be pursued where aligned with project goals, budget and supply chain conditions.

<b>Item</b>	<b>Stretch Actions</b>
1	Adopt advanced low-carbon concrete mixes, including approved cost-premium solutions.
2	Expand embodied carbon assessment beyond primary materials (including selected interior materials and mechanical equipment).
3	Track and report material transportation emissions (A4) accurately and identify mitigation opportunities.
4	Track and reduce construction-stage emissions (A5), including use of low-carbon construction energy sources and equipment.
5	Incorporate end-of-life and circularity strategies, including design for disassembly, adaptability and recyclability (C1–C4).

## PART-2 – PHASE-BY-PHASE CHECKLIST

Part 2 outlines phase-based actions aligned with LCRES, showing what to do, when and with whom.

### Discovery and Site Planning

#### **Action:**

This phase is included for context only and does not require embodied carbon actions or analysis.

#### **Intent:**

Discovery and Site Planning establish site-driven conditions that influence embodied carbon in the project but are generally not controllable through design or material decisions. While these factors can affect material availability and transportation emissions, they are primarily driven by functional, regulatory and site constraints.

Key site-related factors influencing embodied carbon include:

- **Site conditions:** Soil, seismicity, and climate influence structural and material demands.
- **Market access and supply chain:** Remote locations may have less low-carbon material options compared to urban locations.
- **Transportation impacts:** Longer distances increase transportation emissions.

### Facility Planning

#### **Action:**

Establish early whole-building embodied carbon targets and embed them into the business plan.

#### **Intent:**

Facility Planning is when the project budget and business plan are developed. This phase establishes whole-building embodied carbon targets in the business plan to guide design and procurement decisions in later phases.

A whole-building Life Cycle Assessment is not recommended at this stage, as design and material selections are not yet defined. Minimum reduction targets (10–20%) can typically be set with minimal cost impact. Stretch targets may have cost and labour implications and cab, not be reliably assessed at this stage.

Step-by-step actions	Target		Roles	Notes
	Minimum	Stretch		
Set whole-building embodied carbon target in the business plan.	10-20% reduction	20-40% reduction	<b>Lead:</b> Sustainability consultant*  <b>Review:</b> EES	These are early targets to be updated during the design phases. Stretch targets may require added budget and resourcing.

Align targets with either internal goals only or third-party standards (e.g. LEED, ZCB).	Internal target	LEED credits or ZCB alignment	<b>Lead:</b> Sustainability consultant* <b>Review:</b> EES	Third-party alignment may require additional budget, consulting support and documentation
Identify and recommend which materials will be evaluated based on the identified business plan target (minimum or stretch).	<i>See Directed Embodied Carbon Approach: Material Scope and Priorities</i>		<b>Lead:</b> Sustainability consultant*	Required scope of evaluation depends on target and budget. This is to be refined in early design.

\*Note: The sustainability consultant involved during Facility Planning supports programming and target setting within the business plan. This is distinct from the sustainability consultant engaged during design.

**Key Outcome:**

Business plan includes early embodied carbon targets with aligned budget and resourcing.

## Launch

**Action:**

Embed embodied carbon targets and scope into procurement and contracts.

**Intent:**

Launch stage confirms the project delivery method and executes the prime contract.

Step	Step-by-step actions	Roles
1	Include embodied carbon targets from the business plan in the RFP for the prime consultant.	<b>Lead:</b> PM <b>Support:</b> EES
2	Include embodied carbon targets from the business plan in the prime contract.	<b>Lead:</b> PM <b>Support:</b> EES
3	Procure a sustainability consultant with LCA experience as outlined in this appendix*.	<b>Lead:</b> PM, Prime consultant <b>Support:</b> EES

\*Note: This step may be undertaken during early schematic or in line with consultant procurement timeline.

**Key Outcome:**

Embodied carbon targets and scope are contractually embedded. Clear expectations are established for roles, responsibilities and collaboration.

## Design

**Action:**

Translate embodied carbon targets into design decisions, specifications and procurement requirements.

**Intent:**

Design (SD, DD and Contract Documentation) is where embodied carbon targets established during Facility Planning are translated into material decisions, specifications and procurement requirements. This phase is where coordinated team actions deliver whole-building embodied carbon reductions. Establishing a baseline before schematic design, or using indicative design information, is not recommended. Once key material options and quantities are available, a baseline wbLCA is completed and the whole-building target updated. Achievement of the target is then verified once the final design is established.

Below is the recommended order of steps to be followed for all contract delivery models.

Step	Step-by-step actions	Roles
<b>Schematic Design</b>		
1	Sustainability consultant with LCA experience communicates early embodied carbon targets, scope, roles and responsibilities outlined in this document through an onboarding meeting or workshop*.	<b>Lead:</b> Sustainability consultant <b>Participant/ Support:</b> EES, Prime consultant, Lead architect or Design manager, General contractor, Structural engineer (if engaged)
2	Integrate requirements into the structural engineer RFP to support embodied carbon reduction.	<b>Lead:</b> Prime Consultant <b>Support:</b> EES, PM, Sustainability consultant
3	Evaluate structurally efficient schemes to reduce embodied carbon <sup>1</sup> . <ul style="list-style-type: none"> <li>Structural engineer to develop structural schemes.</li> <li>Sustainability consultant to evaluate embodied carbon of structural schemes.</li> </ul>	<b>Lead:</b> Structural engineer, Sustainability consultant
4	Define the scope of materials to be addressed. To achieve the minimum 10–20% reduction target, concrete and rebar must be evaluated through supplier coordination, and maximum GWP specifications must be established for concrete, rebar and insulation at a minimum. Refer to <i>Directed Embodied Carbon Approach: Material Scope and Priorities</i> for additional details.	<b>Lead:</b> Sustainability consultant <b>Review/ Support:</b> EES
5	Establish structural performance requirements for concrete and rebar at a minimum. These requirements allow suppliers to identify compliant low-carbon product options.	<b>Lead:</b> Structural engineer <b>Support:</b> Sustainability consultant
<b>Schematic Design or Design Development</b>		
6	Work with potential suppliers and fabricators <sup>2</sup> to identify concrete and rebar options that meet performance requirements and offer the lowest achievable embodied carbon at the given cost. Supplier engagement to be coordinated with the general contractor. Suppliers may use the bidding sheet or similar document appended at the end of this appendix to provide their inputs.	<b>Lead:</b> Sustainability consultant <b>Support:</b> Contractor, Structural engineer, Suppliers
7	Set material-specific embodied carbon targets for concrete mixes and rebar based on supplier feedback on the lowest GWP options available at the given cost. Targets may be set:	<b>Lead:</b> Sustainability consultant <b>Review/ Support:</b> EES

	<ul style="list-style-type: none"> <li>• Conservatively, based on the average GWP of compliant products or</li> <li>• Aggressively, based on the lowest-GWP compliant product</li> </ul>	
8	Obtain structure and envelope quantities from the quantity surveyor where available or from the structural engineer and architect where a quantity surveyor is not engaged. Design team-led quantity takeoffs are a fallback only.	<b>Lead:</b> Sustainability consultant <b>Support:</b> Contractor, Quantity surveyor OR Structural engineer, Architect
9	Create the baseline wbLCA <sup>2</sup> and input the concrete and rebar GWP targets established in the earlier step to refine the whole-building target.	<b>Lead:</b> Sustainability consultant <b>Review/ Support:</b> EES
<b>Design Development or Contract Documentation</b>		
10	Establish material-specific GWP limits (refer to <i>Directed Embodied Approach: Material Scope and Priorities</i> ) and EPD requirements in material specifications for concrete, rebar and insulation at a minimum. For insulation, the GWP limit should align with the BC industry-average EPDs for the type of insulation product.	<b>Lead:</b> Sustainability consultant, Specification writer <b>Support:</b> Architect, Structural engineer
11	Perform the verification wbLCA <sup>3</sup> for the proposed design once the final design and detailed cost-estimate quantities are available.	<b>Lead:</b> Sustainability consultant <b>Support:</b> Contractor, Quantity surveyor

1. Examples of structural and architectural efficiencies include reducing transfer slabs, reducing floor-to-floor heights, improving planning efficiency (thereby reducing program area) and reducing parkade levels.
2. Where available, use local industry-average EPDs for the baseline wbLCA. Otherwise, use conservative estimates based on local product GWP averages.
3. As a stretch goal, wbLCA may be updated using as-built materials and quantities during construction to reflect design and material changes.

**Key Outcome:**

Verification through LCA demonstrates that the whole-building embodied carbon target established in the business plan and refined during early design can be achieved through the final design and specifications.

**Construction**

**Action:**

Verify compliance with embodied carbon targets through submittal review and product selection.

**Intent:**

During Construction, embodied carbon targets established during design are verified for compliance with specifications and product selection by reviewing contractor submittals including EPDs, assembly shop drawings and product cut sheets.

Where approved as stretch goals, the Sustainability consultant is expected to support innovation by tracking transportation-related (A4) and construction-stage (A5) emissions and documenting their impact.

Step-by-step actions	Role
<b>Required</b>	
Review shop drawings and submittals to confirm that specified products comply with GWP limits and EPD requirements. This helps verify that the material and whole-building targets are achieved.	<b>Lead:</b> Sustainability consultant <b>Support:</b> Contractor
Track and assess design or product substitutions and document resulting GWP impacts in the wbLCA. This is to ensure that the whole-building GWP reflects the selected products and materials.	<b>Lead:</b> Sustainability consultant <b>Support:</b> Architect, Contractor
<b>Stretch</b>	
Perform a wbLCA using as-built materials and quantities in place of design-stage assumptions. This will result in a more thorough accountability through the construction phase to fulfill design material choices, a more accurate wbLCA and GWP output and reflect any design changes in the GWP output.	<b>Lead:</b> Sustainability consultant <b>Support:</b> Contractor and/or Architect and Structural engineer
Track and report transportation phase (A4) emissions based on sources of building products and material.	<b>Lead:</b> Sustainability consultant <b>Support:</b> Contractor
Track and report construction phase (A5) emissions based on sources of energy for construction.	<b>Lead:</b> Sustainability consultant <b>Support:</b> Contractor

**Key Outcome:**

At a minimum, the outcome at this phase is a verification of embodied carbon target as designed. If stretch goals are pursued, this phase presents opportunities to innovate and advance the industry for enhanced embodied carbon reductions.

