Quantifying the Carbon Footprint of Every Building.
CITIES have 15 months to reverse climate change, says new report

Can they do it?

A major new climate report slams the door on wishful thinking

The IPCC says that even the most optimistic scenario for climate change is dire.

By Umair Irfan | Updated Oct 7, 2018, 9:00pm EDT
“By 2025, we will become “carbon net positive” by buying enough clean energy and carbon offsets to remove more greenhouse gases from the atmosphere than we emit.”

UF is working toward major institutional changes to reach its goal of carbon neutrality by 2025. The Neutral UF Coalition program is envisioned to reduce the GHG emissions of the university by impacting the footprint of various areas.

“Microsoft has changed the way it operates to reduce our carbon footprint. We have reduced energy consumption, bought clean energy to cover what we can’t reduce and invested in offset projects for the carbon we can’t reduce or replace.”

“We strive to reduce carbon emissions from our operations and provide customers with resilient, low-carbon solutions.”
Over the next 35 years, two trillion \( \text{ft}^2 \) of new and rebuilt buildings will be constructed in cities worldwide.

An entire New York City every 35 days for 35 years!
Understanding Carbon

Embodied Carbon
Manufacture, transport and installation of construction materials

Operational Carbon
Building Energy Consumption
Total Carbon Emissions of **Single Building**

*Global Average Building Carbon Footprint: Business as Usual*

- **Embodied Carbon**: 49%
- **Operational Carbon**: 51%

Total Carbon Emissions of Single Building

Global Average Building Carbon Footprint: 50% Better Operational Performance

- Operational Carbon: 35%
- Embodied Carbon: 66%

Total Carbon Emissions of **All Global New Construction from 2020-2050**

*Business as Usual Projection*

- **Embodied Carbon**: 80%
- **Operational Carbon**: 20%

The graph shows the projected billion kg of CO₂ emissions from embodied and operational carbon for each year from 2020 to 2050.
### Skanska Benchmarking

**RSF:** >100,000 SF  
**Goal Achieved:** LEED Platinum  
**Type:** Office/Mixed/Open

### Carbon Emissions Breakdown

- **Total Tons of CO2e:** 4,545
- **Material Transport:** 321 tonnes of CO2e
- **Worker Transport:** 497 tonnes of CO2e
- **Fuel:** 442 tonnes of CO2e
- **Waste:** 24 tonnes of CO2e
- **44 kg of CO2e PSF**

### Average Craftwork Carbon Emissions per Day

<table>
<thead>
<tr>
<th>Mode</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Alone</td>
<td>72%</td>
</tr>
<tr>
<td>Mass Transit</td>
<td>3%</td>
</tr>
<tr>
<td>Carpool</td>
<td>25%</td>
</tr>
</tbody>
</table>

### Materials Breakdown (in Tonnes of CO2e)

- **Structural Steel:** 2,202
- **Concrete:** 1,073
- **Aluminum: General:** 486
- **Copper: General:** 232
- **All Other Materials:** 486

### Waste Breakdown (in tonnes of CO2e)

- **167 tonnes of CO2e**
- **275 tonnes of CO2e**
Embodied Carbon Benchmarking Study

- Over 1,000 building entries
- 12 Building Categories
- Open Source Database
- Phase 1 of Larger LCA Practice Guide Funded Project
Now What?

Demonstrating the Impact

CO₂
Kg per m²

“High Embodied Carbon” Target

“Low Embodied Carbon” Target

Over 1,000 buildings in the database

Commercial Residential Other Non-Commercial
Demonstrating the Impact

16% operational
84% embodied
(over 50 life cycle)

55,000 tons of CO2
Or... a flying for 70 days
Or... 10,762 driving for 1 year
Or... 172,897 of crude oil

Seattle Midrise Office
Demonstrating the Reduction

Seattle Midrise Office

16% operational
84% embodied
(over 50 life cycle)

= 55 tons of CO2
  or... a flying for 70 days
  or... 10,762 driving for 1 year
  or... 172,897 of crude oil
The Available Resources for Embodied Carbon

**University of Washington Carbon Leadership Forum**
- LCA Practice Guide
- Embodied Carbon Benchmarking Study
- TI/MEP Embodied Carbon Study
- Embodied Carbon Network

[carbonleadershipforum.org](http://carbonleadershipforum.org)

**Architecture 2030**
- Carbon Smart Materials Palette
- 2030 Challenge for Products
- Zero Code

[architecture2030.org](http://architecture2030.org)
# The Available Tools for Embodied Carbon

<table>
<thead>
<tr>
<th>Athena Impact Estimator</th>
<th>Tally</th>
<th>OneClick LCA</th>
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<tr>
<td>Available To</td>
<td>Everyone</td>
<td>Revit Users</td>
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<tr>
<td>Ease of Use</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cost</td>
<td>Free</td>
<td>License Fee</td>
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<tr>
<td>Data Source</td>
<td>Multiple</td>
<td>GaBi (Thinkstep)</td>
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<td>Open Data (API)</td>
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**Industry Analysis**
# The Available Certifications for Embodied Carbon

<table>
<thead>
<tr>
<th></th>
<th>LEED v4 LCA Credit</th>
<th>ILFI Programs (Embodied Carbon Imperative)</th>
<th>Anything Else...?</th>
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<tbody>
<tr>
<td><strong>Full LCA?</strong></td>
<td>Yes</td>
<td>No</td>
<td>?</td>
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<tr>
<td><strong>Cost?</strong></td>
<td>Yes, LCA Study</td>
<td>Yes, Embodied Carbon Offset</td>
<td>?</td>
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<tr>
<td><strong>Standardized Tool?</strong></td>
<td>No</td>
<td>No</td>
<td>?</td>
</tr>
<tr>
<td><strong>Benchmarking Mechanism?</strong></td>
<td>No</td>
<td>No</td>
<td>?</td>
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</table>

- USGBC Zero Carbon
- ILFI Zero Carbon
- LEED Embodied Carbon Pilot Credit
Main Entry: transparent
Pronunciation: tran(t)s-ˈpar-ənt, -ˈpər-
Function: adjective
1 a: transmitting light so that objects lying beyond are entirely visible b: fine or sheer enough to be seen through <transparent gauze>
2: easily detected or understood: obvious <transparent falsehood>

Embodyed carbon refers to carbon dioxide emitted during the manufacture, transport and construction of building materials, together with end of life emissions. So for example, if you are specifying concrete on a project then carbon will have been emitted making that concrete. Mar 1, 2012
## General Contractor – Estimate Quantities

### ASTM Uniformat II Classification for Building Elements (E1557-97)

<table>
<thead>
<tr>
<th>Level 1 Major Group Elements</th>
<th>Level 2 Group Elements</th>
<th>Level 3 Individual Elements</th>
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<tbody>
<tr>
<td>A SUBSTRUCTURE</td>
<td>A10 Foundations</td>
<td>A1010 Standard Foundations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A1020 Special Foundations</td>
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<tr>
<td></td>
<td></td>
<td>A1030 Slab on Grade</td>
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<tr>
<td></td>
<td>A20 Basement Construction</td>
<td>A2010 Basement Excavation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A2020 Basement Walls</td>
</tr>
<tr>
<td>B SHELL</td>
<td>B10 Superstructure</td>
<td>B1010 Floor Construction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B1020 Roof Construction</td>
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<tr>
<td></td>
<td>B20 Exterior Enclosure</td>
<td>B2010 Exterior Walls</td>
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<tr>
<td></td>
<td></td>
<td>B2020 Exterior Windows</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B2030 Exterior Doors</td>
</tr>
<tr>
<td></td>
<td>B30 Roofing</td>
<td>B3010 Roof Coverings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B3020 Roof Openings</td>
</tr>
<tr>
<td>C INTERIORS</td>
<td>C10 Interior Construction</td>
<td>C1010 Partitions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C1020 Interior Doors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C1030 Fittings</td>
</tr>
</tbody>
</table>

### 02. Parking Garage

#### A SUBSTRUCTURE

**A10 FOUNDATIONS**

- **A1010 Standard Foundations**
  - 03300.001 Spread Footings
    - 03.01 Concrete
    - Spread Footings: 1,848.00 cu yd
  - 03300.001 Continuous Footings
    - 03.01 Concrete
    - Continuous Footings: 87.00 cu yd
  - 03300.001 Mat Footings
    - 03.01 Concrete
    - Mat Footings: 1,190.00 cu yd
  - 03300.001 Tower Crane Footing
    - 03.01 Concrete
    - Tower Crane Footing: 93.00 cu yd

#### 03.02 Rebar

- 03210.600 Steel Bar Reinforcement in Spread Footings (70lbs/CY)
  - Steel Bar Reinforcement: 59.00 tons
- 03210.600 Steel Bar Reinforcement in Matt Foundations (110lbs/CY)
  - Steel Bar Reinforcement: 60.00 tons
- 03210.600 Steel Bar Reinforcement in Continuous Footings (50lbs/CY)
  - Steel Bar Reinforcement: 2.00 tons
- 03210.600 Steel Bar Reinforcement in Tower Crane Matt Foundations (110lbs/CY)
  - Steel Bar Reinforcement: 32.00 tons
Environmental Product Declarations

Nutrition Facts

Serving Size 2/3 cup (55g)
Servings Per Container About 8

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>Calories</th>
<th>Calories from Fat 40</th>
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<tr>
<td></td>
<td>230</td>
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</table>

<table>
<thead>
<tr>
<th>% Daily Value*</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Total Fat</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>12%</td>
<td></td>
</tr>
</tbody>
</table>

| Dietary Fiber      | 16%      |                      |
| Sugars             | 1g       |                      |
| Protein            | 3g       |                      |

Life Cycle Impact Results (per m³)
Declared Unit: 1 m³ of 10,000 psi concrete at 28 days

<table>
<thead>
<tr>
<th>OPERATIONAL IMPACTS</th>
<th>PerformX™ PECC10K</th>
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</thead>
<tbody>
<tr>
<td>Plant Operating Energy (MJ)</td>
<td>38.6</td>
</tr>
<tr>
<td>On-Site Plant Fuel Consumption (MJ)</td>
<td>11.1</td>
</tr>
<tr>
<td>Concrete Batch Water (m³)</td>
<td>1.68E-01</td>
</tr>
<tr>
<td>Concrete Wash Water (m³)</td>
<td>1.91E-02</td>
</tr>
<tr>
<td>On-Site Waste Disposal (kg)</td>
<td>0.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENVIRONMENTAL IMPACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Primary Energy (MJ)</td>
</tr>
<tr>
<td>Climate Change (kg CO₂ eq)</td>
</tr>
<tr>
<td>Ozone Depletion (kg CFC 11 eq)</td>
</tr>
<tr>
<td>Acidification Air (kg SO₂ eq)</td>
</tr>
<tr>
<td>Eutrophication (kg N eq)</td>
</tr>
<tr>
<td>Photochemical Ozone Creation (kg O₃ eq)</td>
</tr>
</tbody>
</table>
Environmental Product Declarations – Product Category Rules

CARBON LEADERSHIP FORUM

PRODUCT CATEGORY RULES (PCR) FOR
ISO 14025 TYPE III ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

CONCRETE

Meeting the requirements of one of the following:
ASTM C94
ASTM C90
CSA A23.1/A23.2
UNSPSC code 30111500

EPDs created by this PCR are appropriate to be used to evaluate the environmental impact of the material concrete (does not include reinforcement, curing or formwork) for products manufactured in North America (United States and Canada) and other countries who use the standards listed above.

2.1. Product Description & Declared Unit

The declared unit shall be defined as 1 m³ of concrete. Outputs shall be presented in SI units. They may additionally be presented per cubic yard of concrete.

NOTE: The declared unit is used to characterize a reference flow of material quantity instead of a ‘functional unit’ as this PCR does not address the use or end-of-life phase for concrete. Users of EPD data can integrate the performance-based conditions of concrete application into their own LCA for a defined functional unit analysis of the full life cycle of buildings, roadways or other structures. Concrete is considered an ‘intermediate product’ since it cannot serve a specific function without further processing.

The EPD shall include the following description of the product:
A. UNSPC Product code and CSI Specification number, and;
B. Specified compressive strength at specified age in days (e.g., 20 MPa (3,000 psi) at 28 days, 30MPa (4,000 psi) at 90 days, or between 20 MPa (3,000 psi) and 30MPa (4,000 psi) at 28 days).

Note that compressive strength can be presented in either SI or US units or both as appropriate for the application.

Table 5: Impact Assessment results for ready mix concrete produced at Calportland’s Alameda Ready Mix Plant

| Kennel (US)/Metric | Length | GWP | GDF | AP | EP | DCF | ECF | CDF | UDF | TDF | DWF | CWF | CWF | DCF | TDF | CWF | DWF | CWF | DWF | CWF |
|--------------------|--------|-----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | kg/m3  | kg/m3 |    |    |    | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 | kg/m3 |
|                    |        |       |    |    |    |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|                    |        |       |    |    |    |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|                    |        |       |    |    |    |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
## EPDs – Searchable & Downloadable Repository

### C-Change Labs

<table>
<thead>
<tr>
<th>ID</th>
<th>RULE_DECLARED_PRODUCT_NAME</th>
<th>RULE_PLANT_NAME</th>
<th>RULE_COMPANY_NAME</th>
<th>RULE_CMP</th>
<th>RULE_DECLARED_UNIT</th>
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</thead>
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<tr>
<td>89d7f79559-060-4906-82df-80c-4834796965</td>
<td>M is NW</td>
<td>Riverside</td>
<td>ORCO BLOCK &amp; HARDSCAPE</td>
<td>329.00</td>
<td>1 m³</td>
</tr>
<tr>
<td>054e010f-ac4-435a-8b33-8b8d707770</td>
<td>M is Lump</td>
<td>Romoland</td>
<td>ORCO BLOCK &amp; HARDSCAPE</td>
<td>449.00</td>
<td>1 m³</td>
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<td>e382c9af-cb38-8f2b-910e-c95591297113</td>
<td>M is NW-HE</td>
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<td>ORCO BLOCK &amp; HARDSCAPE</td>
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<td>Romoland</td>
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<td>1 m³</td>
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<tr>
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<td>ORCO BLOCK &amp; HARDSCAPE</td>
<td>365.00</td>
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<tr>
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<td>Romoland</td>
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<td>ORCO BLOCK &amp; HARDSCAPE</td>
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</tbody>
</table>
Data Visualization: Decision Making

80th Percentile Defaults

GWP: kg CO2e/m²

- Steel: 60
- Concrete: 59
- Masonry: 15
- Timber: 11
- Steel and concrete: 65

Structure type and number of projects in database (b)

Choose this one!
Create a specific Project Profile for tracking and reduction, or look at comparable buildings already in database for benchmarking exercise.
Find and compare materials for input into your building’s Project Profile, or do a quick materials search for on demand materials selection by GWP.

Quickly understand CO2e range of a specific material

Search by what you currently know re: material performance and criteria

Number of manufacturer EPDs currently in database that meet material parameters
Sort compliant manufacturers by GWP (CO2e) to find lowest emitting options.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Plant</th>
<th>Product</th>
<th>Compressive Strength 28D</th>
<th>Description</th>
<th>GWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>CENTRAL CONCRETE</td>
<td>Pleasanton (wet)</td>
<td>Mix 3FAEG9Z1</td>
<td>27 MPa</td>
<td>3IN LN 0.50W/C 3/4&quot; 70%SCM 3&quot;-5&quot;SL</td>
<td>144 kgCO2e</td>
</tr>
<tr>
<td>CENTRAL CONCRETE</td>
<td>Hayward</td>
<td>Mix 430PC5Z1</td>
<td>20 MPa</td>
<td>4IN LN 3000 PSI 1&quot; EF70 3-5SL</td>
<td>146 kgCO2e</td>
</tr>
<tr>
<td>CENTRAL CONCRETE</td>
<td></td>
<td></td>
<td></td>
<td>4IN LN 3000 PSI 1&quot; EF70 3-5SL</td>
<td>160 kgCO2e</td>
</tr>
<tr>
<td>CENTRAL CONCRETE</td>
<td></td>
<td></td>
<td></td>
<td>4IN LN 3000 PSI 1&quot; EF70 3-5SL</td>
<td>160 kgCO2e</td>
</tr>
<tr>
<td>CENTRAL CONCRETE</td>
<td></td>
<td></td>
<td></td>
<td>SP 0.55W/C 3/4&quot; 7-9SL AIR</td>
<td>161 kgCO2e</td>
</tr>
</tbody>
</table>

See details and automatically download the associated EPD.
## BUILDING QUANTITIES

### A: SUBSTRUCTURE
- **Slab on Grade**
  - **Founda.**
  - **Weight**: 14.5 kg CO2e
  - **EC** (Conservative): 25.5 kg CO2e

### B: SHELL
- **Columns**
  - **Weight**: 151 kg CO2e
  - **EC** (Conservative): 208 kg CO2e

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### Estimate Quantities

**Skanska USA Building Inc.**

**Floor Area Above:** 30000 sf
**Floor Area Below:** 30000 sf
**Floors:** 5
**Stories:**
**Average Floor H.:** 4 m
**EC (Achievable):** 6.08 M kg CO2e
**EC (Conservative):** 9.32 M kg CO2e

---

**Carbon Emissions**

20,000 kg

**Out of EC3**
Graphically view conservative and best in class CO2e data for each material category and component of your Project.

Select to use the conservative average CO2e of all compliant manufacture EPDs, or a specific manufacturer’s CO2e. Selection auto fills into Project Profile and becomes a part of the CO2e footprint calculated and visualized.
Large variance in emissions of rebar based on manufacturing location.

“High Embodied Carbon” benchmark

“Low Embodied Carbon” benchmark

WA produced rebar

Outputs
## Carbon Smart Design

<table>
<thead>
<tr>
<th>Material Type</th>
<th>COST (cost of material)</th>
<th>CARBON (total kgCO2e)</th>
<th>TOXICITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERTAINTEED GWB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8”, TYPE X</td>
<td>$4,038 increase</td>
<td>$16,577</td>
<td>39% decrease 5,185 kg CO2 reduction</td>
</tr>
<tr>
<td>5/8”, TYPE X, AIR RENEW</td>
<td>$20,615</td>
<td>13,177 kg</td>
<td>RED LIST FREE</td>
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<tr>
<td>USG GWB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/8”, TYPE X</td>
<td>$1,489 increase</td>
<td>$16,577</td>
<td>32% decrease 4,378 kg CO2 reduction</td>
</tr>
<tr>
<td>5/8”, TYPE X, ECOSMART</td>
<td>$18,066</td>
<td>13,474 kg</td>
<td>RED LIST FREE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Did you know….?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,378 kg CO2 emissions equals:</td>
</tr>
</tbody>
</table>

- 1.14 tons of crude oil burned for electricity
- 1 car on the road for 10 months
- A home’s energy use for 125 days
SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

SUBMITTALS (added language)
A. Environmental Product Declaration (EPD): Submit in accordance with the Specification Section for LEED Submittals, Section 013510.01.B.1 – Environmental Product Declarations.
1. Submit a product-specific EPD for 90% by volume for all concrete mixes used in the project in the “Concrete Mix Specification Table” within the Concrete section of the structural general notes.
2. Impact Categories:
   a. Global Warming Potential (GWP): All GWP information submitted shall be in the form of kgCO₂eq/kg.
3. Plant-specific GWP information will be one of the decision criteria when awarding this scope. However, information for each impact category noted above will be reviewed. The impact category information will be evaluated against both industry average impact category datasets, as defined by National Ready Mix Concrete Association (NRMCA) regional mix EPD datasets, as well as the impact category information reported within mill-specific EPDs from competing bidders. If mill-specific impact category information is not provided, industry average EPDs will be used.

The Project has a commitment to reducing the embodied carbon footprint of the materials used in construction by a minimum of 15%, aiming to reach a 30% reduction target. Because of this mandate from the Owner and the GC team’s support of actionable carbon reduction of materials, the following items are requested as part of the Concrete scope of work:

1. Environmental Product Declarations (EPDs) for All Concrete Mixes Utilized on the Project:
   a. Subcontractor/Supplier shall provide on-demand EPDs for Project ready-mix concrete mixes, at milestones as the design progresses, to support Project emissions reductions tracking.
   b. Project GC’s and Design Teams will provide mix performance requirements, locations and proposed schedule of pour to assist in ensuring EPDs generated reflect mixes to be procured during construction.
   c. EPDs of concrete mixes generated will be required with construction submittals to confirm carbon emissions, aka Global Warming Potentials (GWP) of mixes installed.

2. Actual Reductions of Carbon Emissions in Concrete Mixes Utilized on the Project:
   a. The Project is piloting the use of the Embodied Carbon in Construction Calculator (EC3) which includes a database of available EPDs from national materials associations (such as the NRMCA) as well as local suppliers and manufacturers of certain materials, including ready mix concrete.
   b. The Project will utilize these available EPDs in the EC3 database to establish GWP baselines per concrete mix and enable assessment of Project specific EPD GWP numbers in order to understand reductions for the Project.

3. As part of each Subcontractor/Supplier RFP Response, please provide a representative EPD for the following proposed concrete mixes, as provided by Project Structural Engineers. Potential GWP of each mix, provide in EPD, will be part of the assessment of each supplier’s RFP response, alongside other key metrics.
**Leading AEC Firms**
- **Architect** (Perkins+Will), Structural Engineer (MKA), MEP Engineer, Contractor (Skanska)

**Leading Owners**
- Skanska CD, Microsoft Confidential Developer

**Leading Suppliers/Manufacturers**
- Concrete, Steel, Timber, Aluminum, Glazing, GWB, Insulation, Carpet (Interface), Ceiling Tiles (Armstrong)

**Leading Industry Organizations**
- Architecture (AIA), Structural Engineering, Steel (AISC), Concrete, Timber, Autodesk

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**EC3 - Schedule**

<table>
<thead>
<tr>
<th>Goals</th>
<th>Plans &amp; Pilots</th>
<th>Implementation</th>
<th>Construction</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder Engagement</td>
<td>Data Gathering</td>
<td>- Deployment</td>
<td>- Data Accumulation</td>
<td>- Data Accumulation</td>
</tr>
<tr>
<td>Data Collection Pilots</td>
<td>Pilots &amp; Testing</td>
<td>- Training</td>
<td>- Iterative Improvement</td>
<td>- Iterative Improvement</td>
</tr>
<tr>
<td>Goal Setting</td>
<td>Stakeholder feedback</td>
<td>- Audits</td>
<td>- Progress Reports</td>
<td>- Progress Reports</td>
</tr>
<tr>
<td></td>
<td>Contracts</td>
<td>- Iterative Improvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>...</td>
<td>- Progress Reports</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Open to additional projects, then available to public

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**SKANSKA**

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**Charles Pankow Foundation**
Building Innovation through Research

**Carbon Leadership Forum**
University of Washington

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**Leading Supplier/Manufacturers**
Concrete, Steel, Timber, Aluminum, Glazing, GWB, Insulation, Carpet (Interface), Ceiling Tiles (Armstrong)
And Owners, Architects, Engineers (and even Industry) want it.
Reducing Carbon in Design and Policy

Operational Carbon

EUI (Energy Use Intensity)  
Kbtu/SF/Yr

Embodied Carbon

ECUI (Embodied Carbon Use Intensity)  
Kg CO2e/SF
Reducing Embodied Carbon in Design and Policy

**Performance Path**

Minimum Global Warming Potential number that can be met through multiple pathways

**Prescriptive Path**

Attributes of a material/building that when followed result in much lower embodied carbon

- ELECTRIC ARC FURNACE
- POWERED BY RENEWABLES
- USING 100% RECYCLED STEEL

EPDs & WHOLE BUILDING LCAs
Reducing Embodied Carbon in Design and Policy

Prescriptive Path

Attributes of a material/building that when followed result in lower embodied carbon

- ELECTRIC ARC FURNACE
- POWERED BY RENEWABLES
- USING 100% RECYCLED STEEL
STEEL

CARBON IMPACT OF STEEL:

Today, steel is manufactured in two different types of factories. Large steel mills tend to use basic oxygen furnaces (BOFs), which use coal or natural gas to melt iron ore, extracting the iron, with scraps of iron and steel to make new steel. Most of the inputs to a BOF are mined, raw materials, so the recycled content level for BOFs is typically between 25%-37%. Recycled content is important because virgin steel can have an embodied carbon footprint that is up to five times greater than high-recycled content steel (Source).

Smaller factories tend to use electric arc furnaces (EAFs) to melt scrap iron and steel into new steel. They don’t have the ability to process raw iron ore. As a result, the steel manufactured on EAFs has high levels of recycled content, up to 100%, though the average recycled content is 93% for hot rolled shapes (source). Structural steel does not lose any of its metallurgical properties (the physical and chemical behavior of the alloys) when is is recycled, making the properties and performance characteristics of recycled steel equivalent to virgin steel (Source). EAFs are powered by electricity, rather than coal and natural gas, and therefore have the ability to be powered using renewable energy sources.
Reducing Embodied Carbon in Design and Policy

Performance Path
Minimum Global Warming Potential number that can be met through multiple pathways

ATHENA IMPACT ESTIMATOR
TALLY
ONECLICKLCA

EMBODIED CARBON IN CONSTRUCTION CALCULATOR (EC3)

stacy.smedley@skanska.com

EPDs & WHOLE BUILDING LCAs
Reducing Embodied Carbon in Design and Policy

Cities and States will lead the way.
We have 32 years (at most) to get to zero carbon, so we can’t measure impacts based solely on a building’s full lifespan.

When setting performance targets it’s crucial to balance operational savings with associated embodied penalties.

We can’t meet our climate goals without phasing out embodied carbon emissions.