Carbon Leadership Forum’s Embodied Carbon Network


February 21, 2020
Network Overview

Communication and knowledge building platform

~2,000 members from industry, nonprofits, governments, academia

Common mission to phase out emissions from buildings and construction materials
ECN Focus Groups

9 Focus Groups

Buildings  Construction  Education  LCA Data/Tools  Materials

Outreach  Policy  Renewables  Reuse
Series Overview

Research, case studies, strategies to measure and reduce embodied carbon

Six online sessions  Subject matter experts  AIA CE Credits
Webinar Series Disclaimer

This session is provided as part of the Embodied Carbon Network 2019 Webinar Series. We invite guest speakers to share their knowledge and insight on topics related to carbon emissions attributed to building materials. The series aims to introduce topics that lead participants to think and talk about building industry strategies for reducing carbon emissions.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use. Please note the opinions, ideas, or data presented by speakers in this series do not represent members of the Embodied Carbon Network or constitute endorsement by the Network.
Logistics

- 15-20 minute Q&A session after presentations
- To receive AIA continuing education credit: send your AIA member number to info@carbonleadershipforum.org
- To access past webinar recordings, visit: http://carbonleadershipforum.org/embodied-carbon-network/webinars/
- Save the Date!
  - Webinar #2  Education - March 20, 2020
  - ECN Quarterly Call – April 17, 2020
Webinar Overview

Laying the groundwork: Defining construction related carbon emissions
Stacy Smedley
Director of Sustainability Skanska

Influencing Design & Construction Emissions
Jenelle Shapiro
Sustainability Director Webcor

Construction Activity Embodied Carbon
Mark Chen
Sustainability Engineer Skanska
Reducing the Carbon Footprint of Every Building.
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 for 35 years!

every 35 days for 35 years!
Global CO₂ Emission by Sector

- Industry: 30%
- Transportation: 22%
- Building Operations: 28%
- Building Materials and Construction: 11%
- Other: 9%

Total Building Material Impacts??

Understanding Carbon

Embodied Carbon

Operational Carbon
Understanding Carbon

Whole life carbon*  
Embodied carbon*  

PRODUCT Stage  
CONSTRUCTION Process Stage

Use stage embodied carbon*  
USE Stage  
END OF LIFE Stage

Upfront carbon*  
Operational carbon*  
End of life carbon*

Operational energy use  
Operational water use

Beyond the lifecycle*  
Supplementary information beyond the building life cycle

Raw material supply  
Transport  
Manufacturing  
Transport  
Construction-installation process

Use  
Maintenance  
Repair  
Refurbishment  
Replacement

De-construction demolition  
Transport  
Waste processing  
Disposal

Reuse  
Recovery  
Recycle

Benefits and loads beyond the building life cycle

Out of scope
Understanding Carbon

Total Carbon Emissions of **Single Building**

Global Average Building Carbon Footprint: Business as Usual

Embodied Carbon  
+/-50%

Operational Carbon  
+/-50%

Understanding Carbon

Kg per m²

Over 1,000 buildings in the database

Commercial | Residential | Other | Non-Commercial

Over 1,000 buildings in the database

“High Embodied Carbon” Target

“Low Embodied Carbon” Target

http://www.carbonleadershipforum.org/data-visualization/
55,000 tons of CO2

Or... a flying for 70 days

Or... 10,762 driving for 1 year

Or... 172,897 of crude oil

Understanding Carbon

16% operational
84% embodied
(over 30 year lifecycle)
What to do, when.

LCA Tools (Tally, OneClick, Athena)

<table>
<thead>
<tr>
<th>New vs Retrofit?</th>
<th>X vs Y system?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right size the building.</td>
<td>Systems CO2 reductions.</td>
</tr>
</tbody>
</table>

*Start Supplier Outreach
Reducing Embodied Carbon

Supply chain emissions reduction.

Wish List

- Available to Everyone
- Easy to Use
- Free to Use
- Open & Transparent Data Source
- Open API (willing/able to share data with other tools)
- Focused on Supply Chain Accountability

Embodied Carbon in Construction Calculator

Embodied Carbon Reduction Tool (Supply Chain Specific)

Carbon Leadership Forum
University of Washington

Microsoft

Embodied Carbon Reduction
(willing/able to share data with other tools)
Current Partnerships

Lead Sponsors
- Autodesk
-Charles Pankow Foundation
-Interface
-Magnusson Klemencic Associates
-Microsoft
-Skanska USA Building

Pilot Sponsors
-Alexandria
-BASF
-Perkins & Will
-Port of Seattle
-Amazon
-Tally
-Walter P Moore
-Webcor

Association Sponsors
-AIA
-Blue Green Alliance

Early Adopters Sponsors
- Coughlin Porter Lundeen
- LeMessurier
- PCS Structural
- Nucor
- Salesforce
- SCS Global Services
- TK1SC
- Thornton Tomasetti
- WRNS Architects

Methodology Partners
- Arup
- Brightworks Sustainability
- Central Concrete Supply
- Katerra
- Kieran Timberlake
- LMN Architects
- National Ready Mixed Concrete Co
- Urban Fabrick
- WAP Sustainability

Material Sponsors
- Armstrong
- Carbon Cure
- Kingspan

Technology Partners
- Autodesk
- Climate Earth
- mindfulMaterials
- Sustainable Minds
- Tally

Project Leadership
- Charles Pankow Foundation
- CLF Carbon Leadership Forum
- University of Washington
MATERIAL QUANTITY ESTIMATE \times EMBODIED CARBON PER MATERIAL EPDs = BUILDING EMBODIED CARBON (EC) ESTIMATE
Market Transformation

Pilot Users
Waitlist
Active Users

3500
3000
2500
2000
1500
1000
500

11/18
Nov 2018 to Nov 2019 (1 year)

Nov 2019 to Jan 2020 (6 weeks)

PUBLIC LAUNCH
Building Material Quantities from Construction Estimates, BIM models and Tally into EC3
Kg CO2e from Environmental Product Declarations

*current database holds over 22,000 epds
Kg CO2e from Environmental Product Declarations

The EC3 tool version v-17.1.2_b-1161 is in Public Beta, and continues to be developed with a broad range of stakeholders. To learn about, discuss, help define, and improve the EC3 tool, visit our EC3 Community Forum

The Carbon Query Database is **Online** and contains:

![Bar chart](chart.png)

**Digitized Verified EPDs**
- Concrete: 432
- Flooring: 317
- Steel: 196
- Ceiling Panels: 163
- Openings: 83
- Gypsum Board: 81
- Wood: 40
- Aluminium: 39

Legend:
- **Product Specific EPDs**
- **Industry EPDs**
Assess market for EPD adoption.

Use EC3 data to inform procurement and selection.
**Realized Embodied Carbon for Project X**

<table>
<thead>
<tr>
<th>Material</th>
<th>Overall Building</th>
<th>Concrete</th>
<th>Steel</th>
<th>Timber</th>
<th>Aluminum</th>
<th>Glazing</th>
<th>Insulation</th>
<th>Gypsum Board</th>
<th>Ceiling Tiles</th>
<th>Carpet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kg CO2e/sf</td>
<td>Baseline</td>
<td>Achievable</td>
<td>Realized</td>
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<td>Overall Building</td>
<td>80</td>
<td>50</td>
<td>45</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>10</td>
<td>15</td>
<td>10</td>
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<tr>
<td>Concrete</td>
<td></td>
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<td>15</td>
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<tr>
<td>Steel</td>
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<td>Timber</td>
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<td>Aluminum</td>
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<td>Insulation</td>
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<td>3</td>
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<td>Gypsum Board</td>
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<td>Ceiling Tiles</td>
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<td>0.5</td>
<td>1</td>
<td></td>
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</tbody>
</table>

Legend: **Baseline**, **Achievable**, **Realized**
30% reduction in CO2 emissions JUST BY having data and ASKING.
ELECTRIC SITE RESEARCH PROJECT
Huge Potential for Code/Buy Clean Policy

- Require baseline project to be created
- Report actual procured materials with verified EPDs
- Set Material Embodied Carbon Intensity (mECI) limits
- Set Building Embodied Carbon Intensity (bECI) limits

Embodied Carbon + Operational Carbon = Total Carbon
(EC + OC = TC)
Buy Clean California Act

State agencies, University of California and California State University System, construction materials industries, other interested parties can learn more about the embedded carbon emissions of construction materials used in public works projects.

The Buy Clean California Act, (Public Contract Code § 3500-3505), states the Department of General Services (DGS) is required to establish and publish the maximum acceptable Global Warming Potential (GWP). Its targets embedded carbon emissions of structural steel (hot-rolled sections, hollow structural sections, and plate), carbon steel rebar, flat glass, and mineral wool board insulation. These materials must have a GWP that does not exceed the limit set by DGS.
EC3
www.buildingtransparency.org

?
stacy.smedley@skanska.com
Engaging in the design and construction phases to actionably reduce upfront embodied carbon

Jenelle Shapiro
Sustainability Director
jenelle@webcor.com
01 Lay the Ground Work
01 Early Scope 3 Emissions

- “Purchased Goods & Services”
- Includes all upstream (i.e. cradle-to-gate) emissions from the production of products purchased or acquired

Source: Greenhouse Gas Protocol
01 Easy First Step – Use of EC3

- Began in April 2019
- Supported development from another GC’s perspective
- Collaborated with Skanska as partner, not competitor
- Not a challenge “selling” to Executives

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**Purchased good** | **Supplier** | **Quantities purchased (kg)** | **Supplier-specific emission factor (kg CO₂/kg)**
--- | --- | --- | ---
Cement | Supplier C | 200,000 | 0.15
Plaster | Supplier D | 600,000 | 0.10
Paint | Supplier E | 200,000 | 0.10
Timber | Supplier F | 100,000 | 0.25
Concrete | Supplier G | 50,000 | 0.20

Note: The activity data and emissions factors are illustrative only, and do not refer to actual data.

**Total emissions of purchased goods by Company A** is calculated as follows:

\[ \sum (\text{quantities of good purchased (e.g., kg)} \times \text{supplier-specific emission factor of purchased good or service (e.g., kg CO}_2\text{/kg)}) \]

\[ = (200,000 \times 0.15) + (600,000 \times 0.1) + (200,000 \times 0.1) + (100,000 \times 0.25) + (50,000 \times 0.2) \]

\[ = 145,000 \text{ kg CO}_2 \]

Source: Greenhouse Gas Protocol Technical Guidance
02 Once we “mastered” the tool
02 Taking it to the next level

- Insight into EC3 allowed us to think bigger
- Development of our corporate carbon commitment

What new norms could we directly influence as a GC?

What were local jurisdictions doing that we could build upon?

What needed more focus within our industry?
02 Webcor’s Carbon Commitment

1. Employ the EC3 on all new projects to compare and reduce embodied carbon emissions from construction materials through informed materials selection.

2. Request and collect data on all concrete, structural steel, rebar, drywall and glass manufacturers to provide EPDs at time of bid for review as part of Webcor’s evaluation process.

3. Continue as a pilot partner of EC3 to provide tool updates based on our valuable industry expertise.

4. Go beyond the public project requirements set forth by California’s Article 5: Buy Clean California Act, establishing maximum allowable global warming potential (GWP) limits (beginning in January 2021).

Find more info about Webcor’s implementation [here](#).
03 Implementation
03 Critical team

- EXECUTIVES
- CLIENTS
- SUSTAINABILITY DEPARTMENT
- DESIGN PARTNERS (STRUCTURAL ENGINEERS & ARCHITECTS)
- SELF-PERFORM GROUPS (CONCRETE & DRYWALL)
03 Process Roadmap

• Walk through this process for all self-perform groups (Concrete, Rebar, Drywall)
• Define decision/action points during design and construction to influence embodied carbon
  • Spec design
  • Solicitation of bids
  • Buyout and procurement of materials
03  Bid Buyout Process

Developed EPD request forms for:

- Carpet
- Ceiling Tile
- Concrete
- Rebar
- Drywall/Framing/Insulation
- Enclosure/Glazing
- Structural Steel/Metal Stairs
- Timber

INTRODUCTION:

Webcor Builders has partnered with the Carbon Leadership Forum and will be using the Embodied Carbon in Construction Calculator (EC3) on this project. The tool can be found and accessed online at https://buildingtransparency.org/.

EC3 allows users to measure the embodied carbon in specific products and materials through the use of Environmental Product Declarations (EDPs), please see example EPDs for partition assembly materials attached.

- Embodied carbon refers to carbon dioxide emitted during the manufacture, transport and construction of building materials, together with end of life emissions.
- An EDP is a report which lists the environmental impacts of a specific material based on a unit of measure (e.g. square foot, ton, cubic yard).

The embodied carbon measurement is to assist in reducing the embodied carbon in the project’s materials. Webcor understands this is accomplished through both the sourcing of the materials, as well as the designer’s specifications.

In your proposal, Webcor would like to evaluate the embodied carbon expected in the gauge framing, light gage, and other sheet goods to be installed based on the sourced products.

EDP ATTACHED (See Form on Next Page):

The EDPs for the light gage framing, gypsum board, and other sheet goods anticipated for the project are attached. If the products have not been specified at this time, please provide general information that aligns with what is anticipated to be installed in the project.
03 Concrete: Bid Evaluation

- Currently, bids prioritize cost, schedule and design impacts
- Goal of making informed decisions between manufacturer material options
- Concrete leveling sheets updated to evaluate GWP levels with cost

<table>
<thead>
<tr>
<th>MILD STEEL</th>
<th>SUB #1</th>
<th></th>
<th>SUB #2</th>
<th></th>
<th>SUB #3</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>LBS</td>
<td>$/LB</td>
<td>PRICE</td>
<td>LBS</td>
<td>$/LB</td>
<td>PRICE</td>
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<td>Protection Slab</td>
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<tr>
<td>Mat Foundation (including support steel)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mat Foundation Welded Wire Mesh on Top Mat</td>
<td></td>
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<tr>
<td>Spread Footings &amp; Grade Beams</td>
<td></td>
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</tr>
<tr>
<td>Pile Caps &amp; Grade Beams</td>
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</tr>
</tbody>
</table>

Total kgCO2e

WEBCOR BUILDERS
03 Drywall: Bid Evaluation

- Align sustainability drivers with construction means and methods
- Support incentivizing EPD development, as many manufacturers don’t currently generate
04 Case Studies
04 960 W 7th, Los Angeles

- 56-story, 1.4m sf mixed-use apartment tower
- Early coordination with GC, ready-mix supplier and design team
- Aggregate evaluation to increase compressive strength
  1. Weaker option, local = > cement (OLD)
  2. Premium option, Orca in BC = greater distance, < cement (NEW)

### EPD Comparison

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
<th>Est. Project Quantity</th>
<th>Cement</th>
<th>Fly Ash</th>
<th>Slag</th>
<th>GWP per unit</th>
<th>Total GWP</th>
<th>ODP</th>
<th>AP</th>
<th>EP</th>
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</thead>
<tbody>
<tr>
<td>OLD</td>
<td>Mat Foundation 1&quot; 6000PSI PU PL F’c @ 56 DAY</td>
<td>17,860</td>
<td>600</td>
<td>200</td>
<td>0</td>
<td>428</td>
<td>7,644,080</td>
<td>1.10E-05</td>
<td>1.34</td>
<td>0.50</td>
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<tr>
<td>NEW</td>
<td>Mat Foundation 1&quot; 6000PSI PU PL F’c @ 56 DAY</td>
<td>17,860</td>
<td>506</td>
<td>169</td>
<td>0</td>
<td>391</td>
<td>6,983,260</td>
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<td>2.19</td>
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<td>1,228</td>
<td>846</td>
<td>0</td>
<td>0</td>
<td>583</td>
<td>715,924</td>
<td>1.40E-05</td>
<td>1.68</td>
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<tr>
<td>NEW</td>
<td>Basement Walls 1/2&quot; 6000PSI PU</td>
<td>1,228</td>
<td>580</td>
<td>102</td>
<td>0</td>
<td>436</td>
<td>535,408</td>
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<td>2.24</td>
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<td>OLD</td>
<td>Concrete on Steel Deck 1&quot; 4000PSI PU PL</td>
<td>73</td>
<td>592</td>
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<td>0</td>
<td>415</td>
<td>30,295</td>
<td>1.00E-05</td>
<td>1.25</td>
<td>0.49</td>
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<tr>
<td>NEW</td>
<td>Concrete on Steel Deck 1&quot; 4000PSI PU PL</td>
<td>73</td>
<td>421</td>
<td>105</td>
<td>0</td>
<td>322</td>
<td>24,236</td>
<td>1.20E-05</td>
<td>2.05</td>
<td>0.40</td>
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<tr>
<td>OLD</td>
<td>Mild Steel Slabs &amp; Beams 1&quot; 5000PSI PU PL</td>
<td>18,250</td>
<td>705</td>
<td>0</td>
<td>0</td>
<td>490</td>
<td>8,942,500</td>
<td>1.20E-05</td>
<td>1.44</td>
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<td>PT Slabs 1&quot; 6000PSI PU PL</td>
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<td>322</td>
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<td>6,293,235</td>
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<td>0.38</td>
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<td>Columns &amp; Walls 3/8&quot; 8000PSI PU PL</td>
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<td>483</td>
<td>3,394,041</td>
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<td>6,011,120</td>
<td>1.80E-05</td>
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Total GWP Savings: **11,779,690**
04 Unnamed Project, Northern California

- Cost and schedule evaluation for two proposed designs
  1. Reinforced concrete core walls
  2. Composite steel/concrete plate shear walls
- Evaluated the embodied carbon impact via EC3

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>BASE ESTIMATE - CORE WALLS</th>
<th>DESIGN ALTERNATE - CORE WALLS</th>
<th>EMBODIED CARBON ANALYSIS - BASE ESTIMATE</th>
<th>EMBODIED CARBON ANALYSIS - DESIGN ALTERNATE</th>
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<tbody>
<tr>
<td>Core Walls</td>
<td>Reinforced Concrete Wall</td>
<td>Composite Plate Shear Wall</td>
<td>Unit of Measure is kCO2e</td>
<td>Unit of Measure is kCO2e</td>
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<td>Core Walls - Steel Surface Area (SF), Int.</td>
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<td>Levels</td>
<td>B1-L33</td>
<td>B1-L33</td>
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<td>Concrete w/ rebar &amp; formwork (inc. core fill, FOMD)</td>
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<td>61,488,649</td>
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<td>Metal Deck</td>
<td>$</td>
<td>4,300,078</td>
<td>$</td>
<td>4,443,680</td>
</tr>
<tr>
<td>Steel Core + framing</td>
<td>$</td>
<td>44,916,237</td>
<td>$</td>
<td>51,207,822</td>
</tr>
<tr>
<td>Corretion Modifications</td>
<td>$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMBODIED CARBON TOTAL</td>
<td>110,704,964</td>
<td>97,713,111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMBODIED CARBON DELTA</td>
<td></td>
<td></td>
<td>-12,991,853</td>
<td></td>
</tr>
</tbody>
</table>

- The Composite Plate Shear Wall Design Alternate has less embodied carbon than the typical concrete core wall design included in the base estimate.
- This embodied carbon reduction is similar to removing 31.8 million miles driven by a passenger car or;
- Removing 2,758 cars off the road for one year.
05 Next Steps
05 Continue Momentum

• Work to improve the process
• Test out on more projects
• Redirect as needed
• Evaluate overall Scope 3 emissions impact as time progresses
• Collaborate with other AEC and manufacturer leaders
• Opportunities are endless…
Construction Activity Carbon Emissions Accounting
## Emissions Scope

**Kg CO2e from Environmental Product Declarations**

### LIFE CYCLE ASSESSMENT STAGES AND REPORTED INFORMATION

In accordance with the PCR, the life cycle stages included in this EPD are as shown below (X = included, MND = module not declared).

<table>
<thead>
<tr>
<th>Product</th>
<th>Construction Process</th>
<th>Use</th>
<th>End-of-Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

X = included, MND = module not declared

---

**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>
</tr>
</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>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Primary Energy (MJ)</td>
<td>3,017</td>
</tr>
<tr>
<td>Climate Change (kg CO₂ eq)</td>
<td>445</td>
</tr>
<tr>
<td>Ozone Depletion (kg CFC 11 eq)</td>
<td>1,31E-08</td>
</tr>
<tr>
<td>Acidification Air (kg SO₂ eq)</td>
<td>2.96</td>
</tr>
<tr>
<td>Eutrophication (kg N eq)</td>
<td>0.09</td>
</tr>
<tr>
<td>Photochemical Ozone Creation (kg O₃ eq)</td>
<td>0.61</td>
</tr>
</tbody>
</table>

---
What Emissions Sources Are We Tracking?

Any engine providing construction site services to the project that runs off of diesel, mainly:

• Material Trucking Transport to Site
• Waste Haul Trucking from Site
• Off-Road Equipment and Vehicles within Job Site Fencing

...And Temporary Power (kWhs)
Emissions Factors

**EPA Emissions Factors for Greenhouse Gas Inventories:**

- 22.51 lbs CO2 per Gallon of Diesel Fuel Combustion (Tailpipe Emissions Only)
- 3.22 lbs CO2 per Vehicle Mile – Medium & Heavy Duty Trucks (Tailpipe Emissions Only)

*Contact your local utility for temporary power kWh emissions factors. Data may be available online as well.

What Are We and Our Trade Partners Already Tracking?
### Monthly Submittals & Tracking

#### A4 Stage: Transport

<table>
<thead>
<tr>
<th>Month/Year:</th>
<th>Dec-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated or Actual Input:</td>
<td>Actual</td>
</tr>
<tr>
<td>Vendor Name:</td>
<td>Joe tilt Excavation</td>
</tr>
<tr>
<td>Trade:</td>
<td>Earthwork and Utilities</td>
</tr>
</tbody>
</table>

**Legend**
- Calculated Cell (DO NOT EDIT)
- User Cell (ENTER DATA HERE)

**Notes:**
- *If a material is not used this month, enter "0" for quantity, and distance derived.
- **Distance delivered to jobsite shall be defined as the number of vehicle miles traveled between the project site and the final point of manufacture of the material and/or product.**

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Date</th>
<th>Material*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Already tracking via Superintendent Project Delivery Schedule

Trades are typically already tracking this to an extent. At a minimum, just ask for fuel invoices.

#### A5 Stage: Installation

<table>
<thead>
<tr>
<th>Month/Year:</th>
<th>Dec-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated or Actual Input:</td>
<td>Actual</td>
</tr>
<tr>
<td>Vendor Name:</td>
<td>Joe tilt Excavation</td>
</tr>
<tr>
<td>Trade:</td>
<td>Earthwork and Utilities</td>
</tr>
</tbody>
</table>

**Legend**
- Calculated Cell (DO NOT EDIT)
- User Cell (ENTER DATA HERE)

**Notes:**
- *If a material is not used this month, enter "0" for quantity, and distance derived.
- **Distance delivered to jobsite shall be defined as the number of vehicle miles traveled between the project site and the final point of manufacture of the material and/or product.**

<table>
<thead>
<tr>
<th>Sub Activity</th>
<th>Needed Equipment</th>
<th>Fuel Type</th>
<th>Oem/Rent</th>
<th>Engine Year</th>
<th>Engine Tier (off-road only)</th>
<th>Horsepower</th>
<th>Qty</th>
<th>Days on Site</th>
<th>Hours Use Per Day</th>
<th>Fuel Efficiency (gallons per hour)</th>
<th>Fuel Use (gall)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation</td>
<td>KOMATSU PC 32MRC-11</td>
<td>Diesel</td>
<td>Own</td>
<td>2019</td>
<td>1</td>
<td>1</td>
<td>240.00</td>
<td>2</td>
<td>7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excavation</td>
<td>KOMATSU PC 238</td>
<td>Diesel</td>
<td>Own</td>
<td>2020</td>
<td>4</td>
<td>165</td>
<td>1</td>
<td>1</td>
<td>151.00</td>
<td>3</td>
<td>453</td>
</tr>
<tr>
<td>Excavation</td>
<td>KOMATSU PC 46LC-11</td>
<td>Diesel</td>
<td>Lease</td>
<td>2019</td>
<td>4</td>
<td>359</td>
<td>1</td>
<td>1</td>
<td>318.50</td>
<td>8.5</td>
<td>2707.25</td>
</tr>
<tr>
<td>Excavation</td>
<td>KOMATSU PC 46LC-11</td>
<td>Diesel</td>
<td>Lease</td>
<td>2019</td>
<td>4</td>
<td>359</td>
<td>1</td>
<td>1</td>
<td>297.00</td>
<td>9.1</td>
<td>2720.7</td>
</tr>
<tr>
<td>Excavation</td>
<td>DEERE 424</td>
<td>Diesel</td>
<td>Own</td>
<td>2015</td>
<td>3</td>
<td>185</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Excavation</td>
<td>JOHN DEERE SKID STEER 32</td>
<td>Diesel</td>
<td>Own</td>
<td>2012</td>
<td>4</td>
<td>60</td>
<td>1</td>
<td>1</td>
<td>26.00</td>
<td>3</td>
<td>78</td>
</tr>
</tbody>
</table>
# Monthly Submittals & Tracking

## Temporary Power

### Monthly Utility
### Invoice to Job Site

<table>
<thead>
<tr>
<th>Start Date</th>
<th>End Date</th>
<th>Multiplier</th>
<th>Kilowatt Hours (kWh)</th>
<th>Electric Demand (kW)</th>
<th>Reactive Power (kVAR)</th>
<th>Meter Read Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/16</td>
<td>1/15</td>
<td>120</td>
<td>12,000</td>
<td>—</td>
<td>—</td>
<td>Actual Read</td>
</tr>
<tr>
<td>100</td>
<td>200</td>
<td>120</td>
<td></td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>
## Reporting and Metrics

**SKANSKA**

**PROJECT** - Mark's Building  
**CLIENT** - MC  
**LOCATION** - Seattle, WA

### Construction Activity Carbon Emissions Report - Month/Year

<table>
<thead>
<tr>
<th></th>
<th>Demolition CO2 Intensity (lbs/af)</th>
<th>Demolition Water Usage Intensity (gals/af)</th>
<th>CO2 per Excavation CY (lbs/CT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.7</td>
<td>3.2</td>
<td>26.3</td>
</tr>
</tbody>
</table>

**CO2 Footprint (tons)** | **% of Total CO2 Emissions** | **Water (gals)** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>774</td>
<td>100%</td>
<td>374,000</td>
</tr>
</tbody>
</table>

**PROJECT TOTALS**

**MATERIAL TRANSPORT**
- Concrete Supply Material Transport - Jane's Concrete: 24 tons, 3.1%  
- Site Material Transport - Joe Dirt Excavation: 4 tons, 0.5%  
- Excavation Dirt Export - Joe Dirt Excavation: 154 tons, 19.9%  
- Rebar Material Transport - Rod Buster Rebar: 3 tons, 0.4%  
- Drilling and Shoring Material Transport - Drill Master Drilling: 1 ton, 0.1%  
- Electrical Material Transport - Sparky's Electrical: 1 ton, 0.1%  
- General Site Material Transport - Skanska: 6 tons, 0.7%  

- **MATERIAL TRANSPORT SUBTOTAL**: 193 tons, 24.9%

**TEMP UTILITIES**
- Site Temp Power: 8 tons, 1.0%  
- Temp Water - Joe Dirt Excavation: 149,600 gallons  
- Temp Water - Bob's Demolition: 224,400 gallons

- **TEMP UTILITIES SUBTOTAL**: 7.9 tons, 1.0%

**OFF-ROAD EQUIPMENT AND VEHICLE FUEL**
- Structural Demolition - Bob's Demolition LLC: 53 tons, 6.8%  
- General Requirements - Skanska: 15 tons, 1.9%  
- Site Earthwork - Joe Dirt Excavation: 384 tons, 49.6%  
- Mobile Cranes - Skanska: 3 tons, 0.4%  
- Drilling and Shoring Activities - Drill Master Drilling: 97 tons, 12.6%  
- Electrical - Sparky's Electrical: 1 ton, 0.2%

- **OFF-ROAD EQUIPMENT AND VEHICLE FUEL SUBTOTAL**: 554 tons, 58.8%

**C&D WASTE HAUL TRANSPORT**
- Waste Hauling Transport - Bob's Demolition LLC: 5 tons, 0.7%  
- Site Waste Haul Transport - Joe Dirt Excavation: 2 tons, 0.2%  

- **C&D WASTE HAUL TRANSPORT SUBTOTAL**: 7 tons, 0.7%

**OFFICE STAFF TRANSIT**
- Office Staff Commute - Skanska: 12 tons, 1.6%

- **OFFICE STAFF TRANSIT SUBTOTAL**: 12 tons, 1.6%

### Construction Activity Carbon Emissions Breakout by Source/Trade

<table>
<thead>
<tr>
<th>Source/Trade</th>
<th>CO2 (tons)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jane's Concrete</td>
<td>24</td>
<td>3%</td>
</tr>
<tr>
<td>Joe Dirt Excavation</td>
<td>544</td>
<td>70%</td>
</tr>
<tr>
<td>Rod Buster Rebar</td>
<td>3</td>
<td>0.4%</td>
</tr>
<tr>
<td>Drill Master Drilling</td>
<td>98</td>
<td>13%</td>
</tr>
<tr>
<td>Sparky's Electrical</td>
<td>2</td>
<td>0.3%</td>
</tr>
<tr>
<td>Skanska</td>
<td>36</td>
<td>5%</td>
</tr>
<tr>
<td>Tal Building</td>
<td>8</td>
<td>1%</td>
</tr>
<tr>
<td>Bob's Demolition LLC</td>
<td>58</td>
<td>8%</td>
</tr>
<tr>
<td>Sub Activity</td>
<td>Needed Equipment</td>
<td>Fuel Type</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Soil Nailing</td>
<td>REED C50-SS 11-048</td>
<td>DIESEL</td>
</tr>
<tr>
<td>Shotcrete/Service Jobsite</td>
<td>REED C50-SS 11-038</td>
<td>DIESEL</td>
</tr>
<tr>
<td>Service Jobsite</td>
<td>Sullivan 1600 H 8-022</td>
<td>DIESEL</td>
</tr>
<tr>
<td>Service Jobsite</td>
<td>CAT D5GXL 6-040</td>
<td>DIESEL</td>
</tr>
<tr>
<td>Grout Pumping</td>
<td>Link-Belt TCC 750 201022</td>
<td>DIESEL</td>
</tr>
<tr>
<td>Various</td>
<td>Link-Belt HSL 238</td>
<td>DIESEL</td>
</tr>
<tr>
<td>Soil Nailing</td>
<td>CAT 316 Excavator</td>
<td>DIESEL</td>
</tr>
<tr>
<td>Vertical Elements</td>
<td>Skyjack 10K Reach-Forklift VR1044E</td>
<td>DIESEL</td>
</tr>
</tbody>
</table>
Reduction Strategies – Reduce Fuel Burn

On-Site Concrete Crushing in lieu of Off-Site Hauling & Crushing
Reduction Strategies – Low Carbon Fuels

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Carbon Intensity Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra-Low Sulfur Diesel</td>
<td>98.03</td>
</tr>
<tr>
<td>Biodiesel: Derived from Midwest Soybeans</td>
<td>83.25</td>
</tr>
<tr>
<td>Biodiesel: Derived from Used Cooking Oil</td>
<td>18.72</td>
</tr>
<tr>
<td>Renewable Diesel: Derived from Midwest Soybeans</td>
<td>82.16</td>
</tr>
<tr>
<td>Renewable Diesel: Derived from Tallow</td>
<td>19.65 - 39.33</td>
</tr>
</tbody>
</table>

As illustrated above, renewable diesel made from domestically-sourced soy has a CI score on par with that of soy-based biodiesel. Renewable diesel sourced from animal tallow has even lower CI scores.

One note of caution: palm oil is among the feedstocks for renewable diesel currently available on the world market, but its CI score is not included in CARB’s database. This makes it challenging to assess its carbon impact. Palm farming has been directly linked to massive tropical deforestation in Southeast Asia, making its lifecycle greenhouse gas impact extremely damaging. A recent study found that biofuel production involving land use conversion from forests to crop cultivation have greenhouse gas impacts higher than that of fossil fuels.

Source: Western WA Clean Cities [https://pscleanair.gov/469/4-Things-To-Know-About-Renewable-Diesel](https://pscleanair.gov/469/4-Things-To-Know-About-Renewable-Diesel)
Volvo CE and its customer Skanska are turning the quarrying industry upside down in a groundbreaking study to create the world’s first ‘emission-free’ quarry.
Questions: mark.chen@skanska.com
Thank you!

Embodied Carbon Network | 2020 Webinar Series

carbonleadershipforum.org/embodied-carbon-network

info@carbonleadershipforum.org

@CarbonLeadForum