EMBODIED CARBON IN THE BUILT ENVIRONMENT: SESSION 6 – LCA DATA AND TOOLS

November 30, 2018
Embodied Carbon Network

Communication & knowledge building platform

360+ members from building industry, academia, nonprofits, governments

10 focus groups for topical information exchange

- Academic
- Buildings
- Construction
- LCA Data/Tools
- Materials
- Nodo Hispano
- Outreach
- Policy
- Renewables
- Reuse
Series Overview

Knowledge/strategies for reducing carbon emissions caused by building materials

- Six online sessions (2018)
- Subject matter experts From ECN focus groups
- AIA Continuing Education Credits
Webinar Series Disclaimer

This session is provided as part of the Embodied Carbon Network 2018 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.
Webinar Overview

Landscape of building LCA data & tools in North America

Jeremy Gregory
Executive Director
Concrete Sustainability Hub (MIT)

The Athena Institute and the Impact Estimator for Buildings

Jennifer O’Connor
President
Athena Sustainable Materials Institute

One Click LCA – LCA made easy

Panu Pasanen
Chief Executive Officer
Bionova and One Click LCA
Webinar Overview

CE Enterprise – the concrete sustainability suite
Laurel McEwan
Vice President, EPD Services
Climate Earth

Tally Introduction
Roderick Bates
Principal and Researcher
KieranTimberlake

Embodied Carbon in Construction Calculator (EC3)
Stacy Smedley
Director of Sustainability
Skanska USA
Landscape of building life cycle assessment data and tools in North America

Jeremy Gregory
Research Scientist, MIT CEE Department
Executive Director, MIT CSHub

*Embodied Carbon Network LCA Data and Tools Webinar*
*November 30, 2018*
What is a green building?
A life cycle perspective should be used to evaluate environmental impacts of building design strategies.

- **Materials & Products**
  - Use recycled
  - Reduce energy
  - Improve material performance

- **Design & Construction**
  - Use less (i.e., stronger) material
  - Create longer-lasting designs
  - Reduce construction impacts

- **Operation**
  - Reduce building energy consumption
  - Reduce maintenance
  - Minimize damage due to hazards

- **End-of-Life**
  - Enable material recovery
  - Enable component recovery

Trade-offs among strategies should be evaluated quantitatively.
Life-cycle assessment: Method for quantifying environmental impact

Materials & Production + Design & Construction + Use + End-of-Life

Activity:
- Raw Materials
- Energy
- Releases to Land
- Air Emissions
- Water Effluents

Product
Building LCA Scope from EN 15978

- **Production**
  - Product 1: A1-A3
  - Product 2: A4-A5
  - Product n: Production

- **Construction**
  - Product 1: A4-A5
  - Product 2: Construction
  - Product n: Construction

- **Usage**
  - Product 1: B1-B5
  - Product 2: Usage
  - Product n: Usage

- **End of life**
  - End of life: C1-C4

- **Beyond**
  - Beyond: D

**Operational**

- Building energy
- Operational water

**Life cycle**

- Production: A1-A3
- Construction: A4-A5
- Usage: B1-B5
- Operational: B6-B7
- End of life: C1-C4
- Beyond system boundary: D
## Scope of different building LCAs

<table>
<thead>
<tr>
<th>Building Product EPD*</th>
<th>Materials &amp; Production</th>
<th>Construction</th>
<th>Usage</th>
<th>Operational</th>
<th>End-of-Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Building LCA</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Whole Building &amp; Whole Life LCA</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
LEED has started to incorporate LCA

EPDs & Whole Building LCA
When can LCAs be compared?
## Potential objectives for building LCAs beyond LEED

<table>
<thead>
<tr>
<th>Building Product EPD</th>
<th>Vendor Decisions</th>
<th>Construction</th>
<th>Usage</th>
<th>Operational</th>
<th>End-of-Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Building LCA</td>
<td>Design Decisions (Same Operational Performance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole Building &amp; Whole Life LCA</td>
<td>Design Decisions (Different Operational Performance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Background vs. foreground life cycle inventory data

**Background data:**
Common to most analyses

**Foreground data:**
Specific to analyzed system
(Specific industries)

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Legend:
- Process
- Product or waste flow
- Elementary flow
- Excluded product or waste flow
- Excluded elementary flow
- Allocation / Substitution

Source: ILCD Handbook, 2010
EPDs use product category rules

- PCRs help ensure that the same rules are followed for foreground inventory data.
- They may or may not specify rules for background data.
Requirements for EPD comparability from ISO 14025

- Product category definition
- Goal and scope
- Inventory analysis
- Impact categories
- Reporting categories
- Provision of additional information

- Materials and substances
- Data collection
- Format for declaration
- Equivalency of stages
- Period of validity

Key elements: scope, data, models in foreground and background. These may or may not be covered in PCR.
Comparisons of EPDs can be problematic

Use caution in vendor decisions

Comparison of type III environmental product declarations for construction products: Material sourcing and harmonization evaluation
M.D.C. Gelowitz, J.J. McArthur (Ryerson University, Toronto)
Journal of Cleaner Production 157 (2017) 125-133

“61% of comparisons (19/31) completed with the same PCR were found to be invalid”
EPDs are not LCI data

Use caution in use of EPDs in WBLCA

**EPD Metrics**
- ozone depletion
- climate change
- acidification
- eutrophication
- smog formation
- human health impacts
- ecotoxicity

**LCI Data**
- Material consumption
- Energy consumption
- Water consumption
- Emissions
- Waste

EPDs without LCI data should only be used in LCAs where:
- There is consistency in background data and models
- There is no interest in understanding drivers of upstream impacts
- Publicly reported comparative assertions will *not* be made
Critical issues in building LCA comparisons

System boundaries

• Boundaries and inclusion of life cycle processes
• Reference study period

Analytical approach

• Criteria for functional equivalence
• Location
• Treatment of time
• Uncertainty analyses
• Allocation
• Treatment of end of life
• Treatment of operational energy
• Treatment of biogenic carbon

Design decisions may or may not include EPDs

- EPDs currently created to satisfy LEED, not to support vendor decisions or for use in LCA
- Early design (and cost) decisions are unlikely to be firm specific because of uncertainty
- Objective: high quality and industry-representative data with variation quantified
A consistent background database is needed

Two parallel efforts underway

North American Life Cycle Inventory Data Center

National Low Carbon Infrastructure Initiative (Canada)

Merge?
A complete set of publications may be found at: http://cshub.mit.edu/buildings/lca


- Ghattas, Randa; Gregory, Jeremy; Noori, Mehdi; Miller, T. Reed; Olivetti, Elsa; and Greene, Suzanne. “Life Cycle Assessment for Residential Buildings: A Literature Review and Gap Analysis.” MIT Concrete Sustainability Hub, Revised 2016.


- Ochsendorf, John; Keith Norford, L; Brown, D; Durschlag, H; Hsu, S.L; Love, A; Santero, N; Swei, O; Webb, A; and Wildnauer, M. “Methods, Impacts, and Opportunities in the Concrete Building Life Cycle.” MIT Concrete Sustainability Hub, 2011.
The Athena Institute and the Impact Estimator for Buildings

Jennifer O’Connor
President
• Non-profit research and advocacy group for LCA in construction.
• Providing pioneering work and leadership since 1997.
• LCA consultants: hundreds of LCA studies on materials and products; EPDs and PCRs; peer reviews.
• Public service: LCA research studies and white papers; LCA education and advocacy; WBLCA guidelines; LCA standards committees.
• Free software tools: the Impact Estimator for Buildings and Pavement LCA.
• Supported by research grants, industry, donors, and our members.
Launched in 2002
PC desktop app
Useful at all stages of design and for all building types
Useful for whole buildings, parts of buildings, or just materials
Full cradle-to-grave disaggregated results (A-C, A-D)
Continuously updated

Multiple reporting options are available, in graphs and tables. In this sample, two projects are compared side-by-side.
• Users can provide a bill of materials or can let the software calculate one
• Operating energy is an optional input
• Delivers detailed LCI and LCA results
• Supported by high-quality regionally-specific material and process LCI/LCA data
• Multiple reporting options including LEED-specific documentation
• Creating a web app version
• Partnering with third-party web apps
• More reporting options

## LCA Measure Table By Assembly Groups (A to C)

<table>
<thead>
<tr>
<th>LCA Measures</th>
<th>Unit</th>
<th>Foundations</th>
<th>Walls</th>
<th>Columns and Beams</th>
<th>Roofs</th>
<th>Floors</th>
<th>Project Extra Materials</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential</td>
<td>kg CO2 eq</td>
<td>2.31E+04</td>
<td>1.99E+04</td>
<td>0.00E+00</td>
<td>5.72E+03</td>
<td>1.59E+03</td>
<td>2.68E+03</td>
<td>5.30E+04</td>
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<tr>
<td>Acidification Potential</td>
<td>kg SO2 eq</td>
<td>1.13E+02</td>
<td>1.51E+02</td>
<td>0.00E+00</td>
<td>5.14E+01</td>
<td>1.38E+01</td>
<td>2.48E+01</td>
<td>3.55E+02</td>
</tr>
<tr>
<td>HH Particulate</td>
<td>kg PM2.5 eq</td>
<td>1.76E+01</td>
<td>4.26E+01</td>
<td>0.00E+00</td>
<td>1.77E+01</td>
<td>4.89E+00</td>
<td>1.58E+01</td>
<td>9.86E+01</td>
</tr>
<tr>
<td>Eutrophication Potential</td>
<td>kg N eq</td>
<td>2.39E+01</td>
<td>6.70E+00</td>
<td>0.00E+00</td>
<td>3.00E+00</td>
<td>1.18E+00</td>
<td>2.14E+00</td>
<td>3.69E+01</td>
</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>kg CFC-11 eq</td>
<td>4.45E-04</td>
<td>2.06E-04</td>
<td>0.00E+00</td>
<td>4.17E-07</td>
<td>1.08E-06</td>
<td>7.87E-06</td>
<td>6.61E-04</td>
</tr>
<tr>
<td>Smog Potential</td>
<td>kg O3 eq</td>
<td>2.79E+03</td>
<td>1.68E+03</td>
<td>0.00E+00</td>
<td>8.98E+02</td>
<td>2.41E+02</td>
<td>4.07E+02</td>
<td>6.01E+03</td>
</tr>
<tr>
<td>Total Primary Energy</td>
<td>MJ</td>
<td>2.02E+05</td>
<td>2.62E+05</td>
<td>0.00E+00</td>
<td>1.95E+05</td>
<td>3.60E+04</td>
<td>6.05E+04</td>
<td>7.55E+05</td>
</tr>
<tr>
<td>Non-Renewable Energy</td>
<td>MJ</td>
<td>1.97E+05</td>
<td>2.43E+05</td>
<td>0.00E+00</td>
<td>1.70E+05</td>
<td>2.27E+04</td>
<td>4.23E+04</td>
<td>6.75E+05</td>
</tr>
<tr>
<td>Fossil Fuel Consumption</td>
<td>MJ</td>
<td>1.83E+05</td>
<td>2.25E+05</td>
<td>0.00E+00</td>
<td>1.65E+05</td>
<td>2.07E+04</td>
<td>4.14E+04</td>
<td>6.35E+05</td>
</tr>
</tbody>
</table>
• Launched as a desktop tool in 2013, and a web app in 2016.

• Provides full cradle-to-grave LCI and LCA results for paving projects like roadways.

• Includes life cycle costing.
WBLCA issues and how we’re trying to help

• Comparability of studies / creation of performance targets: Benchmarking
• Standardized WBLCA practice and transparent reporting: Environmental Building Declarations
• Software user education: Impact Estimator workshops with WBLCA 101

From our benchmarking pilot study: a building compared to a statistically-derived benchmark. For methodology details, see our white paper.
What you’ll find at
www.athenasmi.org

• More info and links for our software tools
• User guides/transparency documents
• Short video demos and FAQs
• Case studies
• Material LCA reports, other LCA-based studies, environmental building declarations, general LCA information and more
• Our guide to the LCA provisions in green building programs
• Link to join our mailing list
• Information on our mandate and how to support us
One Click LCA – LCA Made Easy

Carbon Leadership Forum – November 30th, 2018, Panu Pasanen
Start in the concept stage with Carbon Designer

1. STRATEGY
2. CONCEPT
3. DESIGN
4. SPECIFICATION
5. CONSTRUCTION
6. AS BUILT

CARBON DESIGNER IS A ONE CLICK LCA MODULE

- CREATE A BASELINE BUILDING IN A FEW CLICKS
- USE A SHOEBOX OR COMPLEX GEOMETRY
- SWITCH BETWEEN DIFFERENT TYPES OF CONSTRUCTIONS / STRUCTURAL MATERIALS
- ADJUST MATERIALS AND RECYCLED CONTENT
- GENERATE BILL OF QUANTITIES FOR LEED LCA
INTEGRATES WITH COMMON DESIGN TOOLS & FORMATS

TOTAL FLEXIBILITY FOR DESIGN PHASE MODELING

- Work in the browser, or bring in materials from any supported software
- Patent-pending material mapping algorithm
- No need to create Revit design options, re-label materials in Revit, re-draw in Revit, link models...
- Create options easily online w/ changes in Revit
- Powerful model checker & LCA checker

Trademarks property of their owners. U.S. Patent Pending
Use generic materials or actual manufacturer EPDs

1. STRATEGY
2. CONCEPT
3. DESIGN
4. SPECIFICATION
5. CONSTRUCTION
6. AS BUILT

COMPARE AND CHOOSE PRODUCTS USING EPDS

- ALL PUBLICLY AVAILABLE EPDS (>1200) INCLUDED
- ALL DATA IS PRE-VERIFIED
- ADD YOUR OWN EPDS ON DEMAND
- MATERIALS CARBON BENCHMARKING
- ADD PRIVATE DATA AND CONSTRUCTIONS
- ALSO, A GLOBAL DATABASE OF OVER 10 000 MATERIALS

NORTH AMERICA: 1627 DATAPoints, INCLUDING ANY EPD

Trademarks property of their owners
We serve clients in the US, and 55+ other countries

ENGINEERING
- Integral Group
- Thornton Tomasetti
- ARUP
- Jacobs
- WSP

ARCHITECTURE
- Foster + Partners
- Adrian Smith + Gordon Gill Architecture
- MVRDV

OTHERS
- Skanska
- Saint-Gobain
- STATSBYGG

A FEW OF OUR CLIENTS’ HUNDREDS OF COMPLETED PROJECTS

Colby College
Maine, USA

YMCA Community Centre
Toronto, Canada

Zoo Savanna Hall,
Atlanta, USA

Visionary by Skanska
LEED Platinum, Czech Republic

Bloomberg’s European HQ
‘World’s most sustainable office’
# One Click LCA is the tool for demanding clients

<table>
<thead>
<tr>
<th>WHAT OUR CLIENTS DEMAND</th>
<th>HOW WE DELIVER THAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD, UP-TO-DATE DATA</td>
<td>Database updated &amp; reviewed weekly</td>
</tr>
<tr>
<td></td>
<td>New data added on client request</td>
</tr>
<tr>
<td>ROBUST CALCULATION</td>
<td>Third party verified &amp; compliant</td>
</tr>
<tr>
<td>EASE OF USE</td>
<td>Intuitive interface</td>
</tr>
<tr>
<td></td>
<td>LCA &amp; Model Checkers, benchmarks</td>
</tr>
<tr>
<td>TIME SAVING</td>
<td>Multiple, flexible software integrations</td>
</tr>
<tr>
<td></td>
<td>Certification specific tools</td>
</tr>
<tr>
<td>FAST LEARNING CURVE</td>
<td>Kick off training</td>
</tr>
<tr>
<td></td>
<td>LEED v4 WBLCA workflow</td>
</tr>
<tr>
<td>GREAT SUPPORT</td>
<td>Always response within 24h</td>
</tr>
<tr>
<td></td>
<td>Staffed by LCA Engineers</td>
</tr>
<tr>
<td>GREAT BUSINESS VALUE</td>
<td>Document EPD credits &amp; compliance</td>
</tr>
<tr>
<td></td>
<td>Calculate Life-Cycle Cost</td>
</tr>
<tr>
<td></td>
<td>Infrastructure / Envision</td>
</tr>
<tr>
<td></td>
<td>Circular economy tools</td>
</tr>
</tbody>
</table>

Incorporating One Click LCA as a tool in the building design stage has helped us evaluate, prioritize and optimize our efforts in reducing the lifetime environmental impacts of the projects we design. With One Click LCA uploading, managing, and evaluating data has become very fast and easy through its automated process which links materials with relevant LCA data from the software’s abundant product database. One Click LCA provides the detailed information we need to implement design solutions which are substantially reducing the environmental impacts of our projects.

Natalia Quintanilla  
Building Science Specialist, Smith + Gill Architecture, USA
One Click LCA – LCA Made Easy

General information  www.oneclicklca.com
For LEED v4 specifically  www.lcaforleed.com
Start a free trial  Free 14 day trial
More technical information  Using EPDs in WBLCA
To book a short live demo  Book a slot here

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CE Enterprise
the concrete sustainability suite

Laurel McEwen, VP EPD Services
laurel.mcewen@climateearth.com
EPD Generator

Working with manufactures within the US ready mix concrete industry over the past 6 years Climate Earth has developed an automated system that allows manufactures to generate and publish verified mix specific EPDs in minutes.

› Used by 80 plants around the US
› Published over 20,000 EPD’s
› Compliant with North American PCR
› Published by NRMCA & ASTM
Drawing from Climate Earth’s database of over 20,000 EPDs, the free Concrete Selector provides the building design community with the high, low, median and average embodied carbon for any strength and SCM content.
Drawing on company specific verified EPD data, the Project Builder generates embodied carbon reports for an entire project. The graphic report provides the high, low, median, and average impact for the concrete portion of the project.

https://www.climateearth.com/ce-enterprise/
Designed for QC professionals and engineers, the Concrete Designer generates a full environmental impact report for any new mix design, based on verified EPD data.
CE Enterprise
Software Suite for low carbon construction with concrete

1. EPD Generator
2. Concrete Selector
3. Project Builder
4. Concrete Designer

https://www.climateearth.com/ce-enterprise/
## North American Concrete PCR

### Cradle to Gate system boundary

<table>
<thead>
<tr>
<th>PRODUCTION Stage (Mandatory)</th>
<th>CONSTRUCTION Stage</th>
<th>USE Stage</th>
<th>END-OF-LIFE Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraction and upstream production</td>
<td>Transport to factory</td>
<td>Installation</td>
<td>Use</td>
</tr>
<tr>
<td>Transport to site</td>
<td>Manufacturing</td>
<td></td>
<td>Maintenance</td>
</tr>
<tr>
<td>Installation</td>
<td></td>
<td>Repair</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Replacement</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>De-construction/ Demolition</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Transport to waste processing or disposal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Waste processing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Disposal of waste</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
</table>
North American Concrete PCR

- Life Cycle Inventory – same background data required unless material specific data is published
  - Aggregate, cement, admixtures
  - Truck, ocean, rail transportation
  - Electricity, diesel, natural gas, propane, water

- All data sources reported on EPD

All concrete EPD’s produced are transparent and comparable
TRADITIONAL WORKFLOW

SCHEMATIC DESIGN → DESIGN DEVELOPMENT → CONSTRUCTION DOCUMENTS

LIFE CYCLE ASSESSMENT

OPTIMAL WORKFLOW

SCHEMATIC DESIGN → LCA MODELING → DESIGN DEVELOPMENT → LCA MODELING → CONSTRUCTION DOCUMENTS
Tally™ pulls material quantities from the Revit model to create an accurate bill of goods.

LIFE CYCLE ASSESSMENT FOR THE BUILT ENVIRONMENT PROCESS

ECN | LCA Data & Tools Webinar

KT INNOVATIONS
An affiliate of Kieran Timberlake

thinkstep

AUTODESK

© KT INNOVATIONS

3D NOVEMBER 2018 | © KIERANTIMBERLAKE
Brick

Brick, size as specified by user. Entry includes user-specified mortar, reinforcement (none/low/high), grout (if any) and finish (if any).

- **Brick type**
  - **Brick, generic**
  - **Service Life**
    - **Set to building life**
    - **Existing or salvaged material**

- **Takeoff Method**
  - **by Volume**
  - **Brick volume**
    - **3/8" joint**
    - **81.87 % by vol**

- **Mortar type**
  - **Mortar type N**

- **Grout fill**
  - **None**

- **Reinforcement**
  - **Steel, reinforcing rod**
  - **Service Life**
    - **Default to building life**
    - **Existing or salvaged material**

  - **Takeoff Method**
    - **by Area**
    - **Masonry reinforcement**
      - **Low Reinforcing (#4 @ 48" on center)**
      - **0.81365415 kg/m²**

- **Finish**
  - **None**
Steel, C-stud metal framing
Cold-formed steel C-Studs. User to select steel type and section. Used for exterior and other load-bearing light metal framing.

- Steel type:
  - Cold formed structural steel

- Service Life:
  - Default to building life

- Takeoff Method:
  - by Spacing

- Steel C-stud section:
  - 6" Stud, 12 ga.
  - 3.04 lb/ft
  - 16 in
RELATIVE CARBON FOOTPRINT OF CONCRETE MIXES
(1 yd³ of concrete)

CONCRETE mix assessment

LIFE CYCLE ASSESSMENT FOR THE BUILT ENVIRONMENT
UNDERSTANDING CONCRETE

ECN| LCA Data & Tools Webinar

30 NOVEMBER 2018 | © KIERANTIMBERLAKE
RELATIVE CARBON FOOTPRINT OF METAL COATINGS
(100 sq ft of curtain wall)

Mill Finish  |  Anodized  |  Powder Coat  |  Fluoropolymer  |  Enamel
---|---|---|---|---
300 kg CO₂ eq  | 450 kg CO₂ eq  | 400 kg CO₂ eq  | 350 kg CO₂ eq  | 300 kg CO₂ eq

Coating

Aluminum Extrusion, AEC EPD
LIFE CYCLE ASSESSMENT FOR THE BUILT ENVIRONMENT  UNDERSTANDING RETROFIT
ENVIRONMENTAL BENEFIT OF ADAPTIVE REUSE
(Removing Module A)

% of Total Impacts

Acidification Potential (kgSO2eq)
Eutrophication Potential (kgNeq)
Global Warming Potential (kgCO2eq)
Smog Formation Potential (kgO3eq)
Non-renewable Energy Demand (MJ)

- New
- Retrofit

LIFE CYCLE ASSESSMENT FOR THE BUILT ENVIRONMENT
UNDERSTANDING RETROFIT

ECN | LCA Data & Tools Webinar

30 NOVEMBER 2018 | © KIERANTIMBERLAKE
Questions? Free educational license? Webinar recordings? LEED guide?

Web: [http://choosetally.com/](http://choosetally.com/)

Email: support@choosetally.com

Phone: Rod Bates (215)922-6600x128
Main Entry: transparent
Pronunciation: tran(t)s-\ˈpar-\ənt, -\ˈper-
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>

**Embodied 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>
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<td>A1020 Special Foundations</td>
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<td>A1030 Slab on Grade</td>
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<td></td>
<td>A20 Basement Construction</td>
<td>A2010 Basement Excavation</td>
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<td>B SHELL</td>
<td>B10 Superstructure</td>
<td>B1010 Floor Construction</td>
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<td>B1020 Roof Construction</td>
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<td>B2010 Exterior Walls</td>
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<td>B3010 Roof Coverings</td>
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<td>C INTERIORS</td>
<td>C10 Interior Construction</td>
<td>C1010 Partitions</td>
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<td></td>
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<td>C1030 Fittings</td>
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</table>

## 02. Parking Garage

### A SUBSTRUCTURE

#### A10 FOUNDATIONS

- **A1010 Standard Foundations**
  - 0300.001 Spread Footings: 1,848.00 cu yd
  - 0300.001 Continuous Footings: 87.00 cu yd
  - 0300.001 Mat Footings: 1,190.00 cu yd
  - 0300.001 Tower Crane Footing: 93.00 cu yd

#### 03.02 Rebar

- 03201.600 Steel Bar Reinforcement in Spread Footings (70lbs/CY): 59.00 tons
- 03201.600 Steel Bar Reinforcement in Matt Foundations (110lbs/CY): 60.00 tons
- 03201.600 Steel Bar Reinforcement in Continuous Footings (50lbs/CY): 2.00 tons
- 03201.600 Steel Bar Reinforcement in Tower Crane Matt Foundations (110lbs/CY): 32.00 tons
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<thead>
<tr>
<th>Description</th>
<th>Gross volume (cubic ft)</th>
<th>Net volume (cubic ft)</th>
<th>Gross area (sq ft)</th>
<th>Net area (sq ft)</th>
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<tr>
<td>Totals for Roof elements</td>
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<tr>
<td>Concrete - Precast Concrete</td>
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<tr>
<td>Insulation / Thermal Barriers - Rigid insulation</td>
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<tr>
<td>Roofing - EPDM Membrane</td>
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<tr>
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<tr>
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<tr>
<td>Insulation / Thermal Barriers - Rigid insulation</td>
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<tr>
<td>Roofing - EPDM Membrane</td>
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<tr>
<td>Default Roof</td>
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<td>Totals for Roof element Generic - 3&quot; (id 246676)</td>
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<tr>
<td>Insulation / Thermal Barriers - Rigid insulation</td>
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<tr>
<td>Roofing - EPDM Membrane</td>
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<td>Default Roof</td>
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<td>Masonry - Concrete Masonry Units</td>
<td>9397.86</td>
<td>8860.45</td>
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<td>EIFS - Exterior Insulation and Finish System</td>
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<td>1085.81</td>
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<td>Vapor / Moisture Barriers - Vapor Retarder</td>
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<td>Gypsum Wall Board</td>
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<td>Metal - Stud Layer</td>
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<td>8675.3</td>
<td>31666.31</td>
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<td>Concrete - Cast-in-Place Concrete</td>
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<td>621.26</td>
<td>607.92</td>
<td>977.43</td>
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<td>Masonry - Concrete Masonry Units</td>
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</tbody>
</table>
Environmental Product Declarations

**Nutrition Facts**

- **Serving Size**: 2/3 cup (55g)
- **Calories**:
  - Total: 230
  - Calories from Fat: 40%
- **Amount Per Serving**
  - Total Fat: 8g (12%)
  - Saturated Fat: 1g (5%)
  - Trans Fat: 0g
  - Cholesterol: 0mg (0%)
  - Sodium: 160mg (7%)
  - **Total Carbohydrate**: 37g (12%)
    - Dietary Fiber: 4g (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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<tbody>
<tr>
<td>Plant Operating Energy (MJ)</td>
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<tr>
<td>On-Site Plant Fuel Consumption (MJ)</td>
<td>11.1</td>
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<tr>
<td>Concrete Batch Water (m³)</td>
<td>1.68E-01</td>
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<tr>
<td>Concrete Wash Water (m³)</td>
<td>1.91E-02</td>
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<tr>
<td>On-Site Waste Disposal (kg)</td>
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<table>
<thead>
<tr>
<th>ENVIRONMENTAL IMPACTS</th>
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</thead>
<tbody>
<tr>
<td>Total Primary Energy (MJ)</td>
</tr>
<tr>
<td>Climate Change (kg CO₂ eq)</td>
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<tr>
<td>Ozone Depletion (kg CFC 11 eq)</td>
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<tr>
<td>Acidification Air (kg SO₂ eq)</td>
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<tr>
<td>Eutrophication (kg N eq)</td>
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<tr>
<td>Photochemical Ozone Creation (kg O₃ eq)</td>
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</table>
Environmental Product Declarations – Product Category Rules

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. UNSPSC 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 Samera Ready Mix Plant

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Strength</th>
<th>GWP</th>
<th>OGP</th>
<th>EF</th>
<th>PCC</th>
<th>PER</th>
<th>NR</th>
<th>CR</th>
<th>MRG</th>
<th>CMR</th>
<th>CO2</th>
<th>CO2e</th>
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</table>

www.carbonleadershipforum.org
University of Washington Box 355720, Seattle, WA 98195-3720
<table>
<thead>
<tr>
<th>ID</th>
<th>RULE, DECLARED, PRODUCT, NAME</th>
<th>RULE, PLANT, NAME</th>
<th>RULE, COMPANY, NAME</th>
<th>RULE, OMP</th>
<th>RULE, DECLARED, UNIT</th>
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<td>rd73559-9900-0494-0430-b10-063470925</td>
<td>M x NW</td>
<td>Riversdale</td>
<td>ORO Block &amp; HARDSCAPE</td>
<td>329.00</td>
<td>1 m³</td>
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<td>05454100-ac4e-4350-a5a3-238a97877006</td>
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<td>Romeland</td>
<td>ORO Block &amp; HARDSCAPE</td>
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</table>
Data Visualization: Decision Making

80th Percentile Defaults

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.

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

Quickly understand CO2e range of a specific material

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

See details and automatically download the associated EPD.
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.

Graphically view conservative and best in class CO2e data for each material category and component of your Project.
“High Embodied Carbon” benchmark

“Low Embodied Carbon” benchmark

WA produced rebar

Large variance in emissions of rebar based on manufacturing location
Carbon Smart Design

Range of CO2 Emissions – Seattle Area Concrete Suppliers

- Typical 28 day cure time
  - Minimal SCM’s
- Typical 28 day cure time
  - Some SCM’s
- 56 day cure time
  - More SCM’s

# of EPDs per Supplier:
- Cadman: 5
- CalPortland: 29
- Stoneway: 72
Carbon Smart Procurement

**Range of CO2 Emissions – Seattle Area Concrete Suppliers**

- Typical 28-day cure time
  - Minimal SCM's
- Typical 28-day cure time
  - Some SCM's
- 56-day cure time
  - More SCM's

**Range of CO2 Emissions Regional Rebar Manufacturers**

- US Plants (average)
- Tacoma, WA Plant
- OR/WA Plants
- Seattle, WA Plant

**Range of CO2 Emissions Gypsum Wallboard**

- # of EPDs per Supplier:
  - CertainTeed: 19
  - USG Ecobrane: 17

**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 013500, 013511, or 013512.

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.
Leading AEC Firms
Architect, Structural Engineer (MKA), MEP Engineer, Contractor (Skanska)

Leading Owners
Skanska CD, Microsoft

Leading Organizations/Foundations
Pankow Foundation, MKA Foundation, American Institute for Steel Construction

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

Open to additional projects, then available to public

<table>
<thead>
<tr>
<th>Goals</th>
<th>Plans &amp; Pilots</th>
<th>Implementation</th>
<th>Construction</th>
<th>Construction</th>
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</thead>
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<tr>
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<td>Data Gathering</td>
<td>- Deployment</td>
<td>- Data Accumulation</td>
<td>- Data Accumulation</td>
</tr>
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<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>Contracts</td>
<td>...</td>
<td>- Iterative Improvement</td>
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EVERYONE....?
 Stick around for Q & A

Reminders:

- To receive AIA continuing education credit send your AIA member number to info@embodiedcarbonnetwork.org
- To access past webinar recordings, visit: www.embodiedcarbonnetwork.org/resources
- Stay tuned for the upcoming 2019 webinar series!
Thank you!

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