Using Revit and Dynamo to Assess Embodied Carbon

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Computational Community Leader, Buro Happold
About the speaker

Kayleigh Houde, PE
Computational Community Leader
7 years with Buro Happold
6th year speaking at Autodesk University
Mechanical Engineer by Background
Using Revit and Dynamo to Assess Embodied Carbon

Our intelligent models are rich with modelled elements, parameters, and materials; they're ripe for the assessment of their CO2 impact. Yet how do we make that process seamless? During this session we'll review ways to pull your BIM (Building Information Modelling) elements and apply rich Environmental Product Declaration (EPD) data sets against them, pushing that information back into Revit software, and visualize the overall impact using Revit software’s available color schemes.
Learning Objectives

OBJECTIVE 1
Learn how to model your elements to make their assessment of the CO2 impact seamless.

OBJECTIVE 2
Learn about the storage of EPD data sets to ensure you're assessing your materials properly.

OBJECTIVE 3
Discover Revit software's ability to visualize your results.

OBJECTIVE 4
Discover output to Excel reporting formats.
Agenda

Part I: Preceding Knowledge
- What exactly is Embodied Carbon?
- What should we study as a part of embodied carbon assessment? LCA Scope
- What’s an EPD?
- Accessing EPD Datasets in Dynamo (Introduction to BHoM)

Part II: Assessing Embodied Carbon
- Modeling Practices that Make Studying Embodied Carbon Easier
- Applying EPDs to Your Revit Objects
- Visualizing Your Embodied Carbon Results Back in Revit
- Pushing Your Results to Excel
Part I | Preceding Knowledge
Carbon Reduction Opportunities

- Greater energy efficiency
- Cleaner electrical grids
- Less FF energy source

We can change the trajectory!
Global CO₂ Emissions by Sector

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

Measuring Embodied Carbon: Global Warming Potential

CFC-12
10,200 kgCO₂

CFC-11
4,660 kgCO₂

HCFC-22
1,760 kgCO₂

HFC-134a
1,300 kgCO₂

Nitrous Oxide
265 kgCO₂

HCFC-123
79 kgCO₂

Methane
28 kgCO₂

Carbon
1 kgCO₂
Embodied Carbon within Life Cycle Assessment

A1-A3
Typical Manufacturer or Industry-Wide EPDs
Scope of Study
Scope of Study

Extent of LCA Scope per Carbon Leadership Forum
Scope of Study (for this demo)

<table>
<thead>
<tr>
<th>StructuresScope</th>
<th>FoundationsScope</th>
<th>TenantImprovementScope</th>
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<tr>
<td>Slabs</td>
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<td>Piles</td>
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<td>Beams</td>
<td>Walls</td>
<td>Finishes</td>
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Environmental Product Declarations (EPDs)
How do you measure Embodied Carbon on your projects?

Environmental Product Declaration

MATERIAL QUANTITIES × GWP/QUANTITY = BUILDING EMBODIED CARBON ESTIMATE (GWP)
What an EPD Looks Like

Declaration Owner

Phases of Life
What an EPD Looks Like

Declared Unit, Third-Party Verified

Global Warming Potential (kgCO₂-e)
Accessing EPDs through BHoM in Dynamo
SUSTAINABLE CODE AT SCALE

The Buildings and Habitats object Model

A collaborative computational development project and collective experiment. By sharing and co-creating code we can better shape our environment and our future.

We want to challenge the way we design and work today.

We want technology to be open and accessible for all.

And we think that by working together we can solve harder more impactful problems for the world.

View on GitHub  Download the 3.1.0.8 installer
Why Are We Using BHoM to Measure Embodied Carbon?

• We need somewhere to properly store our datasets, some of which are live!
• Cataloging Objects can be difficult, keeping track of your project’s scope (area, type, what was included (columns, slabs, ducts, etc.)
• We don’t usually see early stage design in Revit alone (Rhino is used for early stage models for example) BHoM allows interoperability
• Revit models are LIVE LIVE LIVE it’s difficult to mark points in the development with regard to LCA (using the LOD in the scope allows you to push those results per stage and compare)
BHoM – Visual Programming in Multiple UIs
Access to BHoM Datasets
BHoM LCA Toolkit

Convert Revit Objects to BHoM Objects in Dynamo through a Pull

- Apply EPD Datasets to those Objects
- Assess their Embodied Carbon with LCA Toolkit Engine Methods

Push the Objects Back to Revit with their Embodied Carbon Information
Part II | Assessing Embodied Carbon
Modeling in Revit to Make Assessment Easier
Tips for Modeling Revit Objects to Make Embodied Carbon Studies Easier

• Assign Materials whether by using their Revit material property, or by noting the material used in the family name
• Ensuring that the mass, area or volume can be accessed as a parameter of the family
• Modeling your objects as their intended category (ducts as ducts, columns as columns (not generic models!))
Create a Consistent Project Parameter for Embodied Carbon
Pulling BHoM Objects from Revit to Dynamo
Sorting Objects
Applying EPDs to Revit Objects
Looking through BHoM EPD Datasets
Choosing the Best Dataset for Your Object

- What design stage are you in?
- Do you know the exact mix for your concrete?
- What region are you in?
- Are you trying to evaluate more than just GWP?
Applying EPDs to Objects
Evaluate Your GWP (Embodied Carbon)
Evaluate Your GWP (Embodied Carbon)
Set Parameter on Revit Objects
Push Revit Objects
Cataloging Your Scope
End to End View

- Pull Objects by Type
- Sort the Objects (if in different LCA categories, or of different materials)
- Add the EPD Dataset for Each Type of Object
- Extract Volume/Mass from the Objects
- Evaluate the GWP (Embodied Carbon)
- Get the GWP Totals
- Set the Revit Parameters
- Catalog Your LCA Scope
- Push to Revit
Columns
Exterior Walls
Ducts
Visualizing Your Embodied Carbon Results in Revit
Visualizing Your GWP Results by Object
Pulling Your Results into Excel
### Pulling Your Results into Excel

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#### Embodied Carbon Totals by Type

**Flumes**

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<th>Column</th>
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**Columns**

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**Walls**

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**Ducts**

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**Total Embodied Carbon**

- Flumes: 2310.320649
- Columns: 11861.369645
- Walls: 80164.43307
- Ducts: 5963.372536

**Graph: Embodied Carbon Totals by Type**

- Flumes: 2310.320649
- Columns: 11861.369645
- Walls: 80164.43307
- Ducts: 5963.372536
Thank You!