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#### EC3 and Embodied Carbon Reduction

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## EC3 and Embodied **Carbon Reduction**

Karl Benjamin ARCH560 Fall 2020





#### **Abstract and Project Information**

The objective of this research was to use the Embodied Carbon in Construction Calculator (EC3) tool to evaluate the embodied carbon emissions in several material categories, allowing for specification and procurement of low carbon options. The case study for this research is the Shiley-Marcos Center for Design & Innovation (University of Portland), an adaptive reuse project currently in the late design and procurement phase of the construction process. This research was intended to contribute to the research done during the design phases related to the Whole Building Life Cycle Analysis (WBLCA) using Tally. I worked primarily with Heather DeGrella and Kelli Kimura from Opsis, as well as Stacy Smedley from Skanska, who has extensively worked on developing EC3.

Throughout the research, I worked in two EC3 files related to the two primary aspects of this research:

- Establishing comparisons to baselines using the construction estimate to determine the possibility of carbon reductions for the Shiley-Marcos project
- Exploring EC3's optimization and compatibility with Tally

In the file related to the construction estimate, I took the material and quantity data, researched the proper specifications, and added them into EC3. I then selected an EPD for each material unit and used EC3 to create comparisons to baselines. From there we were able to see areas of improvement and various baselines for the specified materials. The second file we analyzed the differences between the embodied carbon amount that was reported directly out of Tally versus what EC3 calculated from the same materials and quantities.

### **User Interface**

The user selects an EPD that fits the project needs and EC3 will use the data from this EPD to create summary data and comparisons. Certain specifications, such as concrete's curing time and percentage of SCM, are not required to be disclosed on EPDs. Therefore the list of possible vendors could be inflated. However, it provides a great starting point to select a manufacturer or to compare existing material procurement decisions with better options. There is also the option to select industry EPDs rather than specific products, giving a more conservative comparison.

	PROPERTIES: 03 3				
▼ PERFC	RMANCE SPECIF	ICATIONS			
Co	mpressive Strength		@ Curing Time		
≅ /	4500 psi		28d 👻	≅ Compressive Stren	igth Other
Slur	mp (min) Op	otions	~	≤ W/C Ratio	≥ SCM
O St	andardweight 🔘 Lig	htweight			
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GWF	• Transport Cost				
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l after : 2022-07	7-28 X and Streng	gth @28d ≅ 4500 psi	X and Plant Stra	ight-line Distance ≤ 100 i	miles X
RODUCT E	PDS				
Samples: 47	Ac	hievable: 256 kgC	02e Average:	409 kgCO2e ± 46.9%	
Selected	material				
314565, Cor	vallis, RiverBend Mat	terials, 4500 psi, 2	83 kgCO2e, 79.4 mile	5	
	est EC of any found.	kgCO2e em	bodied per 1 m3	Chart Optio	ons
EPD	iound.	1,100	\$		
	of EPDs found	1.000			
this,	EC lower than so it is a good	800 Conserva 700	Max 819 tive 760	Most match	
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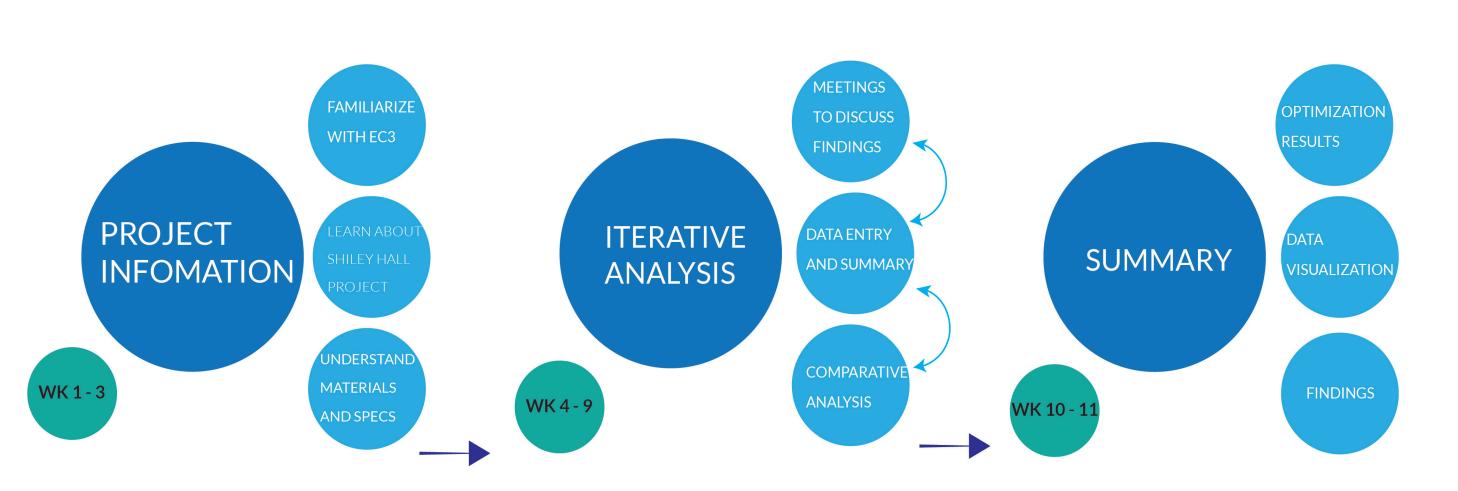
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General purpose

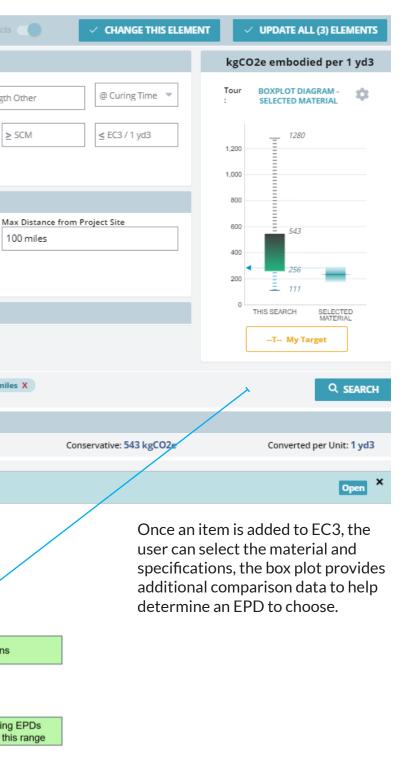
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An example of a list of concrete EPDs in EC3 populated with specifications such as strength and distance from site.



#### **Project Timeline**



Conservative: 538 kgCO2e	C

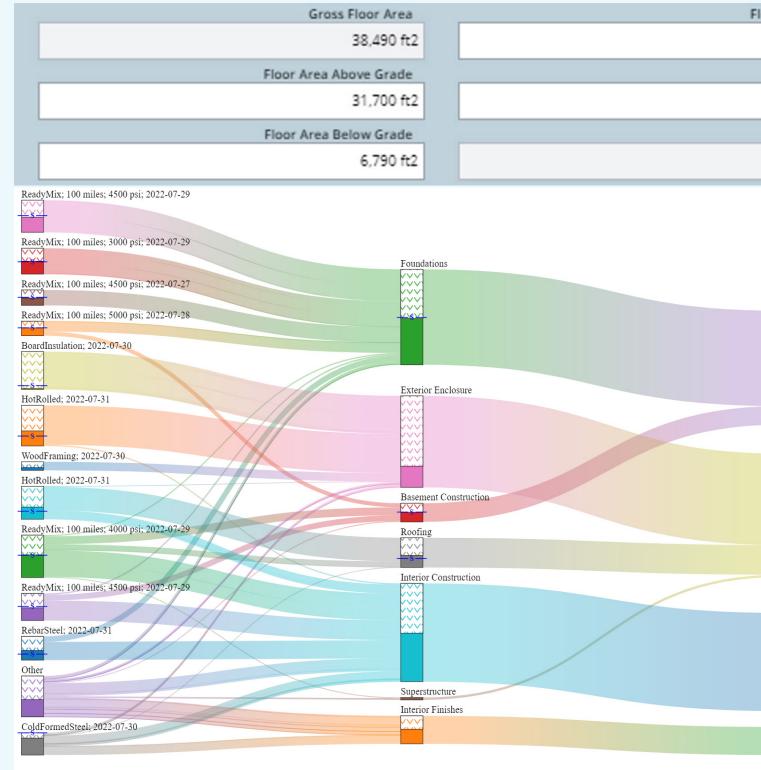
]↑↓	≅ Compressiv ↑↓	≤ EC3 / 1 yd3 J₽	Straight-line D ↑↓	Details
e	4500 psi	554 kgCO2e		Details View
	4500 psi	467 kgCO2e		Details View
d	4500 psi	467 kgCO2e		Details View
t	4500 psi	464 kgCO2e		Details View
e	4500 psi	463 kgCO2e		Details View
d	4500 psi	462 kgCO2e		Details View
d	4500 psi	459 kgCO2e		Details View

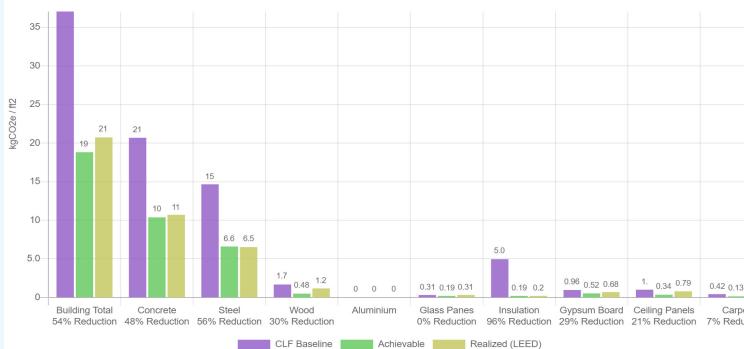
onverted per Unit: 1 yd3

Open ×

#### **Shiley Marcos Case Study**







## **Optimization with Tally**

Data from Tally		Data from EC3 (Tally export)	Differences
Material	Embodied Carbon (kgCO2e)	Embodied Carbon (kgCO2e)	Differences
03 - Concrete	308,405	423,481	(115,077
04 - Masonry	38,833	-	38,833
05 - Metals	89,255	166,034	(76,779
06 - Wood/Plastics/Composites	-160,160	52,618	(212,777
07 - Thermal and Moisture Protection	122,602	10,778	111,825
08 - Openings and Glazing	65,002	130,561	(65,559
09 - Finishes	29,732	41,192	(11,460
Grand Total	493,669	824,664	(330,994

Differences between Tally software and EC3 using the same materials and quantities as a comparison:

- Tally and EC3 calculate their baseline carbon amounts differently
- Existing concrete might have imported into EC3 and treated as new construction
- Tally considers wood products as a carbon sink whereas EC3 does not take this calculation into account
- Certain EPDs not yet available in EC3

# Limitations

- The usefulness of the direct connection to Tally is in question. If there are such large differences in the baseline numbers, does a direct link provide any benefit to to the decision making process?

- Adding material specifications can give a more accurate baseline number of embodied carbon, the downside to this however is if an EPD is not required to list the specification, then the list of possible suppliers becomes incorrectly limited. For example, while EC3 allows the user to enter tensile strength for steel, steel EPDs are not required to specify required to disclose this information. This provides a larger result set that will require additional research to find the best supplier.

EC Total (Ac	ervative)				
EC Total (Ac			EC Intensi	ty (Conservative	)
	M kgCO2e			40.1 kgC02e / ft	2
724	hievable)		EC Inter	nsity (Achievable	)
	4k kgCO2e			18.8 kgC02e / ft	2
EC Total (			EC Int	tensity (Realized	
804	4k kgCO2e			20.9 kgC02e / ft	2
Ac	F Baseline 58% hievable EC Target	<ul> <li>Recommend</li> <li>The finisher -50%, car which can Interface</li> <li>Wood can Stora Ense</li> <li>Ensure that procurem</li> </ul>	ossible supp vith each asso ake informe ocurement of building is a g plant, the a ly lower than project, the ch lower and h other build ations: es section ca pet is a majo be reduced lnc be decrease	oliers and El embly item ed decisions of materials an adaptive mount of co n a regular erefore the e d not as eas dings. an be reduce or driver of t if purchase ed by procu naterial PD, certain	PD data , allowing s as they s. reuse oncrete embodied sy to ed by this, ed from ring from
Baselir	ne C	Conservative Realize	ed Achi		
stics/Composites	64,221	41,648	34,731	18,630	
and Moisture Protection	190,561 91,367	24,128 92,647	7,506 73,447	7,308 38,157	
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	1,706,413	1,234,061	110,392	/1/,230	
1		908,000 452,263 stics/Composites 64,221 nd Moisture Protection 190,561 91,367	Baseline         Conservative         Realize           908,000         908,323         452,263         467,915           stics/Composites         64,221         41,648         91,367         92,647           and Glazing         91,367         92,647         91,367         92,647	908,000         908,323         440,213           452,263         467,915         222,494           stics/Composites         64,221         41,648         34,731           nd Moisture Protection         190,561         24,128         7,506           91,367         92,647         73,447	Baseline         Conservative         Realized         Achievable           908,000         908,323         440,213         444,965           452,263         467,915         222,494         208,169           stics/Composites         64,221         41,648         34,731         18,630           nd Moisture Protection         190,561         24,128         7,506         7,308           91,367         92,647         73,447         38,157

### Conclusions

Because EC3 looks at the materials at a supplier level, it is a tool best used once the majority of design decisions have been made. Opsis benefits from the fact that they included the desire to reduce carbon in their design decisions. This is important because it allowed them to have an implicit range of embodied carbon that was lower than if they had considered carbon at a later point.

The tool will become even more useful as more EPDs are added for more materials. It also puts pressure on manufacturers and suppliers to disclose more information about their products which will make this tool more accurate and inclusive.

While this research is only related to the embodied carbon, there are many factors and decisions that play to the greater issue of carbon. However, embodied carbon is a large category of emissions and it is one that the construction and design industries can control.