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EC3 and Embodied Carbon Reduction

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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.

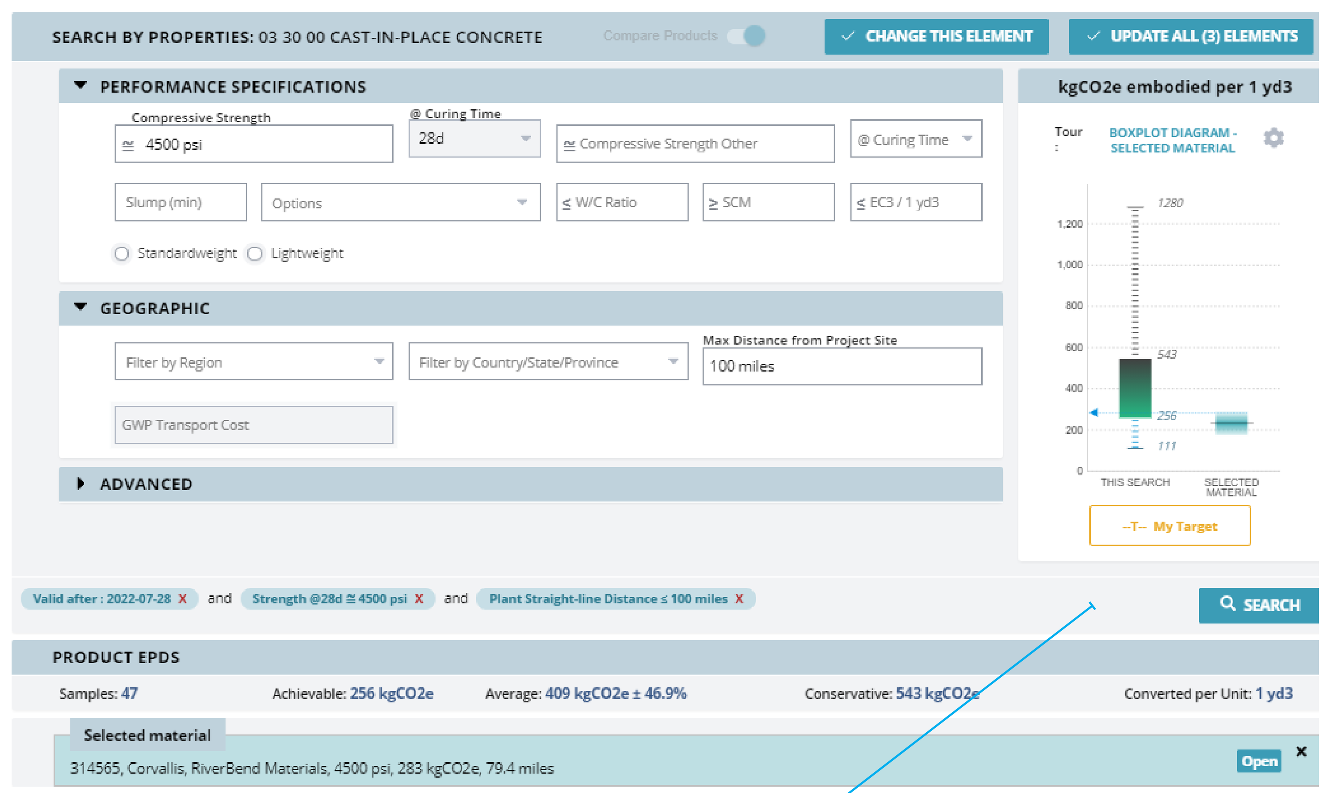
Throughout the research, I worked in two EC3 files related to the two primary aspects of this research:

- 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

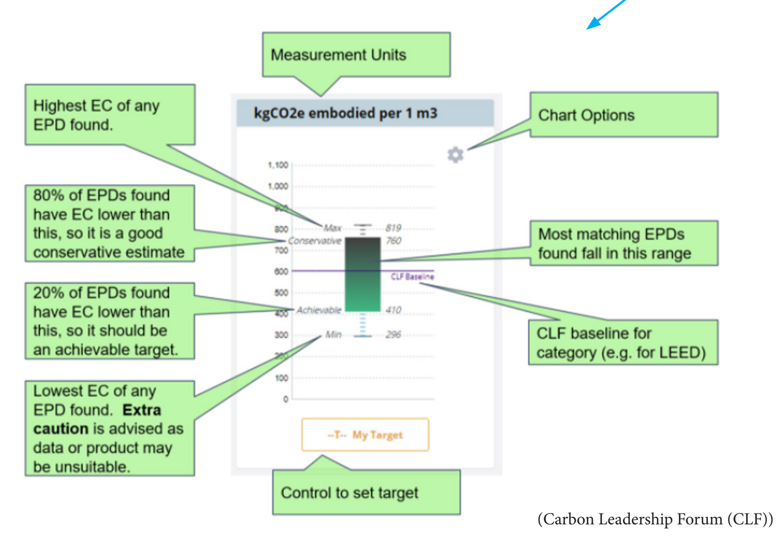
In the file related to the construction estimate, I took the material and quantity data, researched the proper specifications, and added them into EC3. I then selected an EPD for each material unit and used EC3 to create comparisons to baselines. From there we were able to see areas of improvement and 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.

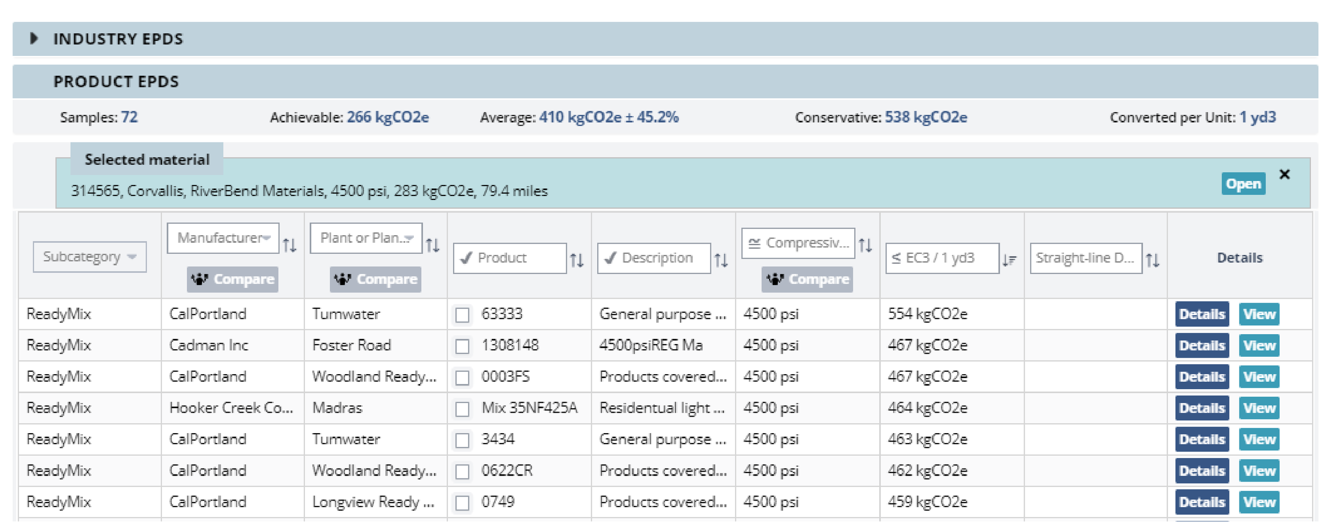
User Interface

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.



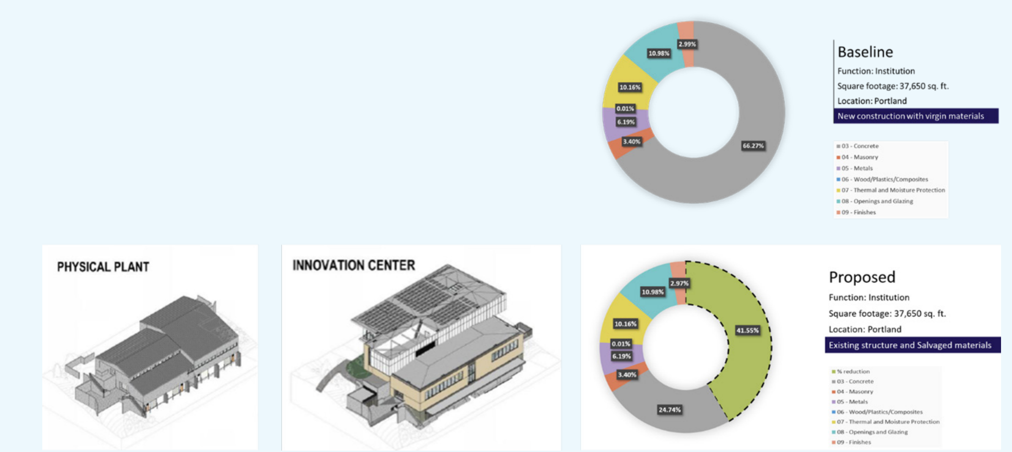
Once an item is added to EC3, the user can select the material and user specifications, the box plot provides additional comparison data to help determine an EPD to choose.



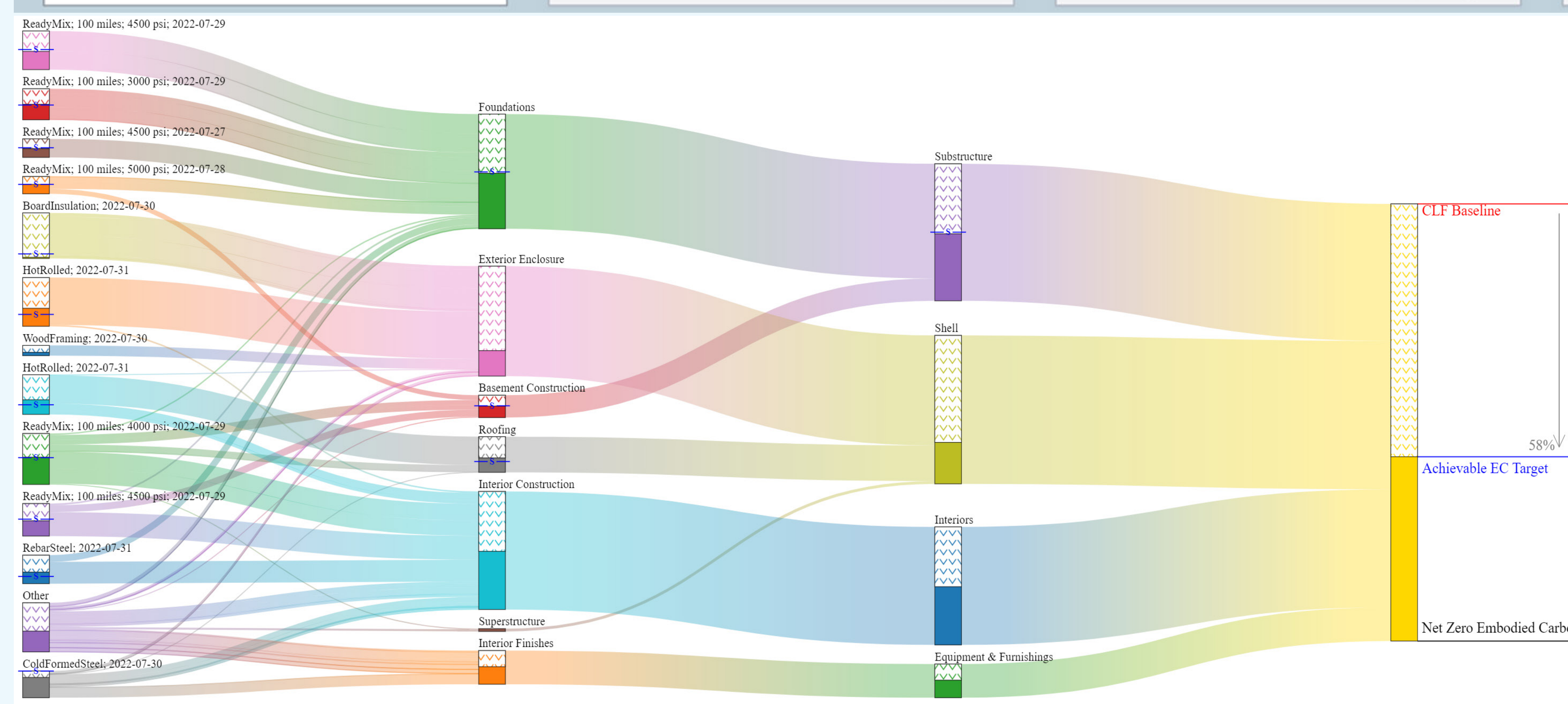


An example of a list of concrete EPDs in EC3 populated with specifications such as strength and distance from site.

Shiley Marcos Case Study



Gross Floor Area	Floors	EC Total (Conservative)	EC Intensity (Conservative)
38,490 ft2	4 Stories	1.54M kgCO2e	40.1 kgCO2e / ft2
Floor Area Above Grade	**Height**	**EC Total (Achievable)**	**EC Intensity (Achievable)**
31,700 ft2	41 ft	724k kgCO2e	18.8 kgCO2e / ft2
Floor Area Below Grade	**Weight**	**EC Total (Realized)**	**EC Intensity (Realized)**
6,790 ft2	7.60M lbs	804k kgCO2e	20.9 kgCO2e / ft2

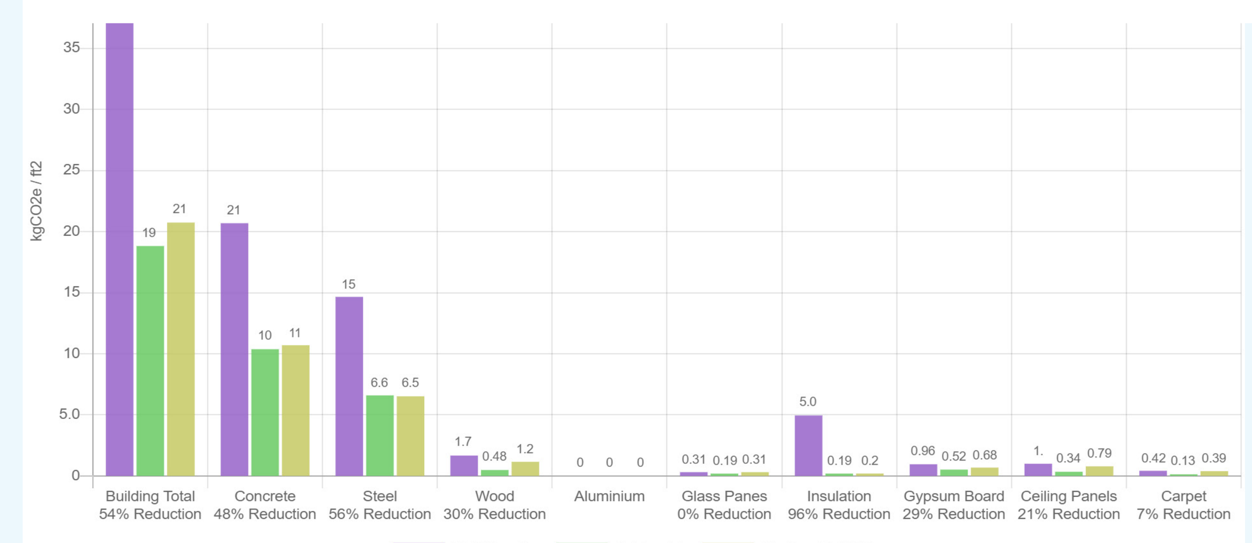


Along with these data visualizations is a large list of possible suppliers and EPD data associated with each assembly item, allowing the firm to make informed decisions as they move into procurement of materials.

Because this building is an adaptive reuse of an existing plant, the amount of concrete is significantly lower than a regular construction project, therefore the embodied carbon is much lower and not as easy to compare with other buildings.

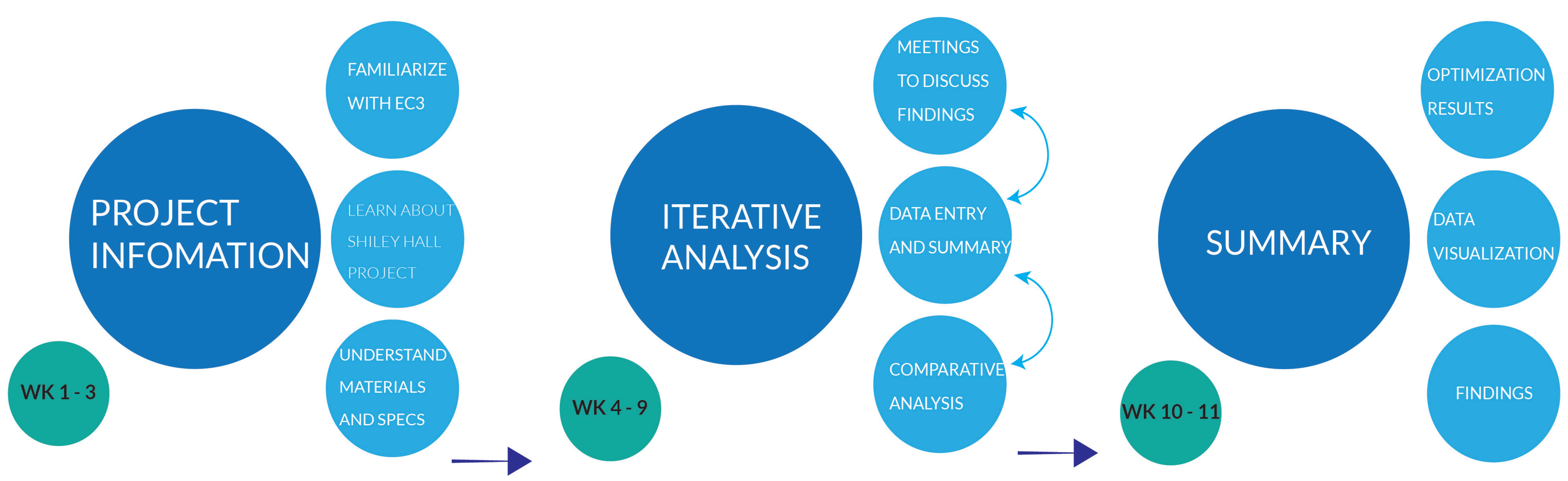
Recommendations:

- The finishes section can be reduced by ~50%, carpet is a major driver of this, which can be reduced if purchased from Interface Inc
- Wood can be decreased by procuring from Stora Enso
- Ensure that selected material procurement has an EPD, certain materials only have a few options in EC3



	Embodied Carbon (kgCO2e) Baseline	Conservative	Realized	Achievable
03 - Concrete	908,000	908,323	440,213	444,965
05 - Metals	452,263	467,915	222,494	208,169
06 - Wood/Plastics/Composites	64,221	41,648	34,731	18,630
07 - Thermal and Moisture Protection	190,561	24,128	7,506	7,308
09 - Finishes	91,367	92,647	73,447	38,157
08 - Openings and Glazing				
Grand Total	**1,706,413**	**1,534,661**	**778,392**	**717,230**

Project Timeline



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

Conclusions

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.

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.