EMBODIED CARBON ASSESSMENT

EmiratesGBC Case Study
My City Centre Masdar

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Under the Patronage of the Royal Danish Consulate General in Dubai

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In recent years the importance of Embodied Carbon has come to the fore. Traditionally, attention was given to Operational Carbon. However, with the advancing of building services efficiency, Embodied Carbon is now having a bigger role to play in the path towards achieving Net Zero aspiration. An important aspect of advancing knowledge in the field of Embodied Carbon is to have a comprehensive database of Embodied Carbon footprint per unit area ($kgCO_2/m^2$) of various built asset typologies, so that these values could be adopted as an approximate benchmark. This will assist designers and constructors to compare and lower the Embodied Carbon footprint of their projects against the benchmark. Currently, there is a gap in the data for Embodied Carbon. Whereas for Operational Carbon, there are various baselines such as ASHRAE that building services professional could refer to.

This case study aims to demonstrate a practical approach for estimating Embodied Carbon of a built asset and to contribute towards the building sector's commitment in the UAE to reduce this crucial part of carbon emissions. It also supports the **EmiratesGBC's Net Zero Centre of Excellence** objectives of advancing the net zero carbon movement in the UAE.

The release of this case study aligns with vision set by World Green Building Council (WorldGBC) to push all new buildings, infrastructure, and renovations to have at least 40% less embodied carbon with significant upfront carbon reduction, and all new buildings to be net zero operational carbon by 2030. The targets also push for new buildings, infrastructure, and renovations to have net zero embodied carbon, and all buildings, including existing buildings, to be net zero operational carbon by 2050.

Read more about the WorldGBC's vision here.

My City Centre Masdar was chosen for this exercise and a total of 13 groups of materials was considered for the final embodied carbon analysis. An overall 14% embodied carbon savings (see Figure 1) is achieved when comparing the embodied carbon emissions of a base case scenario with no carbon reduction measures (i.e. assuming no recycled or low-carbon contents), to the embodied carbon emissions of the as built-scenario with sustainable material procurement (i.e. higher percentages of recycled content).

Figure 1: Embodied Carbon Comparison of Base vs As Built Scenarios

What is Embodied Carbon?

According to the 2020 Global Status Report for Buildings and Construction, buildings are responsible for 38% of global carbon emissions. Carbon emissions are released not only during term operational phase of buildings, **called Operational Carbon**, but also during the very early stages of the construction phase, to account for building materials' manufacturing, transportation, construction, and the buildings' demolition at the end-of-life phases of buildings and infrastructure. These emissions, **commonly referred to as Embodied Carbon**, have largely been overlooked historically, even though they contribute to approximately 10% of all global carbon emissions. While the focus has been on the reduction of Operational Carbon, the past few years have seen the topic of Embodied Carbon grow in importance (see Figure 2).

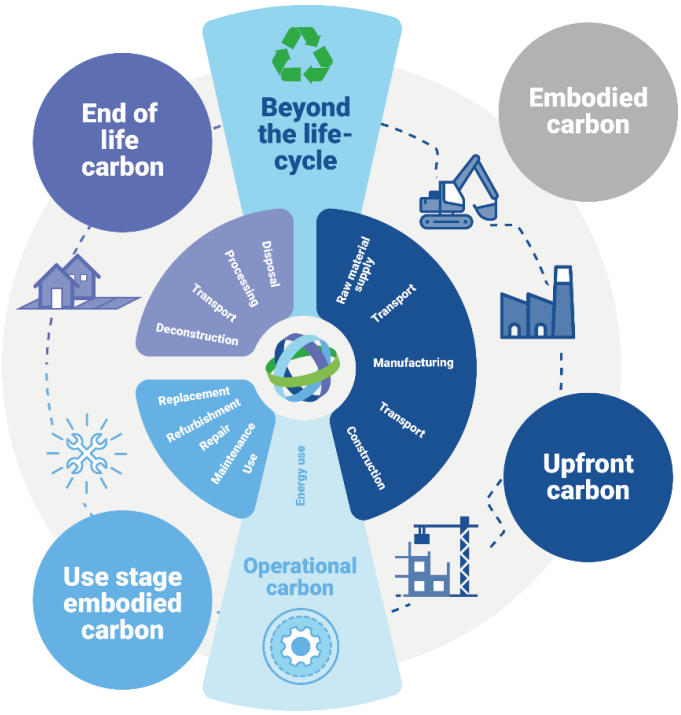

Figure 2: Project lifecycle showing both the scope of the definition and need for whole life carbon consideration. (Courtesy of WorldGBC).

Project Description

As a joint project and under the patronage of the Royal Danish Consulate General Dubai (The Trade Council), Ramboll and The Trade Council carried out a carbon assessment for Majid Al Futtaim's My City Centre Masdar development following ISO 14040:2006 methodology, stages A1-A4. The assessment in this project is aimed to evaluate the impact of sustainable material procurement as compared to business-as-usual material procurement on the embodied carbon emissions of the asset.

My City Centre Masdar is Majid Al Futtaim's first shopping mall in Abu Dhabi, and it is their 25th in the region. This flagship mixed-used development has several sustainability features such as sustainably sourced wood, as well as a range of locally grown produce and a commitment to reducing single-use plastic bag usage. The roof of mall's 600 car parking bays is covered by photovoltaic cells, generating electricity equivalent to one-fifth of the mall's annual energy usage. All the materials used during construction were manufactured within 500 km travelling distance of the project site. These sustainability features helped in achieving Three Pearl rating under Abu Dhabi's Estidama, which can be considered on the same level to the LEED Gold rating for exceptional performance in energy and water conservation. My City Centre Masdar is one of Majid Al Futtaim's exemplary developments that supports in reaching their Net Positive commitments by 2040.

Methodology and Carbon Assessment

A Carbon Accounting Calculator was developed for the purposes of tracking the overall carbon emissions associated with the development. The calculator defined the following parameters:

- Carbon Emission ($kgCO_2e/t$)
- Quantity (tonne)
- Transportation Mode (sea/air/road) & Distance (km)
- Transportation Carbon Emission per tonne ($kgCO_2e/tonne.km$)

Life Cycle Assessment (LCA) was used to compile and examine the inputs and outputs of the materials and the associated environmental impacts directly attributable to the materials and the building (see Figure 3).

Following the life cycle stages, as shown in **Error! Reference source not found.**, the case study focused on the modules A1 to A4 (and D for Timber) to report savings over a base-case scenario.

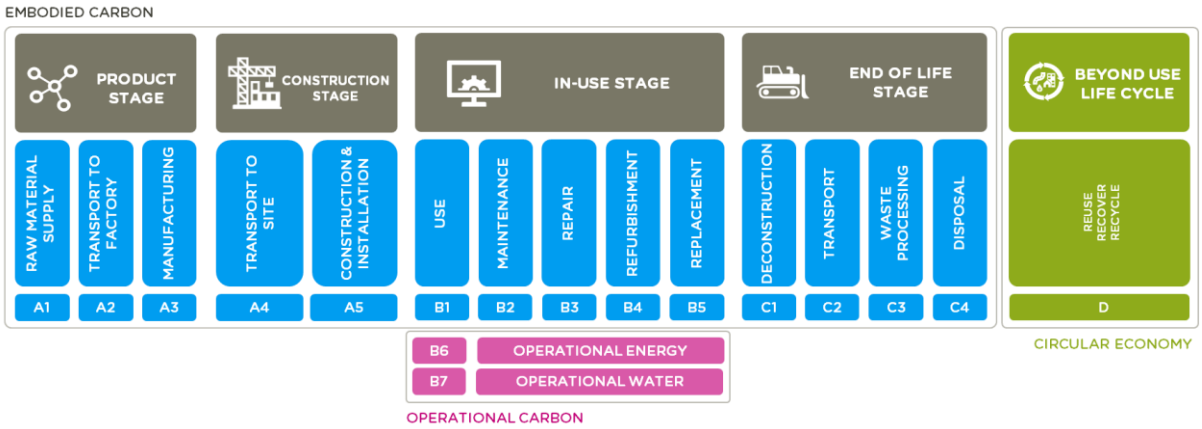

Figure 3: Lifecycle stages or modules of a building

To establish a base-case scenario, it was assumed for the major materials such as concrete and steel to have no recycled content. Additionally, for the base-case, timber was assumed to not be procured through FSC (Forest Stewardship Council) or PEFC (Programme for the Endorsement of Forest Certification) schemes.

For the rest of the materials such as tiles, carpets, insulation etc, no savings were considered between base case and as-built scenario.

Results

The groups of materials that were considered to represent the embodied carbon of the asset are shown in Figure 4. The group 'Other Materials' included elements not considered as part of the structure, such as HVAC systems, which contribute to the embodied carbon footprint of the building through its production and transportation. 'Other Materials' was set to account for 20% of the overall buildings embodied carbon.

Figure 4: Materials considered in embodied carbon assessment

The building skeleton, which is the super structure of the building, comprises of timber, concrete, and steel (structural and rebar), was analysed as it contributes to the larger proportion of the embodied carbon emissions. The other materials were shown to have no savings. 21% reduction from the major components was achieved (see Table 1). The embodied carbon per unit area is shown in Figure 5.

Materials	Base Scenario (tCO_2e)	As Built Scenario (tCO_2e)	Savings (tCO_2e)	% Savings
Concrete	8,702	5,783	2,919	20.31%
Structural Steel	509	496	142	0.99%
Rebar	5,159	5,030		
Timber	0.477	-0.999	1.5	0.01%
TOTAL			**3,062**	**21.31%**

Table 1 Materials and Embodied Carbon Savings

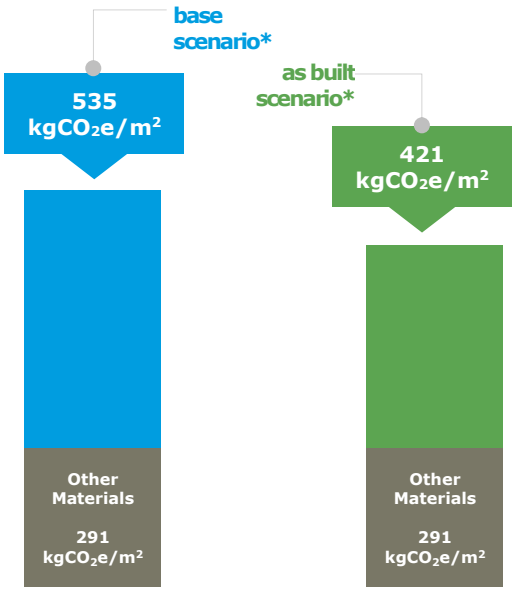

Figure 5: Embodied carbon per square meter figures comparing Base scenario vs As Built Scenario

Conclusion

This case study shows that it is possible to achieve tangible reduction in the embodied carbon emissions associated with our current building construction practices. It is crucial to establish this as a requirement at the earliest stages of the project to ensure appropriate tracking of the targeted emissions reductions through a Carbon Management Process (as shown in Figure 6). It is important to integrate carbon management processes into the built environment to be able to deliver the expected outcomes. It allows for clients to make informed decisions and help in maximising the carbon reductions.

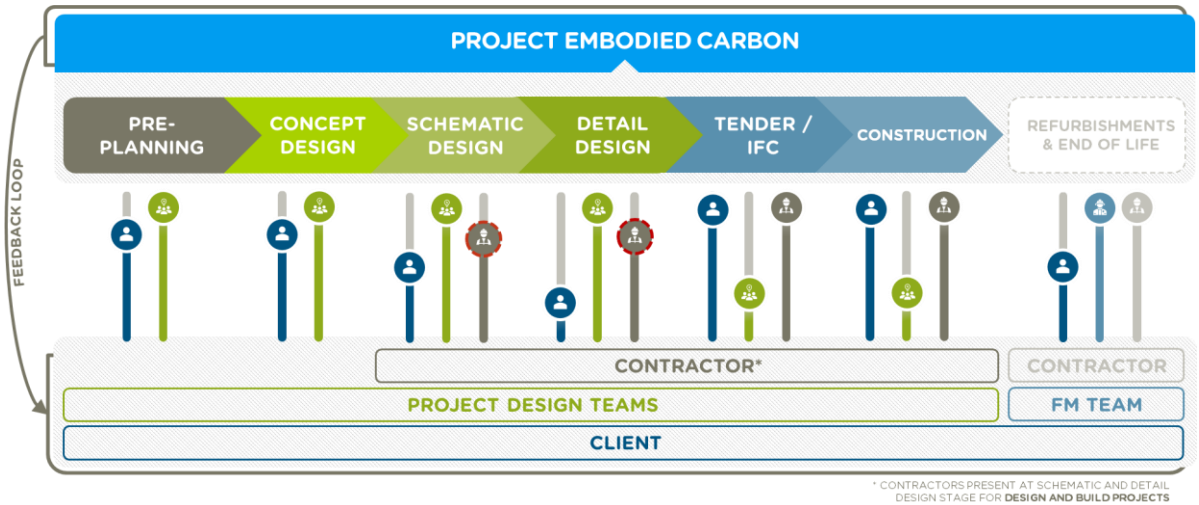

Figure 6: Carbon Management Process

It should be noted that the savings of embodied carbon emissions reported in this case study are based on approximate carbon emission factors and may not completely reflect the actual embodied carbon of the different scenarios being considered.

However, through comparisons between the base case and 'as built' scenarios, the potential savings are assessed accordingly as indicated. The findings of this study help support the work needed to achieve net zero embodied carbon for buildings, infrastructure, and renovations, which is part of the WGBC's global vision to reach net zero by 2050. The aim is to encourage all the stakeholders in the industry to support building a comprehensive database of embodied carbon of various typologies to assist with benchmarking and moving towards carbon reduction targets. Early planning for embodied carbon management will result in bigger carbon savings (see Figure 7), and therefore moving closer to achieving Net Zero goals.

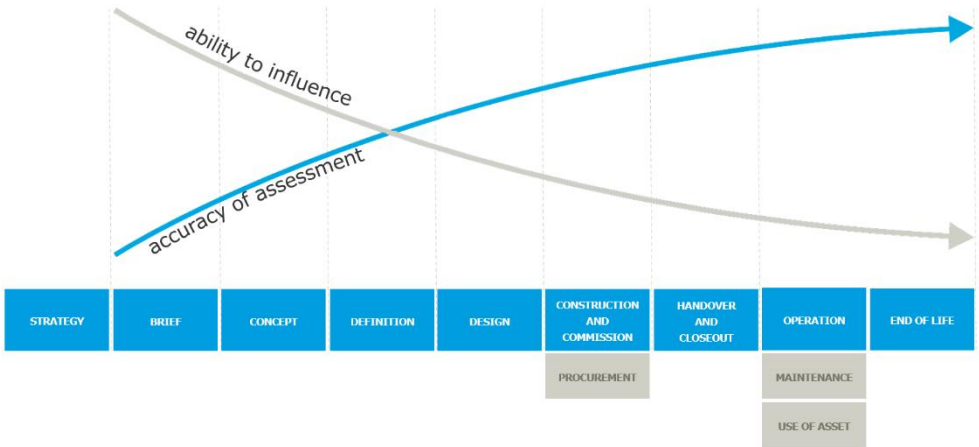

Figure 7: The ability to make an influence during a project workflow