The Building System Carbon Framework

A common language for the building and construction value chain

Contents

The objective of this paper

This paper proposes a new framework which can be used as a common language for carbon emissions, by all actors of the built environment.

The Building System Carbon Framework is targeted at companies involved in manufacturing, designing, constructing, investing, owning, operating, occupying, renovating and demolishing buildings. It helps to align actions across the value chain in order to deliver a net-zero built environment.

The framework enables each user to identify the best emissions-reduction strategies for their part of the value chain, using a common metric and a full life-cycle approach. It is neutral on materials and solutions.

This approach bridges embodied and operational carbon, which is a vital prerequisite for the decarbonization of the built environment.

The building and construction system

A shared vision

To meet the Paris Agreement objectives and limit global warming to 1.5°C or less, it is essential to decarbonize our economy completely by 2050.

For the built environment, this means reaching net zero emissions across all activities in the building and construction system. However, the built environment is currently responsible for almost 40% of the global energy and process-related CO_2 emissions,[1] and so the challenge is significant.

The goal is for all new buildings to operate at net-zero emissions by 2030 at the latest, and for all buildings to operate at net-zero by 2050. Embodied carbon in building materials and equipment needs to be reduced by at least 40% from today's levels by 2030 and to net-zero by 2050.[2] This can be achieved by developing and implementing specific roadmaps for the entire building and construction system.

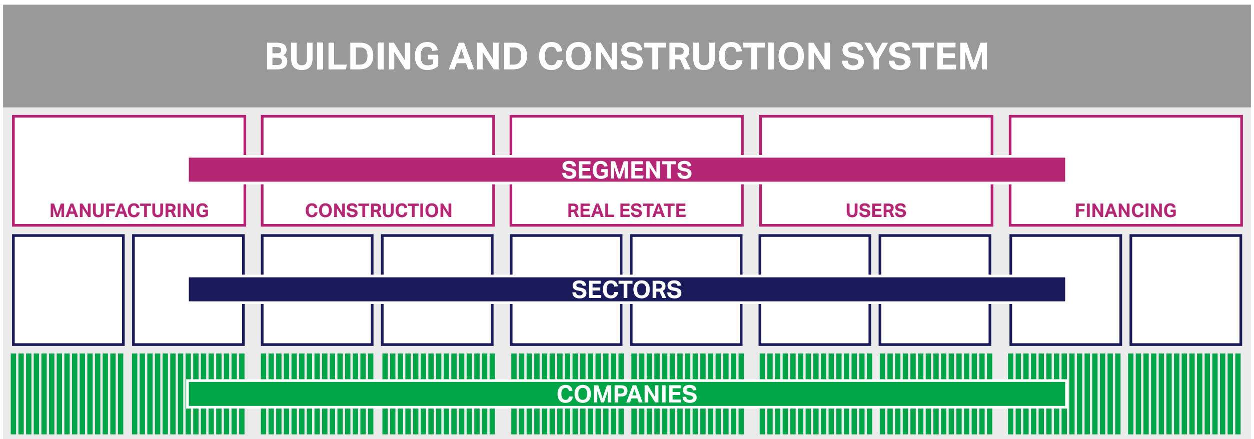
In order to achieve the goal, alignment and collaboration between all companies of the building and construction system is crucial as no-one can do it alone.

Defining the system

The building and construction system is a diverse, fragmented yet interconnected value chain made up of different segments such as manufacturing, construction, real estate, users, and financing all coming together to achieve the primary purpose of delivering buildings.

In this document, we refer to building and construction as a system, including and connecting all the actors and sectors. This system consists of different subgroups where companies are categorized according to the different levels: Company, Sector, Segment, System (Figure 1).

Figure 1: the categories of the building and construction system



Companies are the individual entities providing services to buildings based on their specific line of business.

Sectors represent the traditional way of grouping companies from the same business sector. For example material sectors (i.e., concrete, steel, glass) or professional categories (i.e., engineers, architects, investors, property developers).

Segments group different sectors of the value chain together, based on their specific role and characteristic. Sectors within the same segment have relatively similar functions and objectives.

- **Manufacturing** provides the elements of the buildings. It includes building materials, construction elements and equipment.
- **Construction** is responsible for creating the buildings. It includes architecture, engineering and construction companies.
- **Real Estate** has a transactional or ownership relationship to the buildings. It includes property developers, asset owners, facility managers and brokers.
- **Users** are the occupiers of the buildings. It includes final users of buildings (i.e., hotel, retail).
- **Finance** mobilizes financial capital for the buildings. It includes investors, financial institutions and insurance companies.

System represents the highest level, which accounts for all the stakeholders, companies, sectors and segments that play a role in building and construction.

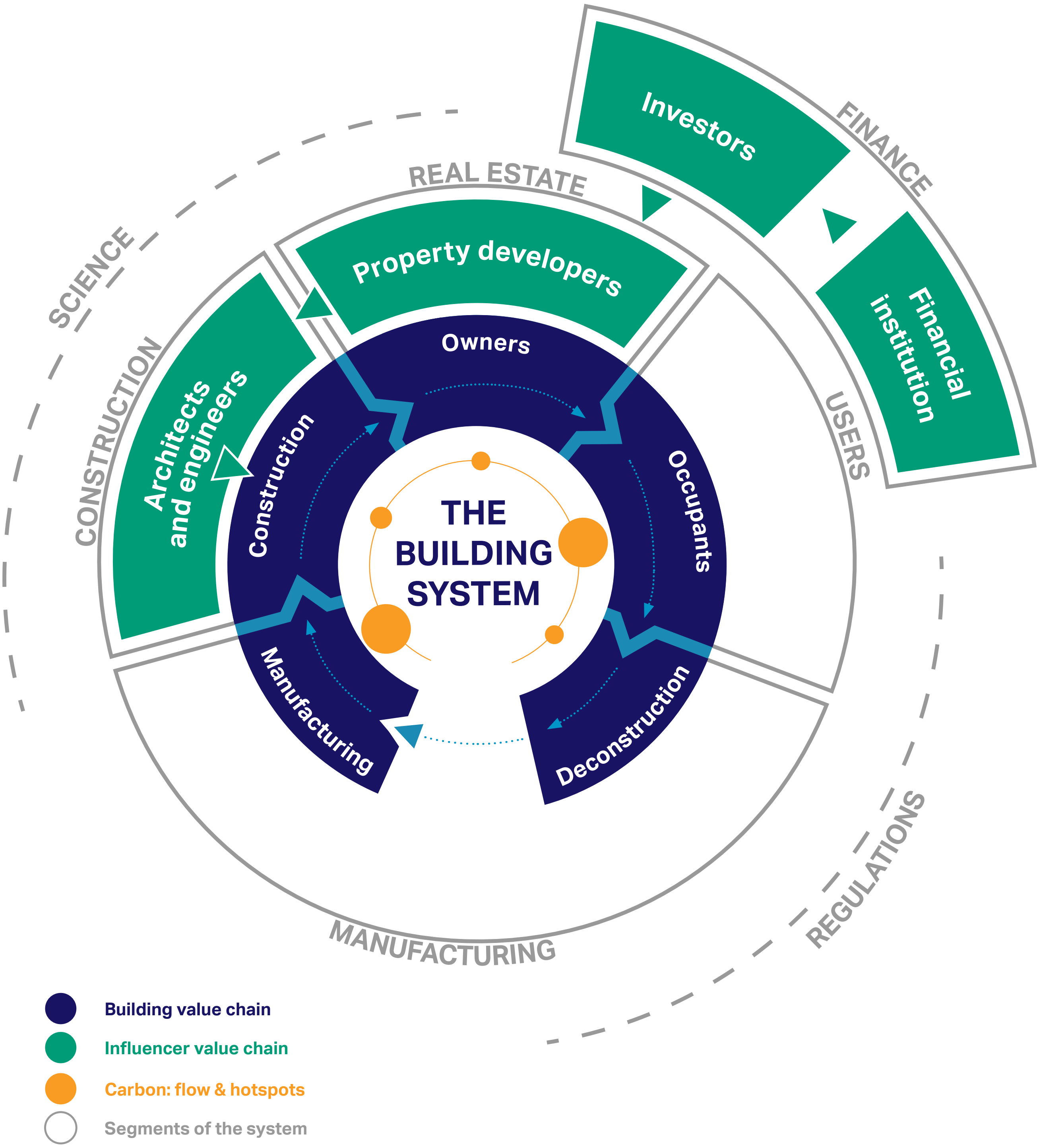
The value chain

Because of the interdependencies within the system, there is not a unique way to represent the building and construction system in its entirety.

The model shown in Figure 2 represents our view of the structure and connections between the different private sector actors of the system.

In this model, stakeholders are part of two connected and converging flows: the ***building value chain*** and the ***influencer value chain.***

Figure 2: The value chains of the building and construction system



The building value chain includes private sector actors required to physically construct and operate a building asset. Companies in this value chain are directly responsible for some part of the life cycle of carbon emissions in buildings. There are two "hotspots" being the manufacturing of materials & equipment (embodied carbon) and the energy consumption by occupants during the use phase (operational carbon).

Carbon emissions released by companies in this value chain are usually accounted for as part of building-related carbon emissions. Based on the Greenhouse Gas Protocol (GHG Protocol)[3] these emissions are reported under the direct company emissions (Scope 1) or indirect emissions (Scope 2) from the process of generating the electricity consumed.

It should be noted that Scope 1 and 2 of a company, for the GHG protocol, are reported as indirect upstream or downstream value chain emissions (Scope 3) of another company. Therefore the emissions of other parts of the building are part of the responsibility and reporting of another company.

To reduce these indirect emissions, it is essential for companies within this value chain to engage and collaborate. That way, they can collectively mitigate the carbon emissions of the whole building system and individually achieve their own carbon reduction targets.

The influencer value chain includes the actors who are responsible for influencing if and how buildings are constructed, but who do not have an active role in building the asset.

Their direct carbon emissions are generally limited, in comparison to the overall system emissions, and not necessarily due to their business but possibly for the their role of "occupants" of buildings.

Nevertheless, the influencer value chain plays a crucial role in the very early stages of buildings, and their decisions have a significant impact on the future emissions of buildings.

The low levels of carbon emissions reported throughout this value chain might result in an underestimation of the importance and power of the companies to drive system decarbonization.

The Building System Carbon Framework

The Building System Carbon Framework (Figure 3) is a conceptual assessment tool developed by WBCSD to provide a simple template and a common language to represent carbon emissions in the building and construction system.

The objective is to encourage stakeholders to have a transparent understanding of where and when carbon emissions are generated. It also encourages all actors to focus on the overall life-cycle emissions of buildings, which is the best indicator of the gap remaining for reaching net-zero emissions at building level and therefore the long term net-zero built environment by 2050 at the latest.

Figure 3: The Building System Carbon Framework

		BUILDING STAGES						
		PRODUCT	CONSTRUCTION	USE		END OF LIFE	EMISSIONS	BEYOND LIFE
		A1-A3	A4-A5	B1-B5	B6-B7	C	$kgCO_2/m^2$	D
BUILDING LAYERS	**Structure** Foundation, load-bearing							
	Skin Windows, roof, insulations							
	Space Plan Interior finishes							
	Services Mechanical, electrical, plumbing							
	Stuff *(optional)* Furniture & appliances							
	Building carbon emissions							
	Carbon compensation Removals and offset							

Embodied carbon · Operational carbon · Partial and total sums

This framework unpacks the building and construction system according to the different life-cycle stages of buildings and the building's layers or components. It uses a transparent and straightforward format to present the information.

The framework is based on the building life-cycle standards defined by the building standards EN15978:2011[4] and supported by the environmental product declaration (EPD) standards EN15804[5] modules. It is inspired by the concept of "Whole Life Carbon Assessment"[6] and the initial framework presented by WBCSD.[7]

The Building System Carbon Framework is designed to be a user-friendly reporting tool that provides a clear overview of the carbon emissions in the building and construction system across both the embodied and operational carbon emissions.

The framework relies on specific data such as EPD, building life-cycle assessments and modeling tools which increase the details and accuracy of the information.

The framework provides a clear overview that combines and summarizes data from various sources.

By simplifying the reporting structure, it enables reflections and opportunities for dialogue between stakeholders and allows them to identify the best emissions-reduction strategies for all parts of the value chain.

It is deliberately not prescriptive in its form and structure, so that it can be adapted to local characteristics, needs and definitions.

The common language of carbon intensity over the total floor area and across the whole life-cycle of buildings, enables allignment and collaboration among all companies when referring to the carbon emissions across the system.

The unit **$kgCO_{2\text{-eq}}/m^2$** is applicable by all the companies across the life-cycle of buildings, elevating and merging the discussion between embodied and operational carbon emissions. It allows attention to be focused on the main objective of achieving an overall net-zero carbon building.

The framework could be applied in different dimensions – for example, at the geographic level (from individual buildings, to neighborhoods, cities or countries) when looking at it for one or more buildings; as well as at business level (companies, sectors and system) when looking at the roles and responsibilities of different industries in the life-cycle of buildings.

The structure

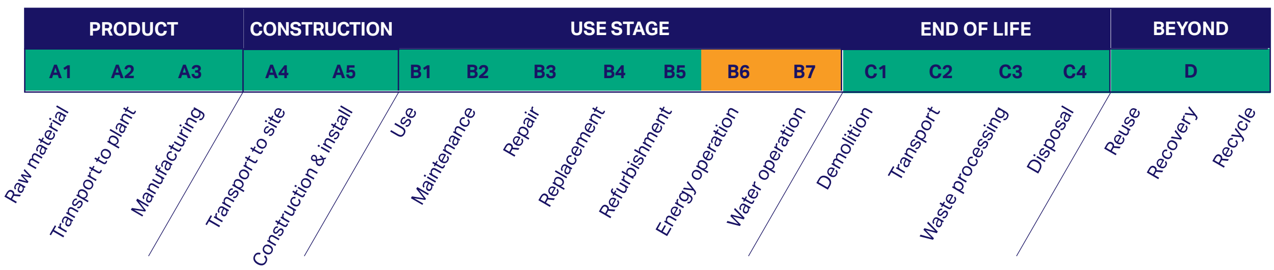
The building stages set out horizontally refer to the life-cycle of buildings and meet the building standard of EN15978:2011 (Figure 4). The standards categorize the life-cycle of buildings according to its main phases:

A. building materials (A1-A3) and construction of buildings (A4-5);
B. use phase of buildings, separating the renovation of buildings (B1-5) from energy (B6) and water (B7) operation of buildings;
C. end of life of buildings, the demolition of buildings (C);
D. the benefits and loads beyond the building life-cycle (D).

Remarkably, with the exception of the operational carbon emissions indicated in the modules B6 and B7, all the other modules refer to embodied carbon emissions of buildings, either during the construction phase, the use phase (renovation) or end-of-life phase (demolition).

Note that module D is considered to be outside the individual building boundaries.

Figure 4: **EN15978:2011 buildings standards refering to the different building stages of the life-cycle of buildings**



For a detailed description of what is included in each module, we refer to the RICS Whole Life Carbon Assessment report.

The **building layers** set out vertically categorize buildings according to their main structure (based on the sharing layers concept).[8]

The purpose is to divide the buildings into the relevant building layers, as each layer generally serves a different purpose, has a different lifetime and life-cycle.

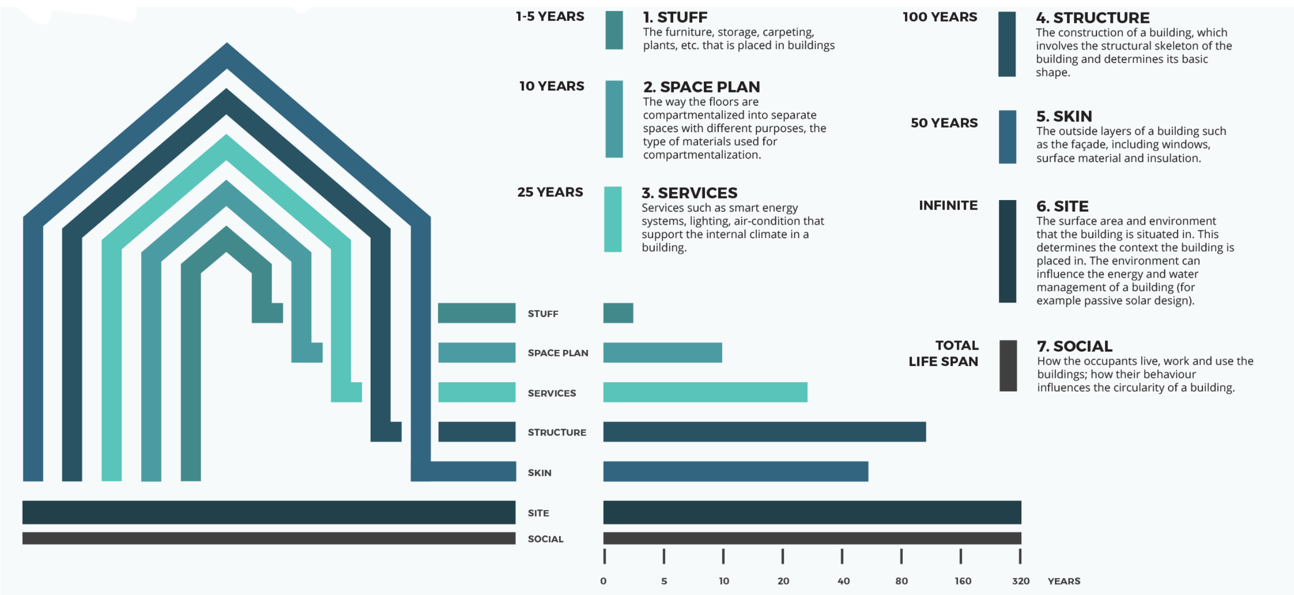
- The **structure** has most, if not all, its impact during the product and construction phase (A).
- Both the **skin** and **space plan** have an impact during the product and construction phase (A). Additionally, they generally need to be upgraded or replaced during the lifetime of buildings, generating additional emissions during the use phase (B). At the same time, they influence the equipment and services installed in buildings (service layer).
- **Services (and stuff)** have emissions during product phase (A), similar to upgrades or replacements during the use phase (B). Importantly, these are the components directly responsible for energy consumption during the use phase (B6).

Although separated in different lines or columns, all layers and stages have a strong link to each other.

Operational emissions: it is important to note the example of how the structure and, in particular, the skin of buildings, play a crucial role in the type and the operation of the services in the buildings, which in turn influence the final energy consumption during the use phase of buildings.

In the box of energy consumption in the operation of buildings (B6) for the service layers, in addition to the carbon emissions, it is recommended to share information on the annual energy consumption. This is to retain information about the overall expected energy consumption across the life of the building and demonstrate the success of energy efficiency measures.

Figure 5: Building model consisting of the building related layers based on the sharing layers[9]



Carbon compensation: the framework provides a separate line for reporting carbon compensations. This is to transparently report and inform on the use of any carbon removal or offset as a measure to compensate for the carbon emissions. Various initiatives promoting decarbonization may have a different measures for understanding which carbon compensation measures should be considered as part of the goal to achieve net-zero. This separation enables users to distinguish between direct mitigation opportunities, which are the priority for decarbonization, and compensation measures that provide an additional opportunity to reduce global emissions.

Beyond building life-cycle: the framework provides a separate column (module D) for reporting the possible benefits and loads beyond the building life-cycle. In a similar way to the carbon compensation above, its use and application in a life-cycle approach have not reached full consensus. For this reason, the consideration and accounting of this information in overall system decarbonization is still evolving, so it can vary based on different initiatives promoting decarbonization or the circular economy.

Timeframe: there are several important time-bound aspects that have to be considered when providing input into the framework as they can have an impact on the final emission count. These include the assumed lifetime of buildings, the replacement rate of non-structural elements and the expected decarbonization of the electricity grid. We advise using local guidance or best practices. For example, the RICS guidance for the UK indicates the lifetime of each building layer and the overall buildings to 60 years.

Benchmarking: if the purpose of using the framework is to compare the carbon emissions between various buildings, additional factors that can influence results need to be considered. Some examples of these are the typology and use of buildings (residential, commercial, office), the geographic location (climate and seismic regulations) and the carbon emission factor of the electricity grid. These can influence the final value. The framework can be used as a carbon lens through which we can look at buildings in general. Carbon emissions are part of the many decision-making factors which are taken into consideration when buildings are developed.

There are also other factors which companies eventually consider when developing buildings. These include:

- environmental aspects (such as material and water efficiency, biodiversity, waste);
- social aspects (job creation, local content, inclusivity, productivity, health and safety);
- economic priorities (costs, local economic development); and
- strategic decisions (dependence on other countries).

Application in the system

The framework allows stakeholders in the building and construction system to make informed decisions based on clear and transparent information.

There are many opportunities for practical application of this framework at geographic-level (building, neighborhood, cities, or countries) as well as business-level (companies, sectors, system).

Below is a list of potential application areas for the framework, some of which will be explored further in order to accelerate the decarbonization of the built environment:

- **Common language** across the system provided by the $kgCO_{2\text{-eq}}/m^2$ metric ensures all stakeholders of the value chain can reference the impact and benefit of their product or service towards overall carbon emissions.
- **Scenarios**, pathways, and relevant carbon budgets can be established by referring to the common language and the framework. It also offers the opportunity to align efforts by companies, initiatives and organizations that are focused on achieving the vision for a net-zero carbon built environment by 2050.
- **Business** can visualize their company, product or service direct emissions (Scope 1 and 2) and how and where they are connected with indirect value chain emissions (Scope 3). It permits users to understand how these are part of overall system emissions and therefore understand where and how they can contribute to reducing the system emissions and collaborate to achieve a net-zero system
- **Commitments** from business can be referenced to the framework to highlight companies' expected mitigation efforts, as well as the contribution toward the whole system to achieve a net-zero built environment.
- **Implementation** (or action) from the private sector can target the main hotspots, taking into consideration the contribution to system decarbonization. The framework will also allow for collaboration across the value chain, where common solutions can be developed and implemented to help achieve system decarbonization.
- **Investments** from the financial sector benefit from simple, meaningful and reliable indicators. The framework enables investors to prompt simple but more specific life-cycle carbon questions on buildings' carbon emissions and assess the climate performance of their assets, and therefore make better informed decisions. At the same time, investors can also assess investments in innovative technologies based on the benefits these can bring to the vision of a net-zero built environment.
- **Regulations,** building codes and standards at the local and national levels can be framed and aligned to achieve life-cycle net zero-carbon emissions; while at the same time enabling innovation and transformation within the various sectors via a material- and technology-neutral approach and without being prescriptive.
- **Public procurement** project owners can use the unified carbon metric to evaluate project proposals. In public tenders, they can incentivize low carbon life-cycle performance, for example by making references to or applying a shadow cost on life-cycle carbon emissions.
- **Renovation** decisions can be informed by comparing the options of different interventions with the current status and new construction.
- **Circular economy** benefits for decarbonization can be quantified by assessing the implication of circular products and business models over the life-cycle of buildings. The opportunity is to enhance the understanding and application of module D of the framework.
- **Additional factors** beyond carbon are also important for making informed decisions. For this reason, it could be interesting to test the life-cycle thinking principle and approach at the base of this framework with other factors, in particular water, biodiversity, jobs and costs.

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ABOUT THE TRANSFORMING THE BUILT ENVIRONMENT PROJECT

WBCSD brings together leading companies in the built environment to help them collaborate and develop pathways towards a fully decarbonized and circular built environment. It helps companies address the transition through a common vision and common language, helping them develop and share knowledge, guidance and tools. The project also helps strengthening the business case for action by engaging the demand side and through advocacy with cities and national governments to advance the enabling environment for sustainable solutions.

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ABOUT WBCSD

WBCSD is a global, CEO-led organization of over 200 leading businesses working together to accelerate the transition to a sustainable world. We help make our member companies more successful and sustainable by focusing on the maximum positive impact for shareholders, the environment and societies.

Our member companies come from all business sectors and all major economies, representing a combined revenue of more than USD $8.5 trillion and 19 million employees. Our global network of almost 70 national business councils gives our members unparalleled reach across the globe. Since 1995, WBCSD has been uniquely positioned to work with member companies along and across value chains to deliver impactful business solutions to the most challenging sustainability issues.

Together, we are the leading voice of business for sustainability: united by our vision of a world where more than 9 billion people are all living well and within the boundaries of our planet, by 2050.

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