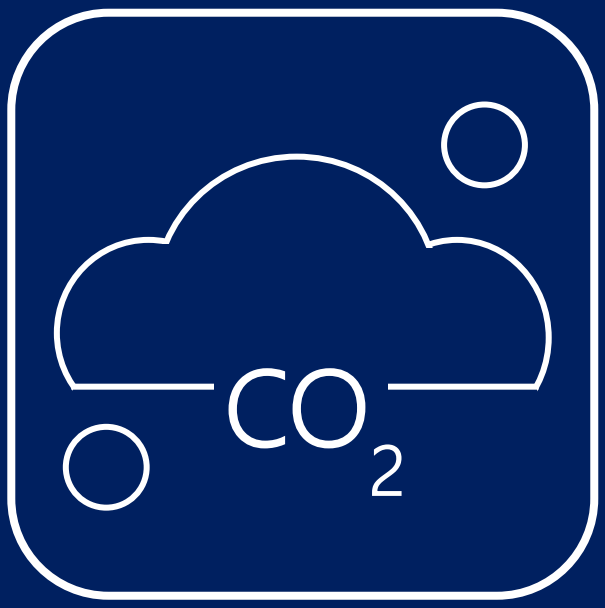

Green Mark 2021

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TECHNICAL GUIDE

Revision Log

Revision	Description	Effective Date
R1.1	1st Version	1/11/2021
R1.2	• Update Innovation section Guidance Notes to include recognition on use of low carbon technologies and solutions as part of sustainable construction practices (e.g. use of low carbon construction site generators) • Minor edit to CN2.2 (ii) Mechanical, Electrical and Plumbing (MEP) systems worked example	1/04/2022
R1.3	• Update the use of Embodied Carbon Calculator (ECC) at the SGBC website to replace the BCA carbon calculator	19/05/2022

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CN 1 Carbon

A maximum of 5 points can be scored across CN 1 Carbon section

CN 1.1 Whole Life Carbon (WLC) Assessment

To help address the climate crisis, reduction in carbon emissions is crucial. The carbon section looks to guide project team's on accounting for the carbon in their projects and promote the reduction in carbon over the lifetime of an asset

CN 1.1 Whole Life Carbon Assessment	New Buildings	Existing Buildings
(i) Whole life carbon assessment (Minimum scope)	3 Points	N.A
(ii) Embodied Carbon		
a. Embodied Carbon Calculation	0.5 Point	1 Point
b. > 10% Reduction from the reference embodied carbon (for Concrete, Glass and Steel)	1 Point	1 Point
	OR	OR
c. > 30% Reduction from the reference embodied carbon (for Concrete, Glass and Steel)	2 Points	2 Points

(i) Whole Life Carbon Assessment

Whole Life Carbon (WLC) emissions encompass carbon emissions resulting from sourcing through construction and the use of a building over its entire life, including its demolition and disposal (cradle to grave). They capture a building's operational carbon emissions from energy use and its embodied carbon emissions, that is, those associated with raw material extraction, manufacture and transport of building materials, construction and the emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal.

A WLC assessment also includes an assessment of the potential carbon emissions 'benefits' from the reuse or recycling of components after the end of a building's useful life. As the benefits of reuse and recycling are relatively unpredictable, they are to be reported separately. Notwithstanding, gauging these potential benefits is important as it gives a carbon value to the future circular economic potential of a design and depicts a true picture of a building's carbon impact on the environment.

Assessment Criteria

Applicable to all new buildings (Non Residential and Residential) and Existing Buildings with Addition and Alteration (A&A) works involving additional gross floor area (GFA) with new construction, addition of floors with independent substructures.

The assessment should cover the development's carbon emissions over its lifetime, accounting for:

- its operational carbon emissions
- its embodied carbon emissions
- any future potential carbon emissions 'benefits', post 'end of life', including benefits from reuse and recycling of building structure and materials.

Documentation Requirements

Submission of the following where applicable:

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Provide project specific background information using WLC Assessment Template
- Provide documentation on Bill of Quantities (BoQ), or as identified in other design information e.g. drawings, tender specifications, BIM model, architectural/ structural plan layouts, elevations, etc. to account for the building elements within the building element groups specified in Table 2 and extent of coverage for WLC assessment
- Provide Software tool details (assumptions, boundary conditions, etc.) for computing WLC assessment
- Provide the WLC assessment results (minimum scope/ full scope) using WLC Assessment Template

At Verification stage (New Buildings & Existing Buildings):

- Provide as built project specific background information using WLC Assessment Template
- Provide as-buit documentation on Bill of Quantities (BoQ), or as identified in other design information e.g. drawings, tender specifications, BIM model, architectural/ structural plan layouts, elevations, etc. to account for the building elements within the building element groups specified in Table 2 and extent of coverage for WLC assessment
- Provide Software tool details (assumptions, boundary conditions, etc.) for computing as-built WLC assessment
- Provide as-buit WLC assessment results (minimum scope/ full scope) using WLC Assessment Template

Guidance Notes

Methodology

Whole Life carbon (WLC) assessment guidance is consistent with *BS EN 15978* and *BS EN 15804* and to be read in conjunction with *RICS Professional Statement (PS): Whole Life Carbon assessment for the built environment*, with adaptation to the local context.

WLC assessment adopts the framework for appraising the environmental impacts of the built environment provided by BS EN 15978: 2011: (Sustainability of construction works — Assessment of environmental performance of buildings — Calculation method). It sets out the principles and calculation method for whole life assessment of the environmental impacts from built projects based on life-cycle assessment. The RICS PS serves as a guide to the practical implementation of the BS EN 15978 principles, which sets out technical details and calculation requirements, with adaptation to the local context in this document.

Life Cycle assessment (LCA)

LCA is fundamental to a WLC assessment. It is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy, and the associated environmental impacts directly attributable to the functioning of a building throughout its life cycle as per ISO 14040: 2006. A LCA helps the architect understand, at design stage, the lifetime consequences of their design decisions. This promotes durability, resource efficiency, reuse and future adaptability, all of which contribute to lifetime carbon reductions. Therefore, all life cycle stages defined by BS EN 15978 should ideally be included in WLC assessment. (refer to Figure 1)

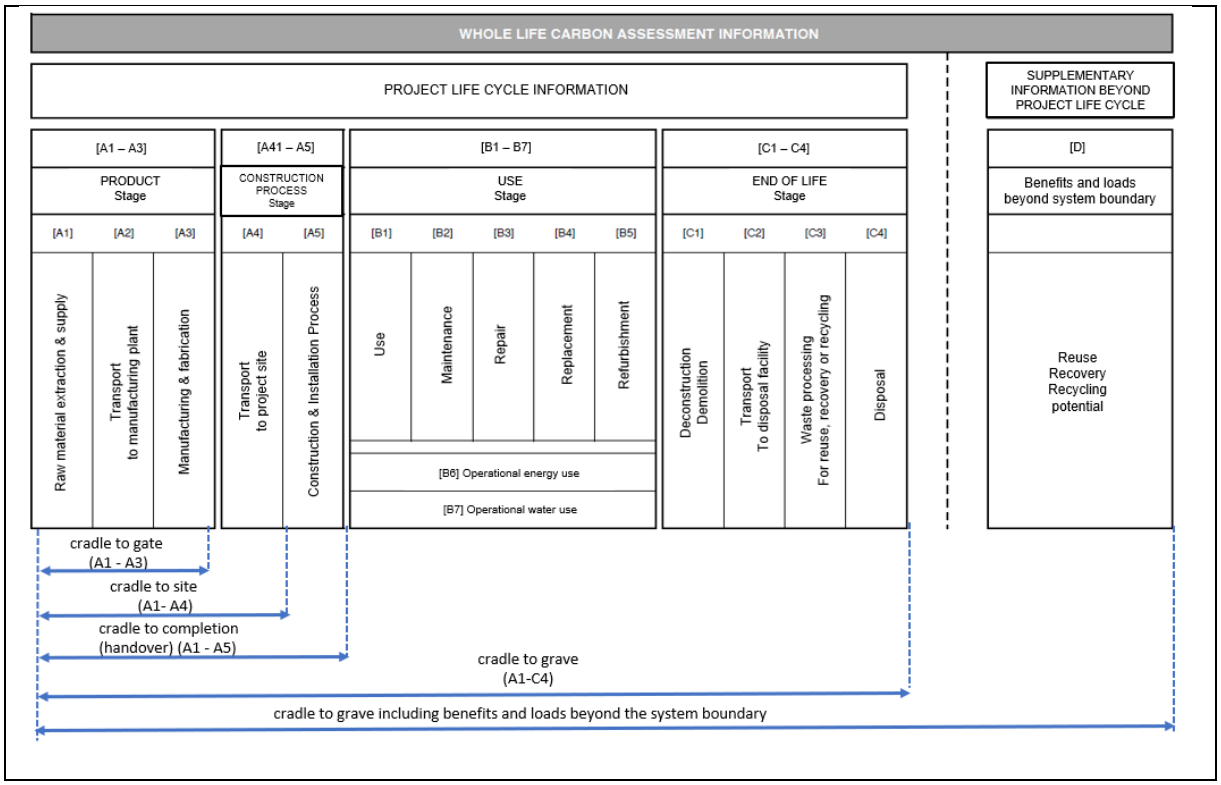

Figure 1: Whole life carbon assessment corresponding to the life cycle stages

Life Cycle Modules

BS EN 15978 and the RICS PS set out four stages in the life of a typical project described as life-cycle modules:

- Module A1 – A5 (Product sourcing and construction stage)
- Module B1 – B7 (Use stage)
- Module C1 – C4 (End of life stage)
- Module D (Benefits and loads beyond the system boundary)

Reference Study Period (RSP)

WLC assessment is carried out based on the building life cycle within the reference study period (RSP). The default value of the reference study period shall be the required service life of the building.

Building type	Reference Study Period (RSP) (years)
Residential	**50**
Non Residential	**50**

Table 1: Reference study period for different building types

Spatial boundaries

The assessment should cover all building components and works relating to the proposed building and its intended use, including its foundations, external works within the site. The site boundary shall be clearly demarcated in the building plan.

Building physical characteristics

A full WLC assessment should cover all items listed in the project's Bill of Quantities (BoQ) or as identified in other design information (drawings, specifications, etc.) that fall under the building element categories specified in Table 2.

The assessment should cover at least 95% (EN15804; 6.3.5) of the cost allocated to each building element category (0 to 7 of Table 2). Items excluded should each account for less than 1% of the total category cost.

Note: Where coverage is lower than recommended, this should be clearly indicated and the actual percentage of coverage must be reported alongside the carbon calculation results in the WLC Assessment Template.

Cost has been selected over physical characteristics, such as mass, to determine the coverage cut-off point as it is more practical than to determine the exact quantities of all items to be included, especially at early design stages.

For items not covered, the subtotal carbon budget of each category should be multiplied by the following adjustment factor to account for the impacts of the items not quantified:

Coverage adjustment factor = (100% / % of cost covered in the given category)

Worked Example

S/N	Building Element Group	Building Element	Total Cost ($)	Scenario 1: Coverage of element group ($) (⩾ 95%)	Scenario 2: Coverage of element group ($) (< 95%)
2	Superstructure (Main)	a. Frame b. Upper floors including balconies c. Roof d. Stairs and ramps	a.10,000 b.10,000 c.10,000 d.10,000	a.10,000 b.8,000 c.10,000 d.10,000	a.9,000 b.9,000 c.9,000 d.9,000
			40,000	38,000 (38,000/40,000 = 95%)	36,000 (36,000/40,000 = 90%)

Coverage adjustment factor = 100% / 90% = 1.11

Sub-total Carbon budget of Building Element Group, Superstructure (Main)

= 1.11 x Carbon budget of Superstructure(Main) (kg CO_2e)

If cost data is unavailable, the same principles apply to the mass or area of elements as appropriate.

S/N	Building part/Element group	Building Element
	Demolition	0.1 Major Demolition Works
0	Facilitation works	0.2 & 0.4 Temporary/ Enabling Works
0	Facilitation works	0.3 Specialist groundworks
1	Substructure	1.1 Substructure
2	Superstructure (Main)	a. Frame b. Upper floors incl. balconies c. Roof d. Stairs and ramps
2	Superstructure (External)	e. External Walls f. Windows and External Doors
2	Superstructure (Internal)	g. Internal Walls and Partitions h. Internal Doors
3	Finishes	3.1 Wall finishes 3.2 Floor finishes 3.3 Ceiling finishes
4	Fittings, furnishings and equipment (FF&E)	4.1 Fittings, Furnishings and Equipment (building related)
5	Building Services/MEP	5.1 Services (building related)
6	Prefabricated Buildings and Building Units	6.1 Prefabricated Buildings and Building Units
7	Work to Existing Building	7.1 Minor Demolition and Alteration Works

Table 2: Building elements groups

Floor area measurement

For WLC assessment, floor areas shall be taken from BIM model, BoQ or cost plan, or architectural plans. The unit of measurement for floor area should be Gross Floor Area (GFA) to represent the entirety of the built asset.

Quantity of measurement

For WLC assessment, material/ product quantities shall be taken from materials delivery orders, BIM model, BoQ/ Cost plan or estimation from architectural plans.

Units of measurement

WLC assessment results shall be reported in the following units: kg CO2 equivalent ($kgCO_2e$), or multiples thereof appropriate, e.g. tCO_2e.

Minimum Scope Requirement of WLC Assessment

Minimum scope of WLC assessment must cover the building elements and life cycle stages specified in Table 2 and Table 3 to score 3 points. Refer to Figure 2 and Appendix 1 on the detailed Minimum Scope requirement of WLC assessment.

Minimum Whole Life Carbon (WLC) Assessment	
Building elements to be included	Substructure Superstructure (Main, External, Internal)
Life cycle stages to be included	Product stage [A1-A3] Construction stage [A4-A5] Maintenance Stage [B2] Facade Replacement Stage [B4] ACMV Operational Energy use [B6]

Table 3: Minimum scope requirement of WLC assessment

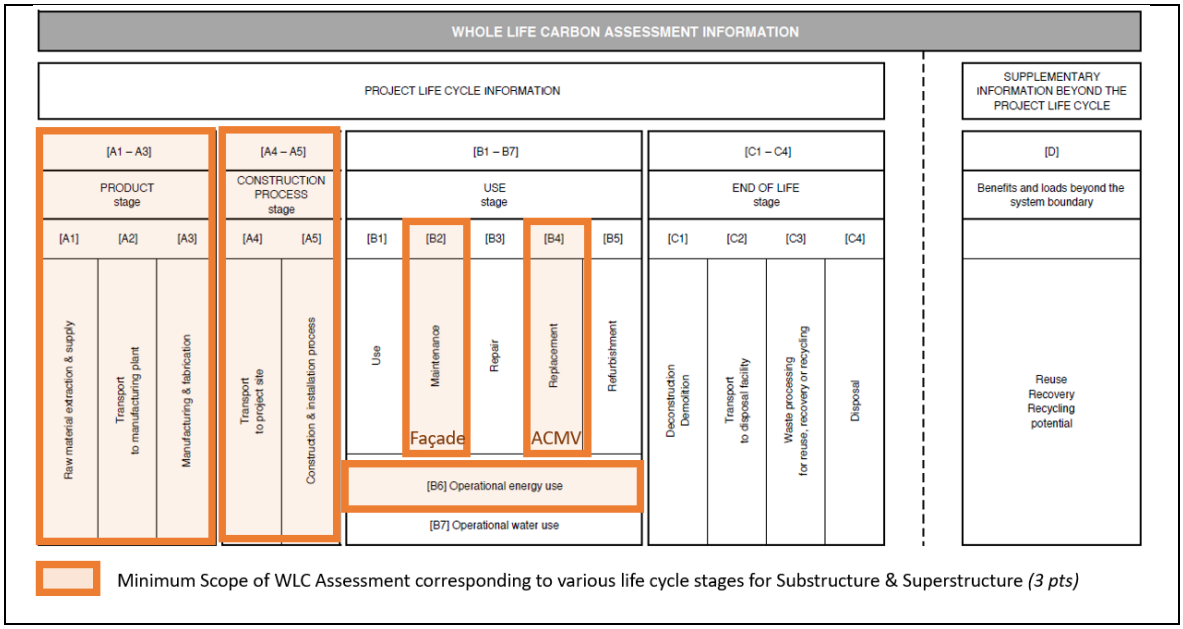

Figure 2 : Life cycle stages to be included in minimum scope of WLC assessment

Full Scope of WLC Assessment

A complete WLC assessment should include, in addition to the minimum scope of WLC assessment, the remaining life cycle stages (including D to be reported separately) and cover all items listed in the project's bill of quantities (BoQ), or design information identified in drawings, specifications, etc. that come under the building element categories specified in Table 2 to score a total of 5 points, of which 2 points is scored under the Innovation section. Refer to Figure 3 on the lifecycle stages to be included under the full WLC assessment.

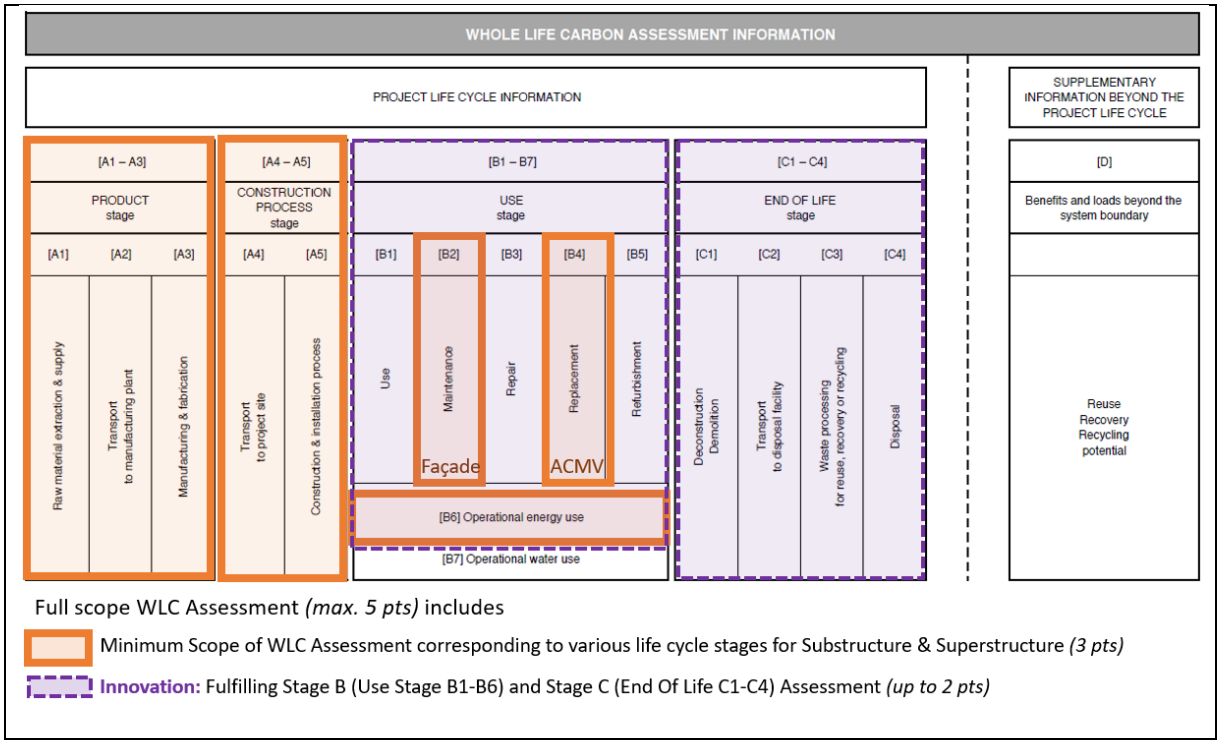

Figure 3 : Life cycle stages to be included in full scope of WLC assessment

Software Tools for calculation of WLC Assessment

Tool	Country of Origin	Project Type	Online/Offline software	Scope (Module)	Data source
One Click LCA	Finland	Buildings and civil works	Offline	A to C	Built-in with access to widely spread local EPD databases, including Ecoinvent
eToolLCD	Australia	Buildings	Online	A to C (+ D)	Uses Ecoinvent database (EPDs) which includes data by BRE in the UK.
IES VE	UK	Buildings	Offline	A to C	Built-in with access to some of the most widely spread local EPD databases, including Ecoinvent
Tally	USA	Buildings	Offline	A to C	Uses Gabi database which contains EPDs.
Sturgis Carbon Calculator	UK	Buildings	Offline	A to C	EPD database built over more than 10 years of practice in the UK. It allows the possibility to input additional EPDs manually.

Table 4: Examples of software tools for calculation of Whole Life Carbon (WLC) Assessment

For use of alternative software tools not listed in Table 4, it needs to fulfill the following criteria:

- It adopts the BS EN 15978 methodology for WLC assessment
- The scope covers modules A, B, C and D
- Where the selected software tool does not include module D by default, this has to be accounted for separately (refer to Appendix on Module D Computation (without software)
- The database from which the life-cycle assessment information is sourced is based on EPDs that reflect the country of origin of the material selected.

Carbon Data Sources

The following are acceptable sources of carbon data for materials and products, in order of preference:

- Type III environmental declarations (EPDs and equivalent) and datasets in accordance with EN 15804
- Type III environmental declarations (EPDs and equivalent) and datasets in accordance with ISO 21930
- Type III environmental declarations (EPDs and equivalent) and datasets in accordance with ISO 14067
- EPDs and datasets in accordance with ISO 14025, ISO 14040 and 14044
- Type III environmental declarations (EPDs and equivalent) and datasets in accordance with PAS 2050

Additional Guidance

Type III environmental declarations should be issued by a designated programme operator adhering to the requirements of ISO 14025.

Where there is no specific qualifying carbon data for items included in the assessment, then allowable carbon information available for equivalent or closely similar products, that complies with the above requirements, should be used. (also refer to EN 15978: 8.4 and 10.3)

The most recent geographically and technologically appropriate data should be selected depending on project location and subject to anticipated supply chains.

Carbon data for modules [A1–A3], [B1], [B2], [B3], [C1],[C3], [C4] and [D] should be retrieved from the allowable carbon data sources specified and used in line with the project-specific scenarios developed at building level.

Carbon figures for the remaining life stages [A4], [A5], [B4– B7], [C2] should be calculated on a project-specific basis, considering the project location, likely procurement routes, anticipated operation and maintenance schedules and EoL scenarios. Where EPD data is used for these modules, the carbon values should be adjusted accordingly to fit the project-specific scenarios.

The assessor must explicitly state the data sources used in the WLC assessment.

The specific product data should not be older than five years and generic data not older than ten years. (refer to EN 15804; 6.3.7)

Allowable Carbon conversion factors

Carbon dioxide equivalence (CO2e) emissions from electicity use, grid emission factor (Scope 2 emissions) can be assumed as 0.4085 kg CO_2/kWh. (refer to EMA's website on energy transformation for more information)

Diesel CO_2 emission factor can be assumed as 3186.3 kg CO_2/tonne or 741.1 kg CO_2/GJ (refer to NEA website on Greenhouse Gas Emission Measurement and Reporting Guide for more information)

(ii) Embodied Carbon Assessment Criteria

Applicable to new buildings (Non Residential and Residential) and existing buildings (Non-Residential and Residential) undergoing addition and alteration works involving additional gross floor area (GFA) with new construction, addition of floors with independent substructures

Embodied carbon of the development can be computed using the Embodied Carbon Calculator (refer to Embodied Carbon Calculator Instruction Manual at the SGBC website for more details) or embodied carbon software tools which are linked to robust carbon data sets such as the Inventory of Carbon and Energy (ICE) database, Ecoinvent database, RICS Building carbon database, etc. (also refer to Table 4)

- Embodied Carbon computation (including substructure) of new buildings (Non Residential and Residential) (0.5pt)
- Embodied Carbon computation (including substructure) of existing building (Non-Residential and Residential) undergoing addition and alteration works involving additional gross floor area (GFA) with new construction, addition of floors with independent substructures (1.0pt)

The reduction of embodied carbon for concrete, glass and steel shall be computed using the *Embodied Carbon calculator hosted at the SGBC website.*

- Where results show more than 10% reduction from the embodied carbon reference value for concrete, glass and steel have been achieved, score of 1 point
- Where results show more than 30% reduction from the embodied carbon reference value for concrete, glass and steel have been achieved, score of 2 points

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- To submit results of embodied carbon footprint in excel format using the Embodied Carbon calculator template or embodied carbon software tools with the relevant supporting documentation and calculations. Preliminary/proposed concrete mix designs are acceptable at the design stage but as-built concrete mix designs must be submitted during verification.
- For inputs of self-declaration of emission factors via the Embodied Carbon calculator, project team must provide documentation on the source of emission factors with the relevant detailed calculations.
- On the use of other carbon software tools for embodied carbon computation, detailed report of the carbon footprint of the development including (but not limited to) the quantum and types of materials used within the development, the emission factors with supporting documentation are to be submitted.

At Verification stage (New Buildings & Existing Buildings):

- To submit results of as-built embodied carbon footprint in excel format using the Embodied Carbon calculator template or embodied carbon software tools with the relevant supporting documentation and calculations. As-built concrete mix designs highlighting the amendments/ changes in the mix (with supporting documents) to be submitted, if applicable.
- For inputs of self-declaration of emission factors via the Embodied Carbon Calculator (ECC), project team must provide documentation on the source of emission factors with the relevant detailed calculations.
- On the use of other carbon software tools for embodied carbon computation, detailed report of the as-built carbon footprint of the development including (but not limited to) the quantum and types of materials used within the development, the emission factors with supporting documentation are to be submitted.

Guidance Notes

Embodied carbon of the development

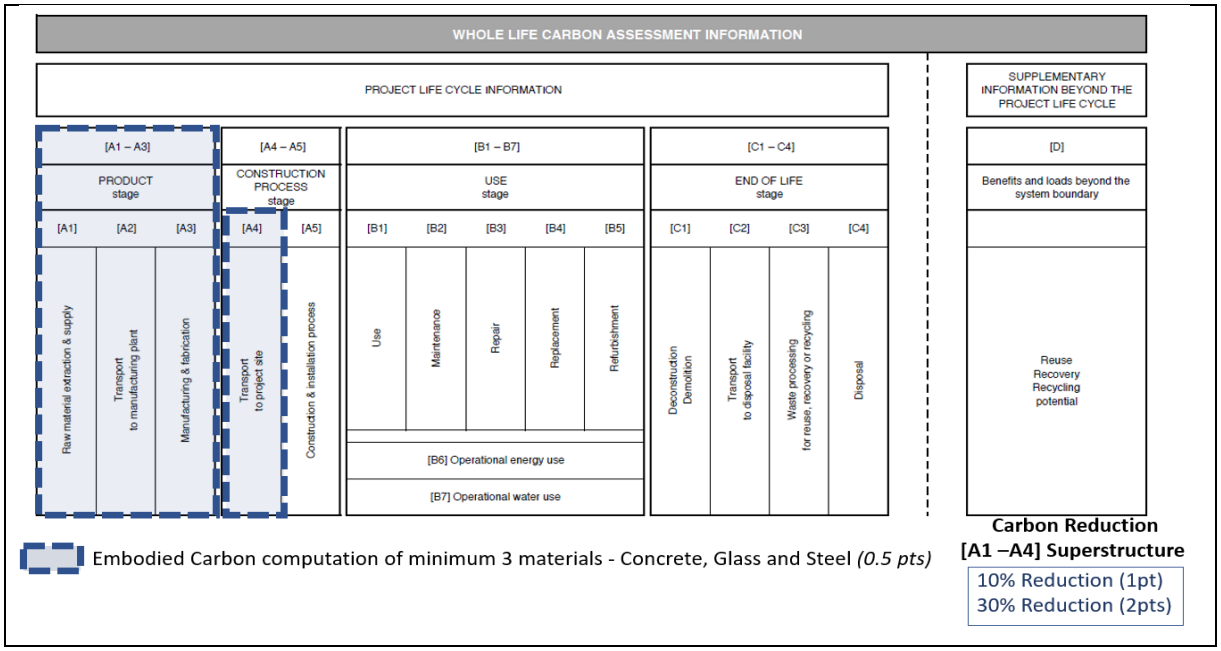

Figure 4 : Embodied Carbon computation of the development

Embodied carbon reference values of different building typologies

The embodied carbon reference values of different building typologies based on life cycle modules [A1] to [A4] for superstructure only in Table 5 are adopted as baselines in the computation of embodied carbon reduction for Concrete, Glass and Steel for the development.

Building Typology	Reference value (kgCO2e/m2) [A1] to [A4] emissions for Superstructure only
Non-Residential	**1000**
Residential	**1500**
Industrial	**2500**

Table 5: Embodied carbon reference values of different building typologies

CN 1.2 2030 Transition Plan

To encourage and recognise advanced climate leadership of the building management in rapid decarbonization. This section is aligned with the WorldGBC Net Zero Carbon Buildings commitment.

Assessment Criteria

CN 1.2 2030 Transition Plan	New Buildings	Existing Buildings
(i) Develop and publish as 2030 Transition Plan that delineates steps to deliver a net zero carbon building from 2030 for the asset under assessment, based on scope 1 and 2 emissions	1 Point	For Non-Residential Buildings 3 Points For Residential Buildings 1 Point
(ii) At least 50% offset of scope 2 emissions offset at the time of verification	N.A	For Non-Residential Buildings 2 Points For Residential Buildings N.A

Applicable to all new buildings and existing buildings with retrofitting works. All relevant building scope 1 and 2 operational energy related emissions which are under the direct control or are part of the base building scope.

Documentation Requirements

For New Buildings (Design Stage)

Submission of a 2030 Transition Plan as outlined below, endorsed by (i) the developer/building owner representative

For New Buildings (Verification Stage)

As-built transition plan and update of relevant information publicised

For Existing Non-Residential Buildings

Submission of a 2030 Transition Plan as outlined below, endorsed by (i) the developer/building owner representative (3 points)

A detailed analysis of the scope 2 carbon emissions for the building with 50% offset by renewable energy certificates (REC's) compliant to SS 673: 2021 Singapore Standard Code of practice for renewable energy certificates. (2 points)

For Existing Residential Buildings

Management Council to provide the transition plan for the development and guiding procurement policies with evidence of resolutions passed in AGM's that allow for the transition plan to be implemented.

Guidance Notes

The transition plan should follow the following outline.

Transition Plan Outline:

- **Commit** advanced trajectory for project/portfolio/organisation building(s) to operate at net zero carbon by 2030
- **Disclose** measure, disclose and assess annual asset and portfolio energy demand and carbon emissions. Baseline needs to be disclosed publicly through corporate social responsibility (CSR) reporting, the entity's website or market mechanisms. All scope 1 and scope 2 operational carbon emissions are to be measured using carbon dioxide equivalence (CO_2e) in tonnes (t) and over a continuous 12 month interval. In summary, the portfolio working baseline is the direct emissions (scope 1) plus the indirect emissions (scope 2) minus the avoided emissions (renewables and offsets)

  Guiding Assumptions
  - Carbon dioxide equivalence (CO_2e) for scope 2 emissions relating from electricity use, grid emission factor can be assumed as 0.4085 kg CO_2/kWh (further information may be found on EMA's website on energy transformation)
  - Diesel CO_2 emission factor can be assumed as 3186.3 kg CO_2/tonne or 741.1 kg CO_2/GJ (further information may be found in NEA website on Greenhouse Gas Emission Measurement and Reporting Guide)

- **Act** Develop and implement a carbon emissions reduction strategy that includes energy demand reduction targets, building measures to decarbonise grids and renewable energy procurement. Projects are encouraged to use the energy efficiency pathways stipulated in Green Mark 2021 as evaluation metric.

  Renewable procurement
  - Projects should follow a renewable hierachy where feasible. This includes renewable electricity, produced either on-site or off-site, or by offsets; with generating supply to the local grid and sufficient building measures which serve to decarbonise the grid as much as possible. The projects considerations for the different renewable energy solutions should be included as part of report.
  - Purchased renewable energy should follow SS 673: 2021 Singapore Standard Code of practice for renewable energy certificates.

- **Verify** Demonstrate enhanced energy performance, reduced carbon emissions & progress towards net zero carbon assets and portfolio. Publicly report progress annually against targets.

Definitions

Net zero carbon is when the amount of carbon dioxide emissions associated with building operations on an annual basis is zero or negative. Using WorldGBC's definition, a net zero carbon building is highly energy efficient and fully powered from on-site and/or off-site renewable energy sources and offsets.

Scope 1 emissions are defined as direct GHG emissions from sources that are owned or controlled by the company *[e.g. vehicles, industrial process loads, backup generators, refrigerants and natural gas]*

Scope 2 emissions are defined as indirect GHG emissions from the generation of purchased electricity consumed by the company *[e.g. electricity, steam, heating and cooling consumed by the reporting asset]*

CN 2 Construction

A maximum of 5 points can be scored across CN 2 Construction section.

CN 2.1 Sustainable Construction

To encourage sustainable use of construction materials, products and promote sustainable construction methods to reduce environmental impacts during the construction phase.

CN 2.1 Sustainable Construction	New Buildings	Existing Buildings
(i) Design with Low CUI	1 Point*	1 Point*
(ii) Adoption of Sustainable Building Systems	1 Point	1 Point
(iii) Use of Low Carbon Concrete certified by SGBC or equivalent local certification bodies (using CEM II – V cements under SS EN 197-1) for ≥ 80% of applicable superstructure works by volume	1 Point	1 Point
(iv) Replacement of coarse and fine aggregates with RCA, WCS and GF	1 Point	1 Point

**CN 2.1 (i) New and Existing buildings - 1 point for Non Residential; 2 points for Residential*

(i) Design with Low CUI

To reduce the amount of concrete used within the project.

Assessment Criteria

CN 2.1 Sustainable Construction	New Buildings	Existing Buildings
(i) Design with Low CUI to meet the following: **Building types** / **CUI** **Non-Residential** / ≤ 0.35 **Residential** / ≤ 0.45 **Industrial** / ≤ 0.45	For Non Residential Buildings 1 Point For Residential Buildings 2 Points	For Non Residential Buildings 1 Point For Residential Buildings 2 Points

Applicable to new buildings and existing buildings undergoing addition and alteration works involving additional gross floor area (GFA) with new construction, addition of floors with independent substructures.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Soft copy extracts of calculations (e.g. PDF format) from BIM software or calculation showing the quantity of concrete for each floor level which should include all the concrete building elements, such as non-load bearing and architectural concrete components;
- BIM model, architectural and structural plan layout, elevation and sectional plans showing the type of building elements/systems used, the dimensions and sizes of all the building and structural elements;
- Soft copy extracts of calculations (e.g. PDF format) from BIM software or calculations supported by detailed design drawings showing the use of alternative construction methods.

At Verification stage (New Buildings & Existing Buildings):

- Provide as-built BIM model or drawings and as-built CUI calculation for verification

Guidance Notes

CUI serves as an indicator of the amount of concrete used to construct the superstructure that includes both the structural and non-structural elements. CUI does not include the concrete used for external works and substructure works such as basements and foundations.

CUI is defined as the volume of concrete in cubic metres needed to cast a square metre of Constructed Floor Area (CFA). The formula used for calculation is as follows:

Concrete Usage Index = Concrete Volume in m^3 / CFA in m^2

Worked Example on the Calculation of CUI:

**Figures are for illustration purposes only*

Proposed non-residential development comprises a 30-storey block with a basement carpark and the following details:

Project Gross Floor Area (GFA) = 60,000m^2. Superstructure elements are all precast.

Concrete usage for foundation and basement carpark works are excluded in CUI tabulation.

Project Reference No.: AXXXX-00001-20XX			Total no. of storey for the project: 30
Block No: A			GFA of project: 60,000m^2
	Structural System	Volume of concrete (m^3)	Remarks*
1	**1st storey**		
	1.1 Columns	120	C80 300x300 precast columns
	1.2 Beams	320	Precast
	1.3 Slabs	400	Post–tensioned
	1.4 Staircases	93.5	Precast
	1.5 Suspended structures like planter boxes, bay windows, ledges etc	0	-
	1.6 Parapets	0	-
	1.7 External walls - loadbearing walls	0	-
	1.8 External walls – non-loadbearing walls	22	Precast green wall
	1.9 Internal walls – loadbearing walls	55	RC
	1.10 Internal walls –nonloadbearing walls	10	Light weight concrete
	1.11 Others (kerbs, ramps, services risers, etc)	15	RC
	Total volume of concrete for this storey (m^3)		**1,035.5**
	Total constructed floor area for this storey (m^2)		**2,300**
2	**Typical storey (2nd to roof)**		
	1.1 Columns	115	Precast
	1.2 Beams	301.5	Precast
	1.3 Slabs	320	Post–tensioned
	1.4 Staircases	93.5	Precast
	1.5 Suspended structures like planter boxes, bay windows, ledges etc	0	-
	1.6 Parapets	0	-
	1.7 External walls - loadbearing walls	0	-
	1.8 External walls –non-loadbearing walls	22	Precast green wall
	1.9 Internal walls – loadbearing walls	50	RC
	1.10 Internal walls – nonloadbearing walls	10	Light weight concrete
	1.11 Others (kerbs, ramps, services risers, etc)	0	RC
	Total volume of concrete for one storey (m^3)		**912**
	Total constructed floor area for one storey (m^2)		**2630**

	Total volume of concrete for 2nd to 30th storey – includes roof level (m^3)	**27,360**
	Total constructed floor area for 2nd to 30th storey – includes roof level (m^2)	**78,900**
Total volume of superstructure concrete for this project (m^3)		**28,395.5**
Total constructed floor area of superstructure for this project (m^2)		**81,200**

**To indicate if the structural elements are of precast concrete, post-tensioned concrete, high strength concrete (>Grade 60) or reinforced concrete (RC) under the 'Remarks' column.*

With reference to the above table,

Concrete usage for superstructure	Constructed floor area (CFA)
1st storey = 1,035.5 m^3 From 2nd to 30th storey = 27,360 m^3 (including roof level)	1st storey = 2,300 m^2 From 2nd to 30th storey = 78,900 m^2 (including roof level)
Therefore, Total concrete usage = 28,395.5 m^3	Therefore, Total constructed floor areas = 81,200m^2

Important notes: The quantities of the concrete for all the structural and non-structural elements for each floor level are to be computed. All the elements listed in the table such as columns, beams, slabs, suspended structures (like planter boxes, bay windows and ledges etc.), parapets, walls and others (service risers, kerbs, ramps etc.) are to be included. The derivation of the concrete volume breakdown must be traceable on the drawings. The concrete usages for foundation and basement works are to be excluded in CUI computation. For project with raft foundation that is also the floor slab of 1st level, half of the volume will be accountable in the CUI calculation.

CUI of project: 28,395.5 m^3 / 81,200 m^2 = 0.35 m^3/m^2 (non-residential, CUI ≤ 0.35)

Therefore, points awarded for CN 2.1 (i) = 1 point

(ii) Adoption of Sustainable Building Systems and Design for Manufacturing and Assembly (DfMA)

To reduce the quantity of resources used and waste generated in the design and construction of the project.

Assessment Criteria

<table>
<tr><th>CN 2.1 Sustainable Construction</th><th>New Buildings</th><th>Existing Buildings</th></tr>
<tr><td>(ii) Adoption of building system to the following quantum of the Constructed Floor Area (CFA)

<table><tr><th>Building Type</th><th>Adoption of sustainable building system</th></tr><tr><td>Non-Residential</td><td>≥ 50% of CFA</td></tr><tr><td>Residential</td><td>≥ 55% of CFA</td></tr></table></td><td>1 Point</td><td>1 Point</td></tr>
</table>

Applicable to new buildings and existing buildings undergoing addition and alteration works involving additional gross floor area (GFA) with new construction, addition of floors with independent substructures. (Non Residential and Residential)

1 point can be scored if the percentage of coverage on adoption of Sustainable building systems and Design for Manufacturing and Assembly (DfMA) that minimize resource use and waste, with a view to greater integration of components and systems for the corresponding building type has been met. The following can be considered jointly and severally based on percentage (%) coverage over constructed floor area.

a) Advanced Precast Concrete Systems (APCS)
b) Structural Steel
c) Mass Engineered Timber (MET)
d) Prefabricated Prefinished Volumetric Construction (PPVC)
e) Hybrid structural system of:
    i. Structural Steel and Precast Concrete; or
    ii. MET and Structural Steel/ Precast Concrete

Documentation Requirements

<u>At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):</u>

- Soft copy extracts of calculations (e.g. PDF format) from BIM software or calculation showing the percentage, the dimensions and sizes of all building elements/systems used with clear demarcations;
- BIM model, architectural and structural plan layout, elevation and sectional plans showing the type of building elements/systems used, the dimensions and sizes of all the building and structural elements;
- Technical product information (including drawings and supporting documents) of the building elements/systems

<u>At Verification stage (New Buildings & Existing Buildings):</u>

- Provide as-built BIM model or drawings and as-built calculations
- Provide final Buildable Design Score (B-score) for verification on sustainable building systems adopted

Guidance Notes

Building element	Coverage based on area on plan
Mass Engineered Timber (MET)	40,000m^2
Precast concrete	3005m^2
Total Area	43,005m^2

Note: Assume no overlaps in the area of coverage based on project plans. Alternatively, area of coverage can be directly taken off from the plan drawings instead of using the tabular calculation format as shown above.

From the CUI tabulation, CFA = 81,200 m^2

% coverage by area: 43,005 m^2 / 81,200 m^2 = 52.96% > 50%

Therefore, points awarded for CN 2.1 (ii) = 1 point.

(iii) Low Carbon Concrete

To reduce the quantity of resources used and waste generated in the design and construction of the project.

Assessment Criteria

CN 2.1 Sustainable Construction	New Buildings	Existing Buildings
(iii) Use of Low Carbon Concrete certified by SGBC or equivalent local certification bodies (using CEM II – V cements under SS EN 197-1) for ≥ 80% of applicable superstructure works by volume		
a. SGBP 2 ticks or equivalent administered by local certification bodies	0.5 Point	0.5 Point
b. SGBP 3 ticks or equivalent administered by local certification bodies	0.75 Point	0.75 Point
c. SGBP 4 ticks or equivalent administered by local certification bodies	1 Point	1 Point

Applicable to new buildings and existing buildings undergoing addition and alteration works involving additional gross floor area (GFA) with new construction, addition of floors with independent substructures. (Non Residential and Residential)

Documentation Requirements

<u>At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):</u>

- Extract of tender specification, or proposed concrete mix design, or plans showing use of at least SGBP 2 ticks and above or equivalent concrete
- Calculation showing extent of use of at least SGBP 2 ticks and above or equivalent concrete
- SGBC certification of the concrete products/mixes used for the project.

<u>At Verification stage (New Buildings & Existing Buildings):</u>

- As-built calculation showing extent of use of at least SGBP 2 ticks and above or equivalent concrete
- Delivery orders and details of the actual concrete mix used in the project
- SGBC certification of the concrete products/mixes used for the project.

(iv) Replacement of Aggregates

To reduce use of natural aggregates and promote circularity of materials.

Assessment Criteria

CN 2.1 Sustainable Construction	New Buildings	Existing Buildings
(iv) The replacement of coarse and fine aggregates for structural concrete applications [by mass of Recycled Concrete Aggregates (RCA), Washed Copper Slag (WCS), Granite Fines (GF)]		
a. Replacement of EITHER coarse OR fine aggregates	0.5 Point	0.5 Point
b. Replacement of BOTH coarse and fine aggregates	1 Point	1 Point

Applicable to new buildings and existing buildings undergoing addition and alteration works involving additional gross floor area (GFA) with new construction, addition of floors with independent substructures. (Non Residential and Residential)

A maximum of 1 point to meet both minimum requirements in terms of extent of usage and replacement levels as shown in the table below:

Minimum Requirement	RCA	WCS	GF
Extent of usage	≥ 1.5% x GFA	≥ 0.75% x GFA	≥ 1.5% x GFA
Replacement amount (%)	≥ 20%	≤ 10%	≥ 50%

Documentation Requirements

<u>At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):</u>

- Extract of tender specification or proposed concrete mix design showing the maximum clinker content and/or the detailed usage of recycled/ engineered/ alternative aggregates (e.g. RCA/WCS/GF);
- Calculation showing the quantity of recycled/ engineered/ alternative aggregates (e.g. RCA/WCS/GF) to be used for the project;
- SGBC certification of the concrete products/mixes used for the project.

<u>At Verification stage (New Buildings & Existing Buildings):</u>

- As-built drawings highlighting if there is deviation of the building design or usage scope clinkers; recycled/ engineered/ alternative aggregates (e.g. RCA/ WCS/GF) in the project;
- Delivery orders and details of the actual concrete mix used in the project showing the usage of clinkers; recycled/ engineered/ alternative aggregates (e.g. RCA/ WCS/GF);
- SGBC certification of the concrete products/mixes used for the project

Guidance Notes

Worked example on the calculation for the adoption rate of sustainable building systems

The below illustrates different scenarios on how a project can calculate the points scored for this requirement, CN 2.1 (iv).

In this example, the project has made the following aggregate replacements with reference to the above project details under Worked Example for CUI:

a) Scenario 1 - Replacement amount is not within range of minimum required amount

- Coarse Aggregates
  i. 10% replacement with RCA for slabs,
  ii. Additional 30% replacement for all non-load bearing walls in the super structure.
- Fine aggregates
  i. 15% replacement with WCS for all slabs,
  ii. 40% replacement with GF for all slabs.

b) Scenario 2 - Replacement amount meets required amount

- Coarse Aggregates
  i. 20% replacement with RCA for slabs,
  ii. Additional 30% replacement for all non-load bearing walls in the super structure.
- Fine aggregates
  i. 10% replacement with WCS for all slabs,
  ii. 50% replacement with GF for all slabs.

Coarse Aggregates - Recycled Concrete Aggregates (RCA)

a) Scenario 1 – Replacement amount is less than minimum required amount of 20%

Based on mix design, 10% of coarse aggregates are replaced with RCA for slabs. Thus, it does not fulfil the minimum replacement requirement to score point.

Requirements - RCA	Met requirements?
1. Replacement amount	No
2. Extent of usage	-

b) Scenario 2 – replacement amount meets required amount

Based on mix design, 20% of coarse aggregates are replaced with RCA for slabs. This fulfils the minimum replacement amount requirement.

Next, calculate if the extent of usage meets the requirements of ≥ 1.5% x GFA.

Minimum usage requirement for RCA = 0.015 x GFA = 0.015 x 60,000 m^2 = 900 tons

Total concrete volume of all slabs = 400 m^3 + (320 m^3 x 30) = 10,000m^3
Total concrete volume of all non-load bearing walls = 22 m^3 + 10 m^3 + (22 m^3 x 30) + (10 m^3 x 30) = 992m^3

[Approximate coarse aggregate content in concrete = 1 ton/m^3]
Total tonnage of RCA used for super structure
= [(20% x 1 ton/m^3) x 10,000m^3] + [(30% x 1 ton/m^3) x 992m^3] = 2297.6 tonnes > 900 tonnes, therefore meeting minimum extent of usage requirement.

Requirements - RCA	Met requirements?
1. Replacement amount	Yes
2. Extent of usage	Yes

Therefore, points scored = 0.5 points

Fine Aggregates - Washed Copper Slag (WCS)

Note: Amount replacement of WCS shall be ≤ 10%

a) Scenario 1 – Replacement amount is more than 10%

Based on mix design, 15% of fine aggregates are replaced with WCS for slabs. Thus, it does not fulfil the minimum replacement requirement to score this point.

Requirements - WCS	Met requirements?
1. Replacement amount	No
2. Extent of usage	-

b) Scenario 2 – replacement amount meets required amount

Based on mix design, 10% of fine aggregates are replaced with WCS for slabs. This fulfils the minimum replacement amount requirement.

Next, calculate if the extent of usage meets the requirements of ≥ 0.75% x GFA.

Minimum usage requirement for WCS = 0.015 x GFA/2 = 0.015 x 60,000 m^2/2 = 450 tons

Total concrete volume of all slabs = 400m^3 + 320m^3 x 30 = 10,000m^3

Total tonnage of fine aggregate used for super structure
= 0.7 ton/m^3 x concrete volume (m^3), 0.7 ton/m^3 x 28,395.5m^3 = 19,876.85 tonnes
[Approximate fine aggregate content in concrete = 0.7 ton/m^3]

Total tonnage of WCS used for super structure
= [*(10% x 0.7 ton/m^3) x 10,000m^3] = 700 tonnes > 450 tonnes, therefore meeting minimum extent of usage requirement.

Requirements - WCS	Met requirements?
1. Replacement amount	Yes
2. Extent of usage	Yes

Therefore, points scored = 0.5 points

Fine Aggregates – Granite Fines (GF)

a) Scenario 1 – Replacement amount is less than minimum required amount of 50%

Based on mix design, 40% of fine aggregates are replaced with GF for slabs. Thus, it does not fulfil the minimum replacement requirement to score this point.

Requirements - GF	Met requirements?
3. Replacement amount	No
4. Extent of usage	-

b) Scenario 2 – replacement amount meets required amount

Based on mix design, 50% of fine aggregates are replaced with GF for slabs. This fulfils the minimum replacement amount requirement.

Next, calculate if the extent of usage meets the requirements of ≥ 1.5% x GFA.

Minimum usage requirement for GF = 0.015 x GFA = 0.015 x 60,000 m^2 = 900 tons

Total concrete volume of all slabs = 400m^3 + 320m^3 x 30 = 10,000m^3

Total tonnage of fine aggregate used for super structure
= 0.7 ton/m^3 x concrete volume (m^3), 0.7 ton/m^3 x 28,395.5m^3 = 19,876.85 tonnes
[Approximate fine aggregate content in concrete = 0.7 ton/m^3]

Total tonnage of GF used for super structure
= [*(50% x 0.7 ton/m^3) x 10,000m^3] = 3,500 tonnes > 450 tonnes, therefore meeting minimum extent of usage requirement.

Requirements – Granite Fines	**Met requirements?**
3. Replacement amount	Yes
4. Extent of usage	Yes

Therefore, points scored = 0.5 points

Summary of points scored under CN2.1 (iv)

a) Scenario 1

Total points scored for CN 2.1 (iv) = 0 points

- Coarse Aggregates (RCA): 0 pts
- Fine Aggregates: (WCS) 0pts + (GF) 0pts = 0 pt

b) Scenario 2

Total points awarded for CN 2.1 (iv) = 1 point

- Coarse Aggregates (RCA): 0.5 pts
- Fine Aggregates: (WCS) 0.5pts + (GF) 0.5pts = 1 pt

Cap at max. 1 point.

CN 2.2 Sustainable Products & Finishes

To promote sustainable procurement of products, resource efficient and environmentally friendly specifications of products in a building to minimise the resources used in the construction / retrofitting of the building.

Assessment Criteria

CN 2.2 Sustainable Products & Finishes	New Buildings	Existing Buildings
(i) ≥ 60% (by cost) or ≥ 80% (by areas) of the Architectural and applicable landscaping works are at least SGBP 2 ticks or equivalent administered by local certification bodies	For Non Residential Buildings 1 Point For Residential Buildings 2 Points	For Non Residential Buildings 2 Points For Residential Buildings 2 Points
(ii) ≥ 60% (by cost) of Mechanical, Electrical and Plumbing (MEP) systems are SGBP certified or equivalent administered by local certification bodies	For Non Residential Buildings 1 Point For Residential Buildings 1 Point	For Non Residential Buildings 3 Points For Residential Buildings 3 Points

Applicable to all new buildings and existing buildings with retrofitting works or change of MEP systems. (Non Residential and Residential)

There are two options (coverage by cost or by areas) for scoring. The project team should decide on either one which is most appropriate for its context.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

Cost

- Estimated cost of all the architectural and landscaping works/MEP systems* within the project's cost plan/ bill of quantities (BoQ), preferably prepared by an accredited cost consultant.
- Estimated cost of the certified architectural and landscaping products (at least 2 ticks)/MEP systems* within the project's cost plan/bill of quantities (BoQ), preferably prepared by an accredited cost consultant.
- Extracts of the tender design specification showing the building architectural and landscaping works/MEP systems and descriptions of each systems
- Product certificates and catalogue
- Design drawings marking the use of the certified architectural and landscaping products (at least 2 ticks)/MEP systems*.

Area

- Extracts of the tender design specification showing:
  - ➢ The building systems which the project targets to score points for, and descriptions of each
  - ➢ The requirements to use certified environmentally friendly products for building system(s), where they are used
- Tabulation of the building systems which the project targets to score points for in a table format
- Design drawings marking the extent of use for each system and the calculation of the extent of use
- Design details of the systems used; i.e. construction method/ method statement details
- Product catalogues and certificates (if the product selection is confirmed)

At Verification stage (New Buildings & Existing Buildings):

Cost

- Actual cost of all the architectural and landscaping works/MEP systems for the project, preferably prepared by an accredited cost consultant
- Actual cost of the certified architectural and landscaping products (at least 2 ticks)/MEP systems* for the project, preferably prepared by an accredited cost consultant
- Delivery order (DO) or Purchase order (PO) of the products with their corresponding green product certificates
- Photographs and as built drawings showing the use of certified architectural and landscaping products (at least 2 ticks)/MEP systems

Area

- Calculation of as-built areas of all the architectural and landscaping works for the project
- Delivery order (DO) or Purchase order (PO) of the products with their corresponding green product certificates
- Photographs and as-built drawings showing the use of certified architectural and landscaping products

Guidance Notes

- The coverage of ≥ 60% (by cost) or 80% (by areas) should include minimally at least 3 building Products/Finishes
- For MEP systems where product types are not available in the SGBP certification (e.g Air conditioning units at the time of writing), supporting documents such as Environmental Product Declaration (EPD) can be accepted
- Other Environmental product certifications (based in Singapore) can be recognised where equivalence is demonstrated in certification rigor and environmental performance

Worked Example - Cost

2.2(i) Architectural and applicable landscaping works

- Include external wall, roofing and landscaping work (exterior of the building)
- Exclude internal wall, flooring, ceiling, doors (interior of the building) which can score points under CN 3.2 Fit Out Products *(Note: Price indicated are arbitrary for illustration only)*

Architectural Systems	Typical Architectural Products		At least SGBP 2 ticks	Product Cost* ($)	% of Cost for at least SGBP 2 ticks
External Wall	Base	Curtain wall	Yes	$100,000	12%
		Integrated wall system		$10,000	
		Wall panels	Yes	$50,000	6%
		Blocks		$10,000	
		Metal cladding		$10,000	
		Waterproofing	Yes	$50,000	6%
		Grouting	Yes	$50,000	6%
		Sealant		$10,000	
		Adhesives	Yes	$50,000	6%
		Jointing		$10,000	
		Pointing		$10,000	
	External face finishes (Internal face finishes to score under GM3.2 Fit Out products)	Skim coats	Yes	$50,000	6%
		External paints (including primers)	Yes	$50,000	6%
		External coatings		$10,000	
		Corner beads		$10,000	
		Corner protectors		$10,000	
		Fabrics		$10,000	
		Wall papers		$10,000	
		Wall tiles		$10,000	
Roofing	RC flat roof base	Levelling base		$10,000	
		Screed		$10,000	
		Waterproofing		$10,000	
		Insulation		$10,000	
	Frame roof base	Waterproofing		$10,000	
		Insulation		$10,000	
	Finishes	Metal sheets		$10,000	
		Roof tiles	Yes	$50,000	6%
		Tile grouts		$10,000	
		Tiles		$10,000	
		Paints and coatings		$10,000	
		Adhesives		$10,000	
		Pointing		$10,000	
		Skirting		$10,000	
Outdoor	Landscaping	Composite timber decking		$10,000	
		Outdoor play equipment		$10,000	
		Pre-cast kerbs and drains		$10,000	
		Drainage cells	Yes	$50,000	6%
		Green wall panel	Yes	$50,000	6%
			Total Cost	*$830,000*	*66%*

1 point for new building or 2 points for existing building with retrofitting will be award for project achieving ≥ 60% of cost attributed to at least 3 products of SGBP 2 ticks or equivalent by local certification bodies.

2.2(ii) Mechanical, Electrical and Plumbing (MEP) systems

** Price indicated are arbitrary for illustration only.*

MEP Systems	**Typical MEP Products**		**At least certified Level or equiv. GB products**	**Product Cost* ($)**	**% of Cost for at least certified level or equiv. GB products**
Mechanical	ACMV	Automatic Tube Cleaning System	Yes	$10,000	1%
		Centrifugal chiller	Yes	$300,000	37%
		Cooling Tower	Yes	$100,000	12%
	Pump	Chilled water pump		$10,000	
		Condenser water pump		$10,000	
		Heat pump		$10,000	
		Domestic water pump		$10,000	
	Duct	Pre-insulated air conditioning duct	Yes	$30,000	4%
	Thermal Insulation	Thermal Insulation		$10,000	
	Fan	Ceiling cassette fan	Yes	$10,000	1%
	IAQ	Air filter MERV 14	Yes	$10,000	1%
	Pipes & fitting	Siphonic Rainwater Drainage	Yes	$10,000	1%
		Potable water		$10,000	
		Non-potable water		$10,000	
		Sanitary		$10,000	
		Sewage		$10,000	
Electrical	Cable	Power Cable LSOH		$10,000	
		Network Cable		$10,000	
		Extra Low Voltage		$10,000	
	Electrical connector	Electrical connector		$10,000	
	Switchboard	Switchboard		$10,000	
	VSD	Variable Speed Drive		$10,000	
	Vertical transport	Elevator		$100,000	
		Escalator	Yes	$100,000	12%
			Total Cost	*$820,000*	*70%*

1 point for new building or 3points for existing building with retrofitting will be award for project achieving ≥ 60% of cost attributed to at least 3 products of of SGBP certified or equivalent by local certification bodies.

Worked Example - Area

2.2(ii) Architectural and applicable landscaping works

- Include external wall, roofing and landscaping work
- Exclude internal wall, flooring, ceiling, doors, which can score points under CN 3.2 Fit Out Products (*Note: * Area indicated are arbitrary for illustration only*)

Architectural Systems	**Typical Architectural Products**		**At least level-2 GB products**	**Product Area* (m^2)**	**% of area for at least level-2 GB products**
External Wall	Base	AAC block wall	Yes	5,000	9%
		External precast wall	Yes	5,000	9%
		Curtain wall	Yes	5,000	9%
	External face finishes	Plastering	Yes	5,000	9%
		External paints (including primers)	Yes	5,000	9%
Roofing	RC flat roof base	Levelling base	Yes	2,000	4%
		Screed	Yes	2,000	4%
		Waterproofing	Yes	2,000	4%
		Insulation		2,000	
	Finishes	Waterproofing	Yes	2,000	4%
		Insulation		2,000	
		Roof tiles	Yes	2,000	4%
		Tile grouts		2,000	
		Tiles		2,000	
Outdoor	Landscaping	Composite timber decking	Yes	2,000	4%
		Outdoor play equipment	Yes	2,000	4%
		Pre-cast kerbs and drains		2,000	
		Drainage cells	Yes	2,000	4%
		Green wall panel	Yes	2,000	4%
			Total Area	*53,000*	*81%*

1 point for new building or 2 points for existing building with retrofitting will be award for project achieving ≥ 80% of area attributed to at least 3 products of of SGBP 2 ticks or equivalent by local certification bodies.

CN 2.3 Conservation, Resource Recovery and Waste Management

To encourage conservation of existing building structure, recovery of demolished building materials for reuse and/or recycling and waste management.

Assessment Criteria

CN 2.3 Conservation, Resource Recovery and Waste Management	New Buildings	Existing Buildings
(i) Existing structures are conserved and not demolished	1 Point	1 Point
(ii) Existing structures are demolished with an enhanced demolition protocol, where a recovery rate of ≥ 40% crushed concrete waste from the demolished building is sent to approved recyclers with proper facilities	1 Point	1 Point
(iii) Appointment of environmental specialists during construction stage – The main builder is a BCA Green and Gracious Builder with Merit or above rating and has ISO14001 certification	1 Point	1 Point

Applicable to new buildings or existing buildings undergoing major retrofitting work and > 30 years old

Applicable to all structural and non-structural components constituting the building superstructure.

Documentation Requirements

<u>At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):</u>

- Conservation permit and supporting documents if applicable
- Pre-demolition assessment records of demolition site showing clear recovery/ recycling targets and estimated quantities of salvageable materials
- Method statement detailing how sequential demolition is to be carried out
- Waste management plans such as plan layout showing locations of recycling bins for collection and storage of different recyclable waste, records of waste movement from site to recycling facilities, proposed usage of the various types of recovered waste
- Details of best practice pollution prevention policies and procedures at construction and demolition sites
- Documentary evidence on the appointment of environmental specialists during construction stage
- Copy of the main builder's Green and Gracious Builder award with Merit and above rating and ISO 14000 certificate

<u>At Verification stage (New Buildings & Existing Buildings):</u>

- Detailed calculations/records of the volume of waste sent to the relevant approved recyclers
- Copy of the main builder's Green and Gracious Builder award with Merit and above rating and ISO 14000 certificate

CN 3 Fit Out

A maximum of 5 points can be scored across CN 3 Fit Out section

CN 3.1 Green Lease

To promote resource efficient and environmentally friendly specifications of products in a building to minimise the resources used in the fit-out of the building.

Assessment Criteria

CN 3.1 Green Lease	New Buildings	Existing Buildings
Provide and implement a Green Lease (or equivalent) agreement with its tenants. The green lease should establish agreed levels of environmental building performance between the landlord and its tenants. The Green Lease should include (at a minimum) principles relating to: • energy, • water, • waste, • environmental management and • procurement including materials, fit-out as well as facility management practices.	<u>For Non Residential Buildings</u> 1 Point for ≥ 50% of the net lettable area 2 Points for ≥ 70% of the net lettable area 3 Points for every tenant <u>For Residential Buildings</u> N.A	<u>For Non Residential Buildings</u> 1 Point for ≥ 50% of the net lettable area 2 Points for ≥ 70% of the net lettable area 3 Points for every tenant <u>For Residential Buildings</u> N.A

Documentation Requirements

<u>At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):</u>

- To provide Letter of commitment with clear documentation process on how the project aims to implement the level of green lease for the tenants. The green lease document should be finalised indicating the environmental standards to assist tenants in making their fit-out and downstream operation decisions.

<u>At Verification stage (New Buildings & Existing Buildings):</u>

- Official tenancy agreement with Green Lease and compliance procedures incorporated, complete with evidence of its application to the specific tenants. Other documents include list of tenants, net lettable areas and details of tenants with Green Lease.

References

BCA Green Lease Toolkit: https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/sustainability/green-lease-toolkit.docx?sfvrsn=3c597a12_4

CN 3.2 Fit Out Products

Assessment Criteria

CN 3.2 Fit Out Products	New Buildings	Existing Buildings
(i) ≥ 80% (by cost or area) of the fit-out materials used (construction and finishes) for **common areas** (i.e. non-tenanted spaces) shall be at least SGBP 2 ticks or equivalent administered by local certification bodies	For Non Residential Buildings 1 Point For Residential Buildings 1 Point	For Non Residential Buildings 1 Point For Residential Buildings 2 Points
(ii) ≥ 80% (by cost or area) of the fit-out materials used (construction and finishes) for **tenanted spaces** / **dwelling units** shall be conserved or at least SGBP 2 ticks or equivalent administered by local certification bodies	For Non Residential Buildings 1 Point For Residential Buildings 2 Points	For Non Residential Buildings 1 Point For Residential Buildings N.A

Fit out products with Environmental Product Declarations (EPD) certification can score additional points at Innovation section

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

Clear documentation process indicating:

- List of green products that will be used for the common areas with indication on floor plan
- Valid green product certifications by an approved local certification body
- Catalogue of the green product
- Calculation of the value cost or area for all fit-out products
- For tenanted spaces, project that aims to score point will have to provide a letter of commitment with implementation plan for their tenants.

At Verification stage (New Buildings & Existing Buildings):

- Evidence (e.g. photographs) of where the green building products are being deployed
- Calculation of the conserved/value cost or area for all fit-out products
- List of green products that will be used for the common areas with indication on floor plan
- Valid green product certifications by an approved local certification body

Guidance Notes

Worked Example

Example of a proposed development with the following provisions:

Components	Typical Products		Conserved or at least 2 ticks GB product?	Product Cost ($)* or Area ($m^2$)	% cost of product conserved or at least 2 ticks GB product
Internal Wall	Base	Lightweight wall panels	Conserved	$10,000	1.8%
		Drywalls	Conserved	$10,000	1.8%
		Blocks	Conserved	$10,000	1.8%
		Waterproofing	Conserved	$10,000	1.8%
		Jointing	Conserved	$10,000	1.8%
		Wall grouting	Conserved	$10,000	1.8%
		Boarding insulation	Conserved	$10,000	1.8%
	Finishes	Plastering	Conserved	$10,000	1.8%
		Skim coat	Conserved	$10,000	1.8%
		Corner beads	Conserved	$10,000	1.8%
		Corner protectors	Conserved	$10,000	1.8%
		Fabrics	No	$10,000	0%
		Wall papers	No	$10,000	0%
		Wall tiles	No	$10,000	0%
		Tiles grouting vinyl	No	$10,000	0%
		Laminates	No	$10,000	0%
		Veneers	No	$10,000	0%
		Adhesives	Yes	$10,000	1.8%
		Paint	Yes	$10,000	1.8%
Flooring	Base	Levelling base	Conserved	$10,000	1.8%
		Floor screed	Conserved	$10,000	1.8%
		Waterproofing	Conserved	$10,000	1.8%
	Raised floor systems	Insulation	Yes	$10,000	1.8%
		Underlay	Yes	$10,000	1.8%
		Carpets/ carpet tiles	Yes	$10,000	1.8%
	Floor finishes	Underlays	Yes	$10,000	1.8%
		Coatings	Yes	$10,000	1.8%
		Grouting	Yes	$10,000	1.8%
		Pointing	Yes	$10,000	1.8%
		Skirting	Yes	$10,000	1.8%
		Adhesives	Yes	$10,000	1.8%
		Carpets	Yes	$10,000	1.8%
		Vinyl's	Yes	$10,000	1.8%
		Tiles	Conserved	$10,000	1.8%
		Laminate flooring	N.A.	$10,000	0%
		Timber flooring	N.A.	$10,000	0%
		Marble flooring	N.A.	$10,000	0%
Ceiling	Base	Plastering	Conserved	$10,000	1.8%
		Skim coat	Conserved	$10,000	1.8%
	Finishes	Ceiling boards	Conserved	$10,000	1.8%
		Insulation adhesives	Conserved	$10,000	1.8%
		Paint finish	Conserved	$10,000	1.8%
		Coatings	Conserved	$10,000	1.8%
Door	Base	Glass door	Conserved	$10,000	1.8%
		Wooden door	Conserved	$10,000	1.8%
		Door leaf	Conserved	$10,000	1.8%

		Door laminates	Conserved	$10,000	1.8%
		Paint	Conserved	$10,000	1.8%
		Veneers	Conserved	$10,000	1.8%
		Vinyl sheets	Conserved	$10,000	1.8%
		Door Varnish	Conserved	$10,000	1.8%
		Coating	Conserved	$10,000	1.8%
	Accessories	Door frame	Conserved	$10,000	1.8%
		Door frame finishes	Conserved	$10,000	1.8%
		ironmongery	Conserved	$10,000	1.8%
			Total Cost	$550,000 *Sum of all product cost/area*	82.8% *Sum of all % of cost/area for at least level-2 GB products*

1 point or 2 points will be award for project achieving 82.8% of products with at least SGBP 2 ticks or equivalent administered by local green building product certification bodies. The same methodology would apply for common areas and tenanted spaces (including conservation of fit-out products).

** Price indicated are arbitrary for illustration only. If cost of conserved product is not available, to provide best estimate from existing source*

CN 3.3 Tenancy Offsets

Assessment Criteria

Applicable to new buildings with occupants and tenants (Residential only) and existing buildings with occupants and tenants (Non Residential and Residential). To demonstrate leadership to support tenants in the transition towards low/net-zero carbon buildings. This section is aligned with the WorldGBC Net Zero Carbon Buildings commitment of Advocacy.

CN 3.3 Tenancy Offsets	New Buildings	Existing Buildings
For Non Residential Buildings Building owner help tenants to offset operational energy through the aggregation and procurement of renewables, or through the ongoing purchase of certified carbon offsets. (i) ≥ 30% of tenants (by NLA) (ii) ≥ 60% of tenants (by NLA) (iii) ≥ 90% of tenants (by NLA) For Residential Buildings The building owner (e.g. MCST) offset their common areas operational energy through the procurement of renewables, or through the ongoing purchase of certified carbon offsets. (i) ≥ 30% of common areas consumption (ii) ≥ 60% of common areas consumption (iii) ≥ 90% of common areas consumption	For Non Residential Buildings N.A For Residential Buildings 1 point for (i) 2 points for (ii) 3 points for (iii)	For Non Residential Buildings 1 point for (i) 2 points for (ii) 3 points for (iii) For Residential Buildings 1 point for (i) 2 points for (ii) 3 points for (iii)

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- To provide Letter of commitment with clear documentation process on how the project aims to implement the offset of tenants / common areas energy consumption

At Verification stage (New Buildings & Existing Buildings):

- 12 months utility bills of the tenants/common areas consumption. If the full 12 months utility bills are not available, to project using available months of utility bills (with similar operating condition) for 12 months consumption
- To provide relevant documents[1] in supporting the renewable energy[2] or carbon credits claims of offsetting the tenants' or common areas operational energy. Purchased renewable energy should be compliant to the SS 673: 2021 Singapore Standard Code of practice for renewable energy certificates

[1] Supporting documents could include but not limited to: serial no. of renewable energy certificates and carbon credits, vintage/ year, origin/ source of renewable energy generation or carbon offsets.
[2] Projects are encouraged to follow the renewable hierachy where feasible. This includes renewable electricity, produced either on-site or off-site, or by offsets; with generating supply to the local grid and sufficient building measures which serve to decarbonise the grid as much as possible

Whole Life Carbon - Innovation

Assessment Criteria

Whole Life Carbon - Innovation	New Buildings	Existing Buildings
Projects can demonstrate substantial performance to a specific Carbon indicator or outcome, where innovation points can be awarded on a case-by-case basis. Points shall be awarded based on the strength of evidence of benefits and potential impact.	2 Points	2 points

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

The project team is to submit a concise summary that articulates:

- The nature of the environmental benefit of their intervention/innovation
- Justify the impact of the intervention through detailed calculations and comparisons with industry norms
- Substantiate the calculations and comparisons with evidence and data.

At Verification stage (New Buildings & Existing Buildings):

The operations team is to submit:

- Details of the implemented intervention/innovation
- Measurements and recordings of key metrics/indicators to show improvements of environmental performance arising from implemented intervention/innovation
- Lessons learnt if the intervention does not perform as expected

Guidance Notes

Projects can innovate to go above and beyond to attain exceptional Carbon outcomes as intended in one or more criteria or demonstrate unique solutions to enhance other aspects of carbon not specified in the criteria. Innovations will be considered on a case by case basis.

An example, with reference to the Carbon section criteria, would include but not limited to:

- CN 1.1, to conduct a full scope Whole Life Carbon Assessment
- CN 2.1 Use of NEWSand in non-structural applications
- CN 2.1 Use of carbon mineralisation technologies
- CN 2.1 Use of 100% granite fines as aggregate replacement
- CN 2.2 and CN 2.3 Recognising products with EPDs
- CN 2.3 Recognising design for Disassembly/Future adaptability – to facilitate future changes and dismantlement (in part or whole) for recovery of systems, components and materials

Appendix 1 – Whole Life Carbon Assessment

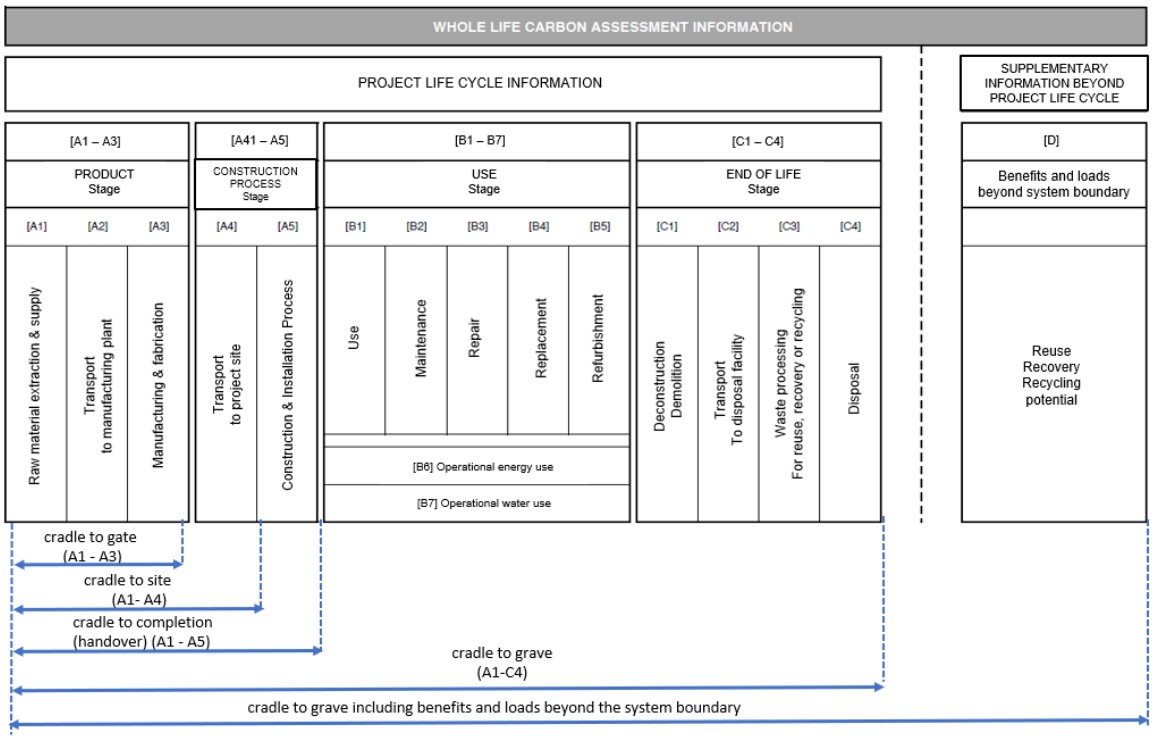

Figure 5: Whole life carbon assessment corresponding to the life cycle stages

Lifecycle Stages:

Modules A1 – A3 : Product Stage
Product stage accounts for carbon emissions arising from the cradle to gate processes; raw material supply, transport and manufacturing.

(also refer to EN 15978; 8.4 and 10.3)

Carbon emissions of materials from the product stage [A1–A3] can be calculated using the Embodied Carbon calculator hosted at the SGBC website. Alternatively, they can be calculated by assigning suitable emission factors derived from acceptable data sources, such as EPDs provided by the manufacturer (b) to the given elemental material quantities (a).

Calculation

[A1-A3] Carbon emissions = Material quantity (a) × Material emission factor (b)

Modules A4 – A5 : Construction Process Stage
Modules [A4] and [A5] respectively capture the emissions associated with the transportation of the materials and components from the factory gate to the project site and their assembly into a building.

[A4] Transport emissions must include all stages of the journey of the products following their departure from the final manufacturing plant to the project site, taking into account any interim stops at storage depots and/or distribution centres.

[A5] The construction – installation process emissions arising from any on- or off-site construction-related activities must be included. This includes any energy consumption for site accommodation, plant use and the impacts associated with any waste generated through the construction process, its treatment and disposal.

Calculation

[A4] Transport carbon emissions can be calculated using the Embodied Carbon Calculator hosted at the SGBC website or any software tools listed in Table 4.

[A5] Construction installation process emissions can be calculated using the Embodied Carbon Calculator hosted at the SGBC website or any software tools listed in Table 4.

Modules B1 – B7 : Use Stage

The Use Stage emissions include operational energy and water use and any embodied carbon impacts associated with maintenance, repair, replacement and refurbishment of building components over its entire life cycle, from practical completion to the end of its service life. (Note: [B7] is **excluded** from WLC assessment)

Reasonable Use scenarios should be developed for maintenance, repair, replacement, refurbishment and operation of the building based on project-specific information and consultation with the project team.

[B1] In use emissions – To account for emissions released from building elements arising from the normal conditions of use and the impact of potential carbon absorption to be included. For example, emissions arising from refrigerants, insulation blowing agents, paints, etc. over the life cycle of the building.

(also refer to EN 15978; 7.4.4.2 and 8.6.2, and EN 15804; 6.3.4.4.2)

[B2] Maintenance emissions - To account for emissions arising from the following building element categories – Roof, External walls, Windows and External Doors, Finishes and Services (MEP). Additional items should be included as appropriate if specific information on their maintenance is provided.

(also refer to EN 15978; 7.4.4.3 and 8.6.3 and EN 15804; 6.3.4.4.2)

Emissions arising from activities relating to maintenance processes for functional and technical performance of the building façade and building integrated technical systems, including cleaning, products used are to be included.

Reasonable Maintenance scenarios should be developed based on data from facilities management and maintenance strategy reports, façade access and maintenance strategies, lifecycle cost reports, O&M manuals and professional guidance.

Example: Painting work on window frames, doors etc. and the annual inspection of and maintenance of the boiler, replacement of filters in heat recovery or air conditioner.

Minimum WLC Assessment scope on [B2] – Emissions from Façade maintenance to be included

The façade maintenance should minimally cover the cleaning and painting of the building. While the cleaning cycle may vary depending on many factors, where there is no specific qualifying data for items the following assumptions may be utilised.

<table>
<tr><th></th><th>Guiding Assumptions</th></tr>
<tr><td>Cleaning Resources used</td><td><u>Glass Surface (Wet Method)</u>
Water usage: 213.7 g/m2
Detergent usage: 1.8 g/m2
<u>Aluminium Panels (Wet Method)</u>
Water usage: 119.7 g/m2
Detergent usage: 3.6 g/m2

Figures are based on study on Façade Cleaning Process analysis (See references)</td></tr>
<tr><td>Façade Cleaning Cycle</td><td><table>
<tr><th>Façade Type</th><th>Industrial Areas</th><th>Other Areas</th></tr>
<tr><td>Glass Curtain Wall</td><td>2 x/year</td><td>1 x/year</td></tr>
<tr><td>Concrete Wall</td><td>1 x/year</td><td>1 x/year</td></tr>
<tr><td>Aluminium Panels</td><td>4 x/year</td><td>2 x/year</td></tr>
</table>
For more details refer to Maintainability of Facilities: For Building Professionals (see reference)</td></tr>
<tr><td>Painting Cycle</td><td>7 years*

*Based on Building Maintenance and Strata Management Act</td></tr>
<tr><td>Emission factor</td><td>To be determined based on repository utilised for assessment or EPD repository</td></tr>
</table>

Guiding assumptions on Façade Maintenance

[B3] Repair emissions – To account for emissions arising from building element categories, which are also applicable as maintenance emissions in [B2].

(also refer to EN 15978; 7.4.4.4 and 8.6.3)

Emissions arising from activities relating to repair processes and any products used, including waste management and EoL stage of the removed part of the components and/or products are to be included.

Reasonable Repair scenarios should be developed based on data from facilities management and maintenance strategy reports, façade access and maintenance strategies, lifecycle cost reports, O&M manuals and professional guidance.

Example: For a window with a broken pane, emissions include waste generated by the pane, production, transportation of a new pane and all impacts due to the repair process (rubber seals, etc.) (Note: applies to the same building element categories as Maintenance emissions)

[B4] Replacement emissions – include emissions from anticipated replacement of building components, including any emissions from the replacement process. These will occur at different cycles depending on the original specification and corresponding life span of different elements. Where there is no specific qualifying data for the lifespan of components, reference can be made to Table : Indicative Life span of Components in calculating the replacement emissions.

Emissions arising from the production, transportation to site and installation of the replacement items, including waste management and EoL stage of the removed component and/ or products are to be included. This is also applicable to any losses during these processes, and the carbon associated with component removal and EoL treatment.

(also refer to EN 15978; 7.4.4.5 and 8.6.3)

Example: Replacement of a roof beam, partition wall, window (frame, glass), etc.

Minimum WLC Assessment scope on [B4] – Emissions from ACMV replacement to be included

The minimum assessment should include the replacement of building Air-conditioning system. Where there is no specific qualifying data, assessors may refer to table on Indicative lifespan of components.

Life span of Components (indicative)

Building part	Building Elements/Components	Expected Life span (years)
Roof	Roof coverings	30
Superstructure	Internal partitioning and dry lining	30
Finishes	Wall finishes	30
	Render/Paint	10
	Floor finishes	30
	Raised Access Floor [RAF]/Finish layers	10
	Ceiling finishes	20
	Substrate/ Paint	10
FF&E	Loose furniture and fittings	10
Services/ACMV/MEP	Heat source, e.g boilers, calorifiers	20
	Water cooled chilled water system	20
	Air cooled chilled water system	15
	Unitary aircon system	10
	Mechanical Ventilation System	15
	Pumps	20
	Solar PV system	15
	Space heating and air treatment	20
	Ductwork	20
	Electrical installations	30
	Lighting fittings	15
	Communications installations and controls	15
	Water and disposal installations	25
	Sanitaryware	20
	Lift, escalator and Conveyor installations	20
Facade	Opaque modular cladding e.g. rain screens, timber panels	30
	Glazed cladding/Curtain walling	35
	Windows and external doors	30

In the absence of more specific data, lifespans provided should be used for the components listed. Where with the actual life expectancies of the specific items to be used in the project are available, they should be used instead.

Total no. of Replacement cycles

$$= \frac{\text{RSP - Life Span of ACMV}}{\text{Life span of ACMV}}$$

Worked Example

RSP : Design life span = 50 yrs

Life span of Air-cooled chilled water system = 15 yrs

Total no. of Replacement cycles

$= \frac{50 - 15}{15} = 2.3$

Minimum no. of Replacement cycles = 2

[B5] Refurbishment emissions – include emissions from building components used in refurbishment and from the refurbishment activities.

Emissions arising from the production, transportation to site and installation of the replacement items, , including waste management of the refurbishment process and EoL stage of the replaced component must be included. This is also applicable to any losses during these processes, and the carbon associated with component removal and EoL treatment.

Calculation of Refurbishment emissions should account for any material additions and variations as per new build instead of like for like as in replacement. If no requirements for refurbishment is stated in Client's brief, scenarios for refurbishment shall be typical for the type of building being assessed.

(also refer to EN 15978; 7.4.4.6 and 8.6.4, EN 15804: 6.3.4.4.2)

Example: A major change of the internal layout (partitioning) and/ or the building envelope, change of technical systems related to heating, cooling or air conditioning, modifications for the purposes of a planned or expected change of use.

[B6] Operational energy use – include emissions from energy use of building integrated systems as projected and/ or measured throughout the lifecycle of the project. Carbon emissions from non-building related systems e.g. ICT equipment, cooking appliances, specialist equipment, etc. should be included.

All energy generating units (renewable and non-renewable sources) located within the building site, regardless if they have other functions such as providing protection against rain and wind penetration to the roof, or façade, must be included in the assessment.

Example: Photovoltic panels installed in the garden of the site, which does not form part of the building envelope but delivering energy for use in the building or as exported energy should be included in the assessment.

(also refer to EN 15978; 7.4.4.7 and 8.6.5)

[B7] Operational water use include all building integrated water consuming processes of building under operation such as processes for drinking water, domestic hot water, irrigation of associated landscape areas, green roofs and green walls, water for heating, cooling, ventilation and humidification, other specific water use of building-integrated systems. (Note: [B7] is **excluded** from WLC assessment)

(also refer to EN 15978; 7.4.4.8 and 8.6.6)

Example: Fountains, swimming pools, saunas. (Note: [B7] is excluded from WLC assessment. Energy use associated with providing domestic hotwater and other water use related systems are included in module [B6])

Modules C1 – C4 : End of Life (EoL) Stage

The end of life stage of a building starts when the building is decommissioned and will no longer be used. The building is considered to have reached its end of life when all components and materials that were to be cleared from the site have been removed and the site is cleared for future re-use. The emissions arising from decommissioning, disassembly, deconstruction and demolition works, including from transportation, processing and disposal of materials at the end of life of the project must be accounted for. For the purpose of the WLC assessment, this EoL stage is assumed to occur at the end of the reference study period (RSP). EoL stage is considered complete within the WLC assessment scope when the site is levelled to the ground and is ready for further use.

[C1] Deconstruction and demolition emissions – include emissions arising from any onsite or offsite deconstruction and demolition activities. Energy consumption for site accommodation and plant use must be accounted for.

(also refer to EN 15978; 7.4.5.2 and 8.7.2)

[C2] Transport emissions – include emissions arising from transportation of deconstruction and demolition to disposal and up to end of waste state.

(also refer to EN 15978; 7.4.5.3 and 8.7.3)

Calculation

[C2] Transport carbon emissions for disposed waste items :

[C2] = Mass of waste to be transported (a) x Transport emission factor (b) x Distance to disposal site

[Note: Assume average heavy goods vehicle (HGV) with 50% load to account for vehicles coming to site empty and leaving with 100% load.]

[C3] Waste Processing for reuse, recovery or recycling emissions – include emissions in treating and processing materials/ components intended to be recovered or recycled prior to reaching end of waste state.

(also refer to EN 15978; 7.4.5.4 and 8.7.4)

Calculation

To develop EoL scenarios for each item. Data from relevant EPDs should be used, adjusted accordingly to suit the EoL scenario.

[C4] Disposal emissions – include emissions of items not being recovered for reuse and/or recycling but intended for final disposal either in landfill or incineration.

(also refer to EN 15978; 7.4.5.5 and 8.7.5)

Calculation

To develop EoL scenarios for each item. Data from relevant EPDs should be used, adjusted accordingly to suit the EoL scenario.

Module D : Benefits and loads beyond the life cycle

Module D Computation (without software)

To calculate figures for module D, the figures should be reported as potential savings under module D, reported in kgCO2e/m2 and calculated as follows (see also RICS PS Section 3.5.5):

For a particular component, (e.g. a steel beam), the figures for modules A1-A3 should be used plus an allowance for transport to the future site.

For an entire structural frame that will remain on site for future reuse, the figures from both the product and construction stages should be used (modules A1-A5), plus an allowance against any avoided deconstruction, using the figures for modules C1, C2 and C4.

Factors and Influences on assessment

Carbon sequestration

Biogenic carbon

Through the process of photosynthesis, atmospheric carbon dioxide (CO_2) is absorbed by the growing trees and this absorbed CO_2 is locked into timber as biogenic carbon until its EoL.

Requirement

Sequestered carbon can only be included in the impacts of the EoL stage of the WLC assessment if the timber is sustainably sourced – certified by FSC, PEFC or equivalent. This is to ensure that any trees felled are being replaced with a minimum of the same number of trees planted to ensure they do not contribute to deforestation and not compromising the overall carbon-absorbing capacity of forests.

Calculation of biogenic carbon in accordance to EN 16449:

$$P_{CO2} = \frac{44}{12} \times cf \times \frac{\rho_\omega \times V_\omega}{1 + \frac{\omega}{100}}$$

P_{CO2} : sequestered CO_2 – biogenic carbon oxidised at EoL

cf : Carbon fraction of woody biomass (dry)

ρ_ω : timber density at the given moisture content

V_ω : timber volume at the given moisture content

ω : moisture content of timber product

Default values in accordance to EN 16449

In the absence of specific data for timber element under study, default values below can be used to calculate sequestered CO_2.

cf = 50%; ω = 12(%)

Where timber is being reclaimed and reused, the sequestered carbon is assumed to be retained and carry forward within the timber elements being recovered and used in subsequent project. (refer to EN 16485; 6.3.4.2) Hence, this sequestered carbon should be included in Module D as a potential future benefit locked within products deriving from recovered timber.

Timber Formwork

Impact of carbon in the use of timber formwork can be considered under the simplified approach in WLC assessment.

Calculation of sequestered carbon in timber formwork

Where the formwork is expected to be reused X times in several projects, the sequestered carbon and the subsequent disposal emissions [C4] in accordance to the anticipated EoL scenario is divided by the X (number of expected reuse).

Timber formwork can be assumed to be reused three times and incinerated at EoL in the absence of more specific information from the project. Carbon sequestration figures should be reported

separately, but included in the total product stage figures [A1 to A3] provided the specified conditions are met.

Carbonation of CaO and $Ca(OH)_2$

Concrete contains calcium hydrated oxides and undergo carbonation, when left exposed. Carbonation is a process where the calcium oxide (CaO) and calcium hydroxide ($CA(OH)_2$) of exposed concrete react with CO_2 in the atmosphere. The carbonation process occurs over the life span of concrete elements and should be included for the in use [B1] stage and EoL stages, where applicable.

Where scenario conditions selected in the data source coincide with the anticipated project specific scenario, data from EPDs or equivalent source can be used to account for the impact of carbonation in stages [B1] and [C3]/[C4].

Life cycle stages corresponding to Standards reference

Life cycle stages (Module)	**BS EN 15978**	**BS EN 15804**
[A1-A3] Product stage	7.4.2 and 8.4	6.3.4.2
[A4-A5] Construction Process Stage	7.4.3 and 8.5	6.3.4.3
[A4] Transport emissions	7.4.3.2 and 8.5	6.2.3
[A5] Construction - Installation Process emissions	7.4.3.3 and 8.5	6.2.3
[B1-B7] Use stage	7.4.4.1 and 8.6.1	6.3.4.4.1
[B1] In use emissions	7.4.4.2 and 8.6. 2	6.3.4.4.2
[B2] Maintenance emissions	7.4.4.3 and 8.6.3	6.3.4.4.2
[B3] Repair emissions	7.4.4.4 and 8.6.3	
[B4] Replacement emissions	7.4.4.5 and 8.6.3	
[B5] Refurbishment emissions	7.4.4.6 and 8.6.4	6.3.4.4.2
[B6] Operational energy use	7.4.4.7 and 8.6.5	6.3.4.4.2
[B7] Operational Water use	7.4.4.8 and 8.6.6	
[C4] End of Life [EoL] stage	7.4.5.1 and 8.7.1	6.3.4.5
[C1] Deconstruction and demolition emissions	7.4.5.2 and 8.7.2	
[C2] Transport emissions	7.4.5.3 and 8.7.3	
[C3] Waste processing for reuse, recovery or recycling emissions	7.4.5.4 and 8.7.4	
[C4] Disposal emissions	7.4.5.5 and 8.7.5	
[D] Benefits and loads beyond the system boundary	7.4.6 and 8.8	6.3.4.6 and 6.4.3

Table: Life cycle stages corresponding to Standards reference

CN References

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