STANDARD INDUSTRI PEMBINAAN

(CONSTRUCTION INDUSTRY STANDARD)

CIS 20:2021

GREEN PERFORMANCE ASSESSMENT SYSTEM IN CONSTRUCTION

Descriptors: carbon based performance assessment system, (site, energy, IEQ, waste, water), carbon emissions reduction, rating

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GREEN PERFORMANCE ASSESSMENT SYSTEM IN CONSTRUCTION

CIDB MALAYSIA

CIS 20: 2021 Green Performance Assessment System In Construction

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TABLE OF CONTENTS

Table

Figure

COMMITTEE REPRESENTATION

This Construction Industry Standard (CIS) was managed and developed by the Construction Industry Development Board Malaysia with the assistance of the Technical Committee on Green Building Rating System which comprises representatives from the following organisations:-

Sustainable Energy Development Authority Malaysia
Jabatan Alam Sekitar Malaysia
Malaysia Energy Professionals Association
The Institutions of Engineers Malaysia
Universiti Sains Malaysia
IJM Construction Sdn Bhd

PREFACE

This Construction Industry Standard (CIS) hereby referenced as CIS 20: 2021 was developed as a green performance assessment system in construction in short Green PASS by the Technical Committee on Green Building Rating System with the assistant of Construction Industry Development Board (CIDB) Malaysia which acted as a moderator and facilitator for the technical committee throughout the development process of this standard.

While this CIS 20: 2021 on Green Performance Assessment System in Construction adopts several components with reference to regulatory requirements under DOSH, DOE, UBBL and several relevant international as well as local standards, it is also dependent on new or updated information and developments concerning this subject area made available through this Technical Committee.

Compliance with this Construction Industry Standard does not of itself confer immunity from legal obligations.

GREEN PERFORMANCE ASSESSMENT SYSTEM IN CONSTRUCTION

SECTION 1: GENERAL

1.1 Introduction

CIDB recognises the need for performance-based standards in addressing green construction to provide a framework linking sustainability with performance in order to mitigate climate change. Green Performance Assessment System in Construction (Green PASS) is designed to meet this need through a standard conformance that promotes sustainable construction in an integrated manner with other Construction Industry Standards (CIS). It is an independent construction standard that assesses and rates the impact of building construction on the environment.

The Green PASS is founded on the principle that a model standard must address building performance beyond those captured by rating systems or other evaluation guides, and therefore, it shall be useable and adoptable in making it an effective system for the construction industry.

This standard is based on minimum requirements for buildings and systems using performance-related provisions and complements existing standards to form a comprehensive assessment system for green building construction.

The Green PASS has incorporated international standards in its development, specifically PAS 2050, Common Carbon Metrics (United Nations SBCI), United Nations GHG Protocol, ANSI and other relevant standards inline with emerging global technological and sustainability requirements.

1.2 Scope

The Green PASS estimates the carbon emission from building construction works throughout a building's life cycle without compromising on desirable comfort level of the building by assessing on the Indoor Environmental Quality (IEQ). The building life cycle defined within this assessment system covers construction, operations, renovation and demolition. The Green PASS provisions are applicable to both building construction and operations.

The evaluation of Green PASS is divided into:

a) Building Construction; and

b) Building Operations

Both categories will be evaluated for embodied carbon and operational carbon for Building Construction and operational carbon for Building Operations.

Embodied carbon is referred to as COe_2 emitted during the construction or retrofitting processes. Operational carbon is CO_2 emitted during building operational stage until the end of life of building. This standard assumes a building life span of 50 years.

In order to ensure that performance against fundamental environmental issues is not over-looked in pursuit of a particular rating, the Green PASS adopt minimum standards of performance for baselines in key areas e.g. energy, water, waste, IEQ. These are minimum

acceptable levels of performance and, in that respect they should not necessarily be viewed as levels that are representative of best practice for the Green PASS.

1.3 Normative reference

The following normative references are indispensable for the development of Green PASS. For dated references, the citation was made in reference to that edition only. In the case of undated references, the citation was based on the latest edition of the publication.

MS 1525, Code of practice on energy efficiency and use of renewable energy for non-residential buildings

MS 2680, Code of practice on energy efficiency and use of renewable energy for residential buildings

PAS 2050, Methods for assessing the life cycle of green house gas (GHG) emissions of goods and services (jointly referred to as “products”)

Inventory of Carbon and Energy (ICE), Geoff Hammond and Craig Jones, University of Bath, UK, 2011

Guidelines on Occupational Safety and Health Management Systems, DOSH Malaysia, 2011

ANSI/ ASHRAE Standard 62 – Ventilation for Acceptable Indoor Air Quality

ANSI/ ASHRAE Standard 55 – Thermal Environmental Conditions for Human Occupancy

ANSI/ ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

CIS 7: 2021, Quality Assessment System for Building Construction Work (QLASSIC)

CIS 10: 2020, Safety and Health Assessment System in Construction (SHASSIC)

1.4 Definitions

For the purposes of this standard, the following definitions shall apply.

1.4.1 Green PASS assessor

This person is a qualified and appointed representative of CIDB, authorised to evaluate the application of the Green PASS.

1.4.2 carbon footprint

This is a measure of the total amount of carbon dioxide emission equivalent (CO_2e) that is directly and indirectly caused by any activity, or is accumulated over the life cycle of a construction product.

1.4.3 **greenhouse gas** (GHG)

GHG are gases that cause global warming by absorbing and emitting infrared radiation into the atmosphere.

The GHG include, but are not limited to, Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrochlorofluorocarbons (HCFCs), Perfluororocarbons (PFCs) and Sulphur Hexafluoride (SF_6).

1.4.4 **climate change**

Climate change is defined as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere.

1.4.5 **evapotranspiration**

Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces.

1.4.6 **indoor environmental quality** (IEQ)

IEQ refers to the overall comfort of a building's interior as well as the comfort and health of its occupants.

1.4.7 **embodied carbon**

The carbon emitted to the atmosphere by the energy consumed by all processes associated with the construction of a building, from the acquisition of natural resources up to the completion of the building.

1.4.8 **operational carbon**

All forms of carbon emitted by the energy consumed during the life span of a building where it is used for the purpose it was designed.

1.4.9 **cradle-to-gate**

Cradle-to-gate is an assessment boundary from the source of raw material (cradle) to the gate of the factory.

1.4.10 **baseline**

Baseline is a base of measurement or point of reference, verified and extracted from recognised authorities. It can also be established from calculations using existing information.

1.4.11 **grey water**

Grey water is the wastewater generated from domestic activities such as laundry, dishwashing and bathing which can be recycled.

1.4.12 **black water**

Black water is the wastewater containing faecal matter and urine.

1.4.13 scope of emissions

a) Scope 1

   Emissions are greenhouse gas emissions which occur as a direct result of activities at a facility.

b) Scope 2

   Emissions cover greenhouse gas emissions from the generation of purchased electricity, steam, heating or cooling consumed by a facility.

c) Scope 3

   Emissions cover all indirect emissions that are not included in scope 2, such as the transport and distribution of purchased fuel.

1.4.14 gross floor area

gross floor area is a building area in m^2.

1.4.15 biodiversity

Biodiversity is the variety of life on earth. It includes all species, animals, plants, fungi, algae, bacteria and the habitats that they depend upon.

1.4.16 life cycle assessment (LCA)

Life Cycle Assessment is a technique to evaluate the relevant energy and material consumed and environmental emissions associated with the entire life of a product, process, activity or service.

1.4.17 native vegetation

Native plants are plants that have adapted to a given area and are not invasive.

1.4.18 carbon neutral

Net zero carbon footprints by balancing a measured amount of carbon released with an equivalent amount sequestered to make up the difference.

1.4.19 carbon storage

Carbon currently held in plant tissue (tree bole, branches, and roots).

1.4.20 carbon sequestration

The estimated amount of carbon removed annually by plants, through the process of photosynthesis.

1.4.21 **carbon dioxide equivalent** (CO_2e)

The universal unit for comparing emissions of different GHGs, expressed in terms of global warming potential (GWP) of one unit carbon dioxide.

1.4.22 **girth at breast height** (GBH)

Girth at breast height (GBH) is a standard method for determining the trunk girth of a standing tree.

1.4.23 **wetlands**

Wetlands are areas such as swamps, bogs, and marshes where water either covers the soil or is present at or near the surface, particularly in the root zone, at least a good portion of the year, including the growing season.

1.5 Objective of Green PASS

1.5.1 Green PASS was designed and developed to achieve the following objectives;

a) to evaluate the environmental impact of construction and operational performance of buildings in relation to carbon emission reduction;

b) to give due recognition for low carbon building construction and operations;

c) to align and support the Low Carbon Cities Framework and Assessment System (LCCF) initiatives;

d) to encourage peer review of construction and operations management practices towards sustainable construction; and

e) to increase awareness of carbon reduction and environmental impact in construction and building operations amongst project stakeholders.

1.5.2 The outcomes of the Green PASS provide information on the:

a) Baseline emissions and project emissions from five elements: site; material; energy; water; waste;

b) A non-GHG qualitative and quantitative analysis of Indoor Environmental Quality;

c) Percentage reduction in carbon emissions; and

d) Opportunity for further improvement.

1.6 Application of Green PASS

Green PASS assesses the whole performance of a building in terms of carbon emission reduction based on five elements; site, material; energy, water and waste, while indoor environmental quality (IEQ) is a qualitative and quantitative assessment of building occupants' comfort and overall satisfaction. The level of achievement in carbon reduction is designated by a diamond scheme. Each bandwidth is signified by a number of diamonds ranging from one to six. An achievement of 100 % carbon reduction is designated carbon neutral, represented by six diamonds.

1.6.1 Green PASS gives recognition to low carbon building by awarding certification for:

a) Building Construction; and

b) Building Operation.

The assessment of Building Construction begins from site possession until the issuance of certificate of completion and compliance (CCC).

Renovation works involving major structural changes and with more than 50 % materials replacement will be considered major construction therefore qualifying for applicability of the Green PASS building construction award.

The assessment of Building Operations will only be eligible upon meeting two conditions specified below:

a) Receipt of certificate of completion and compliance (CCC) for newly completed building; and

b) 12 months of operations with a minimum of 70 % occupancy for newly completed building and retrofitted buildings.

The Green PASS complements other existing green building rating tools by assessing building performance, irrespective of the design guides implemented in the project. It is a dynamic document which will evolve through periodic revisions to reflect robust local values, technological advances, new methods and materials including quality and safety requirements. The Green PASS is a reflection of Malaysian building performance that can be compared and benchmarked with international building performance standards and targets.

1.7 Assessment approach

This standard evaluates the carbon emission of a building construction and operations which is compared to the carbon emission baseline. The carbon emission baseline is the calculation of the sum of embodied and operational carbon conducted or projected in a Business As Usual (BAU) scenario.

In any given project, the percentage of carbon reduction is based on the difference between the CO_2 emission of the BAU scenario and the CO_2 emission of the new/ retrofitted building. The quantum of carbon reduction is designated by a diamond rating.

The submittal documents required by the Green PASS may be superseded by any relevant documentation required for authority submissions, standard compliance or standard operating procedures found within a project procedure manual. This shall minimize document duplication. Alternative submittal documents will in no way compromise the intent of the Green PASS requirements for assessment.

1.8 Baseline

The carbon emission baseline of any embodied or operational carbon is the CO_2 emission projected in anyone of the following scenario:

a) Existing actual or historical emissions, as applicable;

b) Emissions from a technology that represents an economically attractive course of action, or

c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances.

The first and the third approach are relating to mathematical formula expression of (baseline) emission, the second approach relates to identification of baseline scenario. Baselines derived from any of the above methods shall not supersede any existing regulatory requirements or policies.

SECTION 2: STRUCTURE OF GREEN PASS

2.1 Green PASS certification

The Green PASS certification is divided in two categories:

a) Building Construction; and

b) Building Operations.

The overall structure of the Green PASS is summarised in Figure 1.

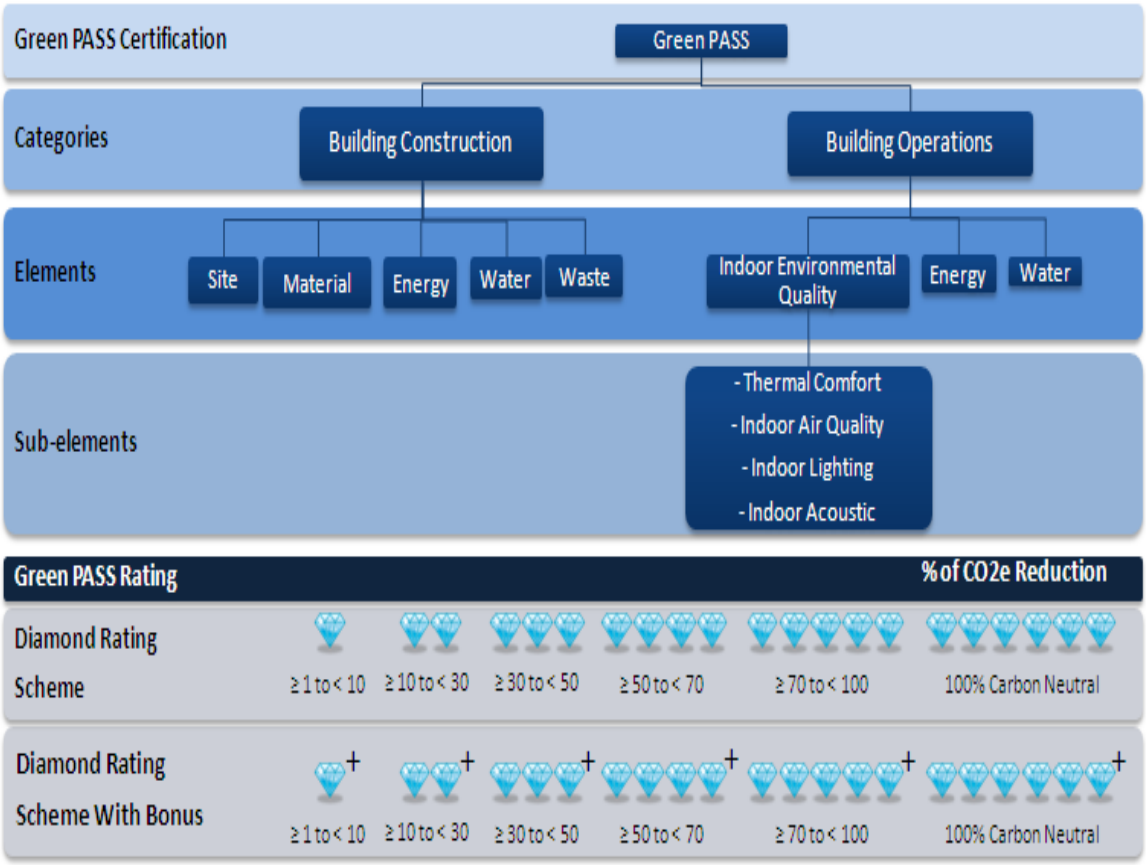


Figure 1. Structure of Green PASS

The Green PASS Building Construction is opened to applications from building developers, consultants or contractors responsible for the whole construction implementation of a project. The Green PASS Building Construction Certification shall be awarded to the respective applicants upon the fulfilment of standard procedures and project implementation requirements.

The assessment for Building Construction is based on five elements; site; material; energy; water; and waste. For each Green PASS application CIDB will appoint an assessor who will conduct the assessment accordingly.

Upon completion of the assessment, the applicant will be awarded a Green PASS certificate displaying:

a) the category of assessment (Green PASS Building Construction or Green PASS Building Operation); and

b) the level of carbon reduction achieved, represented by number of diamonds

The Building Construction Certification is entitled to Bonus Rewards when the project implements sustainable construction practices in accordance to the Construction Industry Standards of IBS, SHASSIC and QLASSIC, and meeting their requirements as described later in Section 5.5.

The Green PASS Building Operations is opened to applications from building owners and will be awarded upon the fulfilment of standard procedures and meeting the requirements of Green PASS.

The assessment for building operations is based on three main elements; IEQ, energy and water. The element of IEQ is further divided into four sub-elements; thermal comfort, indoor air quality (IAQ), indoor lighting and indoor acoustic.

The process of assessment for Green PASS Building Operations is similar to the building construction assessment described above without the Bonus Rewards.

SECTION 3: ASSESSMENT FOR BUILDING CONSTRUCTION

3.1 Site

3.1.1 Intent

To conserve natural ecology, landscapes and reduce the impact on the site's biodiversity due to land use change (development).

3.1.2 Requirements

a) Complete the information required for site and land use change in Table 1 (1A-1H), wherever relevant to the project.

b) Provide an approved site development plan indicating:

   i) natural resources such as water bodies and green open spaces;

   ii) areas for the building, parking and access road;

   iii) natural slopes and significant existing vegetation; and

   iv) vegetation reinstalled on site.

Table 1A. Natural ecology and landscape

A	Natural Ecology and Landscape	Surface Area (m^2)	Types of Vegetation
A1	Wetland ● Natural ● Artificial (specify surface area and type of vegetation)		
A2	Water bodies ● Rivers, streams, waterfalls ● Lakes (specify surface area)		
A5	Green Open Space ● Forest reserves (including urban forestry) ● Parks ● Grassland (specify surface area and type of vegetation)		
A4	Agricultural Land (specify surface area and type of vegetation)		
A6	Peat land (specify surface area and type of vegetation)		

Table 1B. Natural slopes from 15° - 25°

	Natural Slopes						
	Requirements	**Landscape**	**Units**	**Quantity**	**Age (Years)**	**Girth at Breast Height (GBH)**	**Height (m)**
B1	Slope: 15°-25° To restore 40 % of slope area with vegetation	NA	m^2		NA	NA	NA
	Group of vegetation	Specify type of vegetation on slope ● Native plants ● Bamboo ● Grassland ● Shrubs ● Turf	 m^2 m^2 m^2 m^2 m^2			NA	NA
	Individual vegetation	Girth <u>less</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				
		Girth <u>greater</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				

NOTE:
1. Girth can be derive from π (3.142) multiply by diameter.

Table 1C. Natural slopes from 26° - 40°

	Natural Slopes						
	Requirements	**Landscape**	**Units**	**Quantity**	**Age (Years)**	**Girth at Breast Height (GBH)**	**Height (m)**
B2	Slope: 26°-40° To restore 60 % of slope area with vegetation	NA	m^2		NA	NA	NA
	Group of vegetations	Specify type of vegetation on slope ● Native plants ● Bamboo ● Grassland ● Shrubs ● Turf	 m^2 m^2 m^2 m^2 m^2			NA	NA
	Individual vegetation	Girth <u>less</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				
		Girth <u>greater</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				

NOTE:
1. Girth can be derive from π (3.142) multiply by diameter.

Table 1D. Natural slopes greater than 40°

	Natural Slopes						
	Requirements	**Landscape**	**Units**	**Quantity**	**Age (Years)**	**Girth at Breast Height (GBH)**	**Height (m)**
B3	Slope: greater than 40° To restore 100 % of slope area with vegetation	NA	m^2		NA	NA	NA
	Group of vegetation	Specify type of vegetation on slope ● Native plants ● Bamboo ● Grassland ● Shrubs ● Turf	m^2 m^2 m^2 m^2 m^2			NA	NA
	Individual vegetation	Girth <u>less</u> than 34.6 inches (877 mm) ● Plants ● Palm	number number				
		Girth <u>greater</u> than 34.6 inches (877 mm) ● Plants ● Palm	number number				

NOTE:
1. Girth can be derive from π (3.142) multiply by diameter.

Table 1E. Land use for building

	Land Use Change						
	Requirements	**Landscape**	**Units**	**Quantity**	**Age (Years)**	**Girth at Breast Height (GBH)**	**Height (m)**
C1	Site clearing for building footprint (specify area of clearing)	NA	m^2		NA	NA	NA
	Group of vegetation	Specify type of vegetation on slope ● Native plants ● Bamboo ● Grassland ● Shrubs ● Turf	m^2 m^2 m^2 m^2 m^2			NA	NA
	Individual vegetation	Girth <u>less</u> than 34.6 inches (877 mm) ● Plants ● Palm	number number				
		Girth <u>greater</u> than 34.6 inches (877 mm) ● Plants ● Palm	number number				

NOTE:
1. Girth can be derive from π (3.142) multiply by diameter.

Table 1F. Land use for parking space

	Land Use Change						
	Requirements	**Landscape**	**Units**	**Quantity**	**Age (Years)**	**Girth at Breast Height (GBH)**	**Height (m)**
C2	Site clearing for parking footprint (specify area of clearing)	NA	m^2		NA	NA	NA
	Group of vegetation	Specify type of vegetation on slope ● Native plants ● Bamboo ● Grassland ● Shrubs ● Turf	 m^2 m^2 m^2 m^2 m^2			NA	NA
	Individual vegetation	Girth <u>less</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				
		Girth <u>greater</u> than 34.6 inches (877 mm). ● Plants ● Palm	 number number				

NOTE:
1. Girth can be derive from π (3.142) multiply by diameter.

Table 1G. Land use for access road

	Land Use Change						
	Requirements	**Landscape**	**Units**	**Quantity**	**Age (Years)**	**Girth at Breast Height (GBH))**	**Height (m)**
C3	Site clearing for parking access road (specify area of clearing)	NA	m^2		NA	NA	NA
	Group of vegetation	Specify type of vegetation on slope ● Native Plants ● Bamboo ● Grassland ● Shrubs ● Turf	 m^2 m^2 m^2 m^2 m^2			NA	NA
	Individual vegetation	Girth <u>less</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				
		Girth <u>greater</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				

NOTE:
1. Girth can be derive from π (3.142) multiply by diameter.

Table 1H. Reinstallation of landscape

	Reinstallation of Landscape						
	Requirements	**Landscape**	**Units**	**Quantity**	**Age (Years)**	**Girth at Breast Height (GBH)**	**Height (m)**
D	Group of vegetation	Specify type of vegetation on slope ● Native trees ● Bamboo ● Grassland ● Shrubs ● Turf	 m^2 m^2 m^2 m^2 m^2			NA	NA
	Individual vegetation	Girth <u>less</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				
		Girth <u>greater</u> than 34.6 inches (877 mm) ● Plants ● Palm	 number number				

NOTE:
1. Girth can be derive from π (3.142) multiply by diameter.

3.1.3 Baseline

a) In the BAU scenario the whole area of development is assumed to be cleared.

b) Wetland, water bodies and natural reserves are assumed to remain undisturbed during construction.

c) Assume native trees from forest plantation types.

d) Turf grass (lawn) does not exceed 40 % of the vegetated area of building site.

The rates of carbon sequestration for types of vegetation are shown in Table 2 and 3.

Table 2. Carbon sequestration rates of plantation

Classification	Common Name	Scientific Name	Carbon Sequestration (tC/ ha/ year)	Carbon Sequestration (tCO_2/ ha/ year)
Plantation Forest	Sabah Salwood	Acacia Mangium	6.39	23.43
	Teak	Tectona Grandis	5.65	20.71
	Pine	Pinus Spp.	5.65	20.71
	Rubber	Hevea Brasiliensis	6.78	24.86
	Saurian Bawang	Azadirachta Excelsa	5.1	18.70
	Akasia Kuning	A. Auriculiformes	4.8	17.60
	Red Wattle	A. Crassicarpa	6.25	22.92
	Brown Wattle	A. Aulococarpa	6.25	22.92
	Akasia Hibrid	A. Hybrid	6.22	22.81
	Downy Serviceberry	A. Arborea	6.4	23.47
	Kayu Machis	Paraserianthes Falcataria	6.25	22.92
	White Teak	Gmelina Arborea	11.31	41.47
	Mindanao Gum	Eucalyptus Deglupta	11.68	42.83

NOTE:
2. Source from Forest Research Institute Malaysia (FRIM)
3. Use the factor value in Table 2 or the latest official factor issued by FRIM.

Table 3. Carbon sequestration rates of grassland, bamboo and water bodies

Natural Vegetation/ Cover	tCO_2/ ha/ yr
Grassland	0.56
Bamboo (International Network of Bamboo and Rattan)	378
Tropical wetlands (Ohio State University)	2.56

NOTE:
1. Source from Forest Research Institute Malaysia (FRIM)
2. Use the emission value in Table 3 or the latest official factor issued by FRIM.

3.2 Material

3.2.1 Intent

To reduce the environmental impacts of buildings through use of low carbon embodied materials.

3.2.2 Requirements

The carbon emissions from materials manufacturing and transportation can be calculated from Eq. 1.

$$E = (W_{mat} * EF_{mat\ cg}) + (W_{mat} * D_{gs} * EF_{v}) \quad \text{Eq. 1}$$

Where,

E Emissions from materials manufacturing and transportation (kg CO_2e)

W_{mat} Weight of material (kg)

$EF_{mat\ cg}$ Emission factor of material from cradle to factory gate (Table 5) (kWhr/kg)

D_{gs} Distance from factory gate (source of supply) to site (km)

EF_v Emission factor of vehicle used for transporting materials (g CO_2e/ ton.km)

a) Complete the information for materials, transportation distance and mode of transport for construction or renovation works displayed in Table 4.

b) Provide information such as purchase order, invoices, and delivery notes for materials showing manufacturer's address and transportation to construction site. The information shall specify types of materials and distance to transport from factory to construction site.

c) Provide information such as purchase order, invoices, and delivery notes for materials showing manufacturer's address and transportation to site where renovation is done. The information shall specify types of materials and distance to transport from factory to site.

Table 4. Materials and transportation for construction

Category	Construction Material	Weight of Materials (tonne)	Distance Between Source of Supply and Site (km)	Mode of Transport (road/ air/ rail/ sea)
Quarried Material	Quarried aggregate			
	Recycled aggregate			
	Marine aggregate			
	Asphalt, 4 % (bitumen) binder content (by mass)			
	Asphalt, 5 % (bitumen) binder content			
	Asphalt, 6 % (bitumen) binder content			
	Asphalt, 7 % (bitumen) binder content			
	Asphalt, 8 % (bitumen) binder content			
	Bitumen			
	Bricks			
	Clay: general (simple baked products)			
	Clay tile			
	Vitrified Clay Pipe DN 100 and DN 150			

Table 4. Materials and transportation for construction *(continued)*

Category	Construction Material	Weight of Materials (tonne)	Distance Between Source of Supply and Site (km)	Mode of Transport (road/ air/ rail/ sea)
Quarried Material	Vitrified Clay Pipe DN 200 and DN 300			
	Vitrified Clay Pipe DN 500			
	Ceramics: general			
	Ceramics: tiles and cladding panels			
	Sand			
	Soil - general/ rammed soil			
	Stone: general			
	Granite			
	Limestone			
	Sandstone			
	Shale			
	Slate			
Timber	Timber: general			
	Glue Laminated Timber			
	Hardboard			
	MDF			
	Oriented Strand Board (OSB)			
	Particle board			
	Plywood			
	Reclaimed timber			
	Sawn hardwood			
	Sawn softwood			
Metals	Copper: EU tube and sheet			
	Copper: reused copper			
	Iron			
	Lead			
	Steel: general - UK (EU) average recycled content			
	Steel: bar and rod - UK (EU) average recycled content			
	Steel: coil (sheet), galvanised - UK (EU) average recycled content			
	Steel: engineering steel - recycled			
	Steel: pipe- UK (EU) average recycled content			
	Steel: plate- UK (EU) average recycled content			

Table 4. Materials and transportation for construction *(continued)*

Category	Construction Material	Weight of Materials (tonne)	Distance Between Source of Supply and Site (km)	Mode of Transport (road/ air/ rail/ sea)
Metals	Steel: sections - UK (EU) average recycled content			
	Steel: wire - virgin			
	Steel: stainless			
	Steel: reused steel			
	Aluminium: general			
	Aluminium: extruded			
	Aluminium: rolled			
	Handrail: galvanised with fittings			
	Handrail: stainless steel with fittings			
	Handrail: stainless steel welded			
	Sheet piling: light use			
	Sheet piling: medium use			
	Sheet piling: heavy use			
	Flap valves: DN 100 and DN 150			
	Flap valves: DN 200 and DN 300			
	Flap valves: DN 500			
Plastics	Plastics: general			
	Polyethylene: general			
	High density polyethylene (HDPE) resin			
	HDPE pipe			
	Expanded polystyrene			
	General purpose Polystyrene			
	High impact polystyrene			
	PVC: general			
	PVC pipe			
Glass	Primary glass			
	Secondary glass			
	Fibreglass (glasswool)			
	Toughened glass			
Finishing, coatings and adhesives	Paint: general			
	Waterborne paint			
	Solventborne paint			
	Epoxide resin			

Table 4. Materials and transportation for construction *(continued)*

Category	Construction Material	Weight of Materials (tonne)	Distance Between Source of Supply and Site (km)	Mode of Transport (road/ air/ rail/ sea)
Miscellan -eous	Damp proof course/ membrane			
	Rubber			
	Grit			
	Ground limestone			
	Glass Reinforced Plastic - GRP - fibreglass			
	Insulation: general			
	Insulation: fibreglass (glasswool)			
	Insulation: polystyrene			
	Insulation: polyurethane			
	Insulation: polyurethane			
	Plaster: general (gypsum)			
	Plasterboard			
Concrete Blocks	Block – 8 MPa compressive strength			
	Block - 10 Mpa compressive strength			
	Block - 12 Mpa compressive strength			
	Block - 13 Mpa compressive strength			
	Autoclaved Aerated Blocks (AACs)			
Mortars	Mortar (1:3 cement:sand mix)			
	Mortar (1:4 cement:sand mix)			
	Mortar (1:5 cement:sand mix)			
	Mortar (1:6 cement:sand mix)			
	Mortar (1:½:4½ cement:lime:sand mix)			
	Mortar (1:1:6 cement:lime:sand mix)			
	Mortar (1:2:9 cement:lime:sand mix)			

Table 4. Materials and transportation for construction *(continued)*

Category	Construction Material	Weight of Materials (tonne)	Distance Between Source of Supply and Site (km)	Mode of Transport (road/ air/ rail/ sea)
Cements (do not enter cement used in concretes and mortars – that is calculated in those sections)	Average CEM I Portland Cement, 94% Clinker			
	Cement: unknown type			
	Portland Limestone Cement, CEM II/A-LL or L (20 % limestone)			
	Portland Limestone Cement, CEM II/A-LL or L (13 % limestone)			
	Portland Limestone Cement, CEM II/A-LL or L (6 % limestone)			
	Portland Fly Ash Cement, CEM II/A-V (20 % Fly Ash)			
	Portland Fly Ash Cement, CEM II/A-V (13 % Fly Ash)			
	Portland Fly Ash Cement, CEM II/A-V (6 % Fly Ash)			
	Portland Fly Ash Cement, CEM II/B-V (35 % Fly Ash)			
	Portland Fly Ash Cement, CEM II/B-V (28 % Fly Ash)			
	Portland Fly Ash Cement, CEM II/B-V (21 % Fly Ash)			
	Portland Slag Cement, CEM II/B-S (35 % GGBS)			
	Portland Slag Cement, CEM II/B-S (28 % GGBS)			
	Portland Slag Cement, CEM II/B-S (21 % GGBS)			
	Blastfurnace Cement, CEM III/A (65 % GGBS)			
	Blastfurnace Cement, CEM III/A (50.5 % GGBS)			
	Blastfurnace Cement, CEM III/A (36 % GGBS)			
	Blastfurnace Cement, CEM III/B (80 % GGBS)			
	Blastfurnace Cement, CEM III/B (73 % GGBS)			
	Blastfurnace Cement, CEM III/B (66 % GGBS)			

Table 4. Materials and transportation for construction *(concluded)*

Category	Construction Material	Weight of Materials (tonne)	Distance Between Source of Supply and Site (km)	Mode of Transport (road/ air/ rail/ sea)
Cements (do not enter cement used in concretes and mortars – that is calculated in those sections)	Pozzolanic (Siliceous Fly Ash) Cement, CEM IV/B-V (55 % GGBS)			
	Pozzolanic (Siliceous Fly Ash) Cement, CEM IV/B-V (45.5 % GGBS)			
	Pozzolanic (Siliceous Fly Ash) Cement, CEM IV/B-V (36 % GGBS)			
	Cement: general			
	21-35 % Fly Ash (CEM II/B-V)			
	21-35 % GGBS (CEM II/B-S)			
	36-65 % GGBS (CEM III/A)			
	66-80 % GGBS (CEM III/B)			
Other type of Cements	Ground Granulated Blastfurnace Slag (GGBS)			
	Fly Ash			
	Fibre Cement Panels - uncoated			
	Fibre Cement Panels - (colour) coated			
	Cement Stabilised Soil @ 5 %			
	Cement Stabilised Soil @ 8 %			
	GGBS Stabilised Soil			
	Fly Ash Stabilised Soil			

3.2.3 Baseline

a) Consider the materials most commonly used in the region on new building projects similar to the project building being assessed. Conventional materials usually used in construction are concrete, steel and masonry.

b) If not known, materials used for the project will be assumed to be purchased from the manufacturer with a higher market share in the region (major production).

The embodied carbon due to manufacturing (cradle-to-gate) is shown in Table 5:

Table 5. Embodied carbon of building materials

Category	Construction Material	Unit Conversion or Density	Embodied tCO_2e Per Tonne of Material
Quarried material	Quarried aggregate	2.0 tonnes/ m^3	0.005
	Recycled aggregate	2.0 tonnes/ m^3	0.005
	Marine aggregate	2.0 tonnes/ m^3	0.008
	Asphalt, 4 % (bitumen) binder content (by mass)	1.7 tonnes/ m^3	0.066
	Asphalt, 5 % (bitumen) binder content	1.7 tonnes/ m^3	0.071
	Asphalt, 6 % (bitumen) binder content	1.7 tonnes/ m^3	0.076
	Asphalt, 7 % (bitumen) binder content	1.7 tonnes/ m^3	0.081
	Asphalt, 8 % (bitumen) binder content	1.7 tonnes/ m^3	0.086
	Bitumen	2.4 tonnes/ m^3	0.490
	Bricks	1.9 tonnes/ m^3	0.240
	Clay: general (simple baked products)	1.9 tonnes/ m^3	0.240
	Clay tile	2.4 tonnes/ m^3	0.480
	Vitrified clay pipe DN 100 and DN 150	2.4 tonnes/ m^3	0.460
	Vitrified clay pipe DN 200 and DN 300	2.4 tonnes/ m^3	0.500
	Vitrified clay pipe DN 500	2.4 tonnes/ m^3	0.550
	Ceramics: general	1.9 tonnes/ m^3	0.700
	Ceramics: tiles and cladding panels	2.2 tonnes/ m^3	0.780
	Sand	1.2 tonnes/ m^3	0.005
	Soil - general/ rammed soil	1.7 tonnes/ m^3	0.024
	Stone: general	2.0 tonnes/ m^3	0.079
	Granite	2.9 tonnes/ m^3	0.700
	Limestone	2.2 tonnes/ m^3	0.090
	Sandstone	2.2 tonnes/ m^3	0.060
	Shale	2.7 tonnes/ m^3	0.002
	Slate	2.7 tonnes/ m^3	0.035
Timber	Timber: general	0.5 tonnes/ m^3	0.310
	Glue Laminated Timber	0.5 tonnes/ m^3	0.420
	Hardboard	26.0 kg/ m^2*20 mm	0.580
	MDF	14 kg/ m^2*20 mm	0.390
	Oriented Strand Board (OSB)	1 tonnes/ m^3	0.450
	Particle Board	6 kg/ m^2*20 mm	0.540
	Plywood	11 kg/ m^2*20 mm	0.450
	Reclaimed Timber	1 tonnes/ m^3	0.031
	Sawn Hardwood	0.6 tonnes/ m^3	0.240
	Sawn Softwood	0.5 tonnes/ m^3	0.200

Table 5. Embodied carbon of building materials *(continued)*

Category	Construction Material	Unit Conversion or Density	Embodied tCO_2e Per Tonne of Material
Metals	Copper: EU tube and sheet	8.9 tonnes/ m^3	2.71
	Copper: reused copper	8.9 tonnes/ m^3	0.27
	Iron	7.87 tonnes/ m^3	2.03
	Lead	11.34 tonnes/ m^3	1.67
	Steel: general - UK (EU) average recycled content	7.8 tonnes/ m^3	1.46
	Steel: bar and rod - UK (EU) average recycled content	7.8 tonnes/ m^3	1.40
	Steel: coil (sheet), galvanised - UK (EU) average recycled content	7.8 tonnes/ m^3	1.54
	Steel: engineering steel – recycled	7.8 tonnes/ m^3	0.72
	Steel: pipe- UK (EU) average recycled content	7.8 tonnes/ m^3	1.45
	Steel: plate- UK (EU) average recycled content	7.8 tonnes/ m^3	1.66
	Steel: sections - UK (EU) average recycled content	7.8 tonnes/ m^3	1.53
	Steel: wire – virgin	7.8 tonnes/ m^3	3.02
	Steel: stainless	8 tonnes/ m^3	6.15
	Steel: reused steel	7.8 tonnes/ m^3	0.15
	Aluminium: general	2.7 tonnes/ m^3	9.16
	Aluminium: extruded	2.7 tonnes/ m^3	9.08
	Aluminium: rolled	2.7 tonnes/ m^3	9.18
	Handrail: galvanised with fittings	0.0115 tonnes/ m	0.02
	Handrail: stainless steel with fittings	0.0115 tonnes/ m	0.09
	Handrail: stainless steel welded	0.0105 tonnes/ m	0.08
	Sheet Piling: light use	0.1 tonnes/ m^2	0.12
	Sheet Piling: medium use	0.13 tonnes/ m^2	0.15
	Sheet Piling: heavy use	0.19 tonnes/ m^2	0.20
Plastics	Plastics: general	0.96 tonnes/ m^3	3.31
	Polyethylene: general	1.05 tonnes/ m^3	2.54
	High Density Polyethylene (HDPE) Resin	1.05 tonnes/ m^3	1.93
	HDPE pipe	1.05 tonnes/ m^3	2.52
	Expanded Polystyrene	1.05 tonnes/ m^3	3.29
	General Purpose Polystyrene	1.38 tonnes/ m^3	3.43
	High Impact Polystyrene	1.41 tonnes/ m^3	3.42
	PVC pipe	0.83 tonnes/ m^3	3.23

Table 5. Embodied carbon of building materials *(continued)*

Category	Construction Material	Unit Conversion or Density	Embodied tCO_2e Per Tonne of Material
Glass	Primary glass	2.5 tonnes/ m^3	0.91
	Secondary glass	2.5 tonnes/ m^3	0.59
	Fibreglass (glasswool)	0.024 tonnes/ m^3	1.54
	Toughened glass	2.5 tonnes/ m^3	1.35
Finishing, coatings and adhesives	Paint: general	1.225 tonnes/ m^3	2.91
	Waterborne paint	1.25 tonnes/ m^3	2.54
	Solventborne paint	1.2 tonnes/ m^3	3.76
	Epoxide resin	1.19 tonnes/ m^3	5.70
Miscella-neous	Damp proof course/ membrane	0.0009 tonnes/ m^2	4.20
	Rubber	1.5 tonnes/ m^3	2.85
	Grit	2 tonnes/ m^3	0.01
	Ground limestone	0.95 tonnes/ m^3	0.03
	Glass Reinforced Plastic - GRP – fibreglass	1.74 tonnes/ m^3	8.10
	Insulation: general	0.04 tonnes/ m^3	1.86
	Insulation: fibreglass (glasswool)	0.045 tonnes/ m^3	1.35
	Insulation: polystyrene	0.037 tonnes/ m^3	3.43
	Insulation: polyurethane	0.03 tonnes/ m^3	4.84
	Plaster: general (Gypsum)	1.3 tonnes/ m^3	0.13
	Plasterboard	0.92 tonnes/ m^3	0.39
Concrete blocks	Block – 8 MPa Compressive Strength	1.05 tonnes/ m^3	0.06
	Block - 10 Mpa Compressive Strength	1.15 tonnes/ m^3	0.08
	Block - 12 Mpa Compressive Strength	1.25 tonnes/ m^3	0.09
	Block - 13 Mpa Compressive Strength	1.35 tonnes/ m^3	0.11
	Autoclaved Aerated Blocks (AACs)	0.8 tonnes/ m^3	0.31
Mortars	Mortar (1:3 cement:sand mix)	1.05 tonnes/ m^3	0.06
	Mortar (1:4 cement:sand mix)	1.15 tonnes/ m^3	0.08
	Mortar (1:5 cement:sand mix)	1.25 tonnes/ m^3	0.09
	Mortar (1:6 cement:sand mix)	1.35 tonnes/ m^3	0.11
	Mortar (1: ½: 4½ cement:lime:sand mix)	0.8 tonnes/ m^3	0.31
	Mortar (1: 1 :6 cement:lime:sand mix)	2.2 tonnes/ m^3	0.22
	Mortar (1: 2 :9 cement:lime:sand mix)	2.2 tonnes/ m^3	0.18

Table 5: Embodied carbon of building materials *(continued)*

Category	Construction Material	Unit Conversion or Density	Embodied tCO_2e Per Tonne of Material
Cements (do not enter cement used in concretes and mortars – that is calculated in those sections)	Average CEM I Portland Cement, 94 % clinker	2.2 tonnes/ m^3	0.16
	Ground Granulated Blastfurnace Slag (GGBS)	2.2 tonnes/ m^3	0.14
	Fly Ash	2.2 tonnes/ m^3	0.21
	Cement: unknown type	2.2 tonnes/ m^3	0.17
	Portland Limestone Cement, CEM II/A-LL or L (20 % limestone)	2.2 tonnes/ m^3	0.16
	Portland Limestone Cement, CEM II/A-LL or L (13 % limestone)	1.5 tonnes/ m^3	0.95
	Portland Limestone Cement, CEM II/A-LL or L (6 % limestone)	1.5 tonnes/ m^3	0.08
	Portland Fly Ash Cement, CEM II/A-V (20 % Fly Ash)	1.5 tonnes/ m^3	0.01
	Portland Fly Ash Cement, CEM II/A-V (13 % Fly Ash)	1.5 tonnes/ m^3	0.88
	Portland Fly Ash Cement, CEM II/A-V (6 % Fly Ash)	1.5 tonnes/ m^3	0.75
	Portland Fly Ash Cement, CEM II/B-V (35 % Fly Ash)	1.5 tonnes/ m^3	0.82
	Portland Fly Ash Cement, CEM II/B-V (28 % Fly Ash)	1.5 tonnes/ m^3	0.88
	Portland Fly Ash Cement, CEM II/B-V (21 % Fly Ash)	1.5 tonnes/ m^3	0.75
	Portland Slag Cement, CEM II/B-S (35 % GGBS)	1.5 tonnes/ m^3	0.81
	Portland Slag Cement, CEM II/B-S (28 % GGBS)	1.5 tonnes/ m^3	0.87
	Portland Slag Cement, CEM II/B-S (21 % GGBS)	1.5 tonnes/ m^3	0.61
	Blastfurnace Cement, III/A (65 % GGBS)	1.5 tonnes/ m^3	0.67
	Blastfurnace Cement, CEM III/A (50.5 % GGBS)	1.5 tonnes/ m^3	0.73
	Blastfurnace Cement, CEM III/A (36 % GGBS)	1.5 tonnes/ m^3	0.62
	Blastfurnace Cement, CEM III/B (80 % GGBS)	1.5 tonnes/ m^3	0.68
	Blastfurnace Cement, CEM III/B (73 % GGBS)	1.5 tonnes/ m^3	0.74

Table 5. Embodied carbon of building materials *(continued)*

Category	Construction Material	Unit Conversion or Density	Embodied tCO_2e Per Tonne of Material
Cements (do not enter cement used in concretes and mortars – that is calculated in those sections)	Average CEM I Portland Cement, 94 % clinker	2.2 tonnes/ m^3	0.16
	Cement: unknown type	2.2 tonnes/ m^3	0.17
	Portland Limestone Cement, CEM II/A-LL or L (20 % limestone)	2.2 tonnes/ m^3	0.16
	Portland Limestone Cement, CEM II/A-LL or L (13 % limestone)	1.5 tonnes/ m^3	0.95
	Portland Limestone Cement, CEM II/A-LL or L (6 % limestone)	1.5 tonnes/ m^3	0.08
	Portland Fly Ash Cement, CEM II/A-V (20 % Fly Ash)	1.5 tonnes/ m^3	0.01
	Portland Fly Ash Cement, CEM II/A-V (13 % Fly Ash)	1.5 tonnes/ m^3	0.88
	Portland Fly Ash Cement, CEM II/A-V (6 % Fly Ash)	1.5 tonnes/ m^3	0.75
	Portland Fly Ash Cement, CEM II/B-V (35 % Fly Ash)	1.5 tonnes/ m^3	0.82
	Portland Fly Ash Cement, CEM II/B-V (28 % Fly Ash)	1.5 tonnes/ m^3	0.88
	Portland Fly Ash Cement, CEM II/B-V (21 % Fly Ash)	1.5 tonnes/ m^3	0.75
	Portland Slag Cement, CEM II/B-S (35 % GGBS)	1.5 tonnes/ m^3	0.81
	Portland Slag Cement, CEM II/B-S (28 % GGBS)	1.5 tonnes/ m^3	0.87
	Portland Slag Cement, CEM II/B-S (21 % GGBS)	1.5 tonnes/ m^3	0.61
	Blastfurnace Cement, CEM III/A (65 % GGBS)	1.5 tonnes/ m^3	0.67
	Blastfurnace Cement, CEM III/A (50.5 % GGBS)	1.5 tonnes/ m^3	0.73
	Blastfurnace Cement, CEM III/A (36 % GGBS)	1.5 tonnes/ m^3	0.62
	Blastfurnace cement, CEM III/B (80 % GGBS)	1.5 tonnes/ m^3	0.68
	Blastfurnace Cement, CEM III/B (73 % GGBS)	1.5 tonnes/ m^3	0.74

Table 5. Embodied carbon of building materials *(concluded)*

Category	Construction Material	Unit Conversion or Density	Embodied tCO_2e Per Tonne of Material
Cements (do not enter cement used in concretes and mortars – that is calculated in those sections)	Blastfurnace Cement, CEM III/B (66 % GGBS)	1.5 tonnes/ m^3	0.36
	Pozzolanic (Siliceous Fly Ash) Cement, CEM IV/B-V (55 % GGBS)	1.5 tonnes/ m^3	0.48
	Pozzolanic (Siliceous Fly Ash) Cement, CEM IV/B-V (45.5 % GGBS)	1.5 tonnes/ m^3	0.61
	Pozzolanic (Siliceous Fly Ash) Cement, CEM IV/B-V (36 % GGBS)	1.5 tonnes/ m^3	0.23
	Cement: general	1.5 tonnes/ m^3	0.29
	6-20 % Fly Ash (CEM II/A-V)	1.5 tonnes/ m^3	0.34
	21-35 % Fly Ash (CEM II/B-V)	1.5 tonnes/ m^3	0.42
	21-35 % GGBS (CEM II/B-S)	1.5 tonnes/ m^3	0.51
	36-65 % GGBS (CEM III/A)	1.5 tonnes/ m^3	0.59
	66-80 % GGBS (CEM III/B)	1.86 tonnes/ m^3	0.74
Other type of Cements	Ground Granulated Blastfurnace Slag (GGBS)	2.2 tonnes/ m^3	0.14
	Fly Ash	2.2 tonnes/ m^3	0.21
	Fibre Cement Panels – uncoated	1.5 tonnes/ m^3	0.83
	Fibre Cement Panels - (colour) coated	1.5 tonnes/ m^3	0.69
	Cement Stabilised Soil @ 5 %	1.5 tonnes/ m^3	0.71
	Cement Stabilised Soil @ 8 %	1.5 tonnes/ m^3	0.52
	GGBS Stabilised Soil	1.5 tonnes/ m^3	0.32
	Fly Ash Stabilised Soil	1.8 tonnes/ m^3	1.09

NOTE:
1. Source from Environmental Agency 2007
2. Use the emission value in Table 5 or the latest official factor issued by relevant agency.

3.3 Energy

3.3.1 Intent

To ensure the effective use of energy in construction activities and site accommodation at building sites

3.3.2 Requirements

Provide details of energy obtain from hourmeter, electrical metering, purchasing record and other relevant document for all on-site construction related activities, where relevant in Table 6.

Table 6. Emissions generated by energy source used on site

No	Activities	Energy Source* (Electricity/ Diesel/ Petrol/ Natural Gas)	Quantity (units*)
1	Site clearing	Electricity	
		Diesel	
		Petrol	
		Natural gas	
2	Earthwork	Electricity	
		Diesel	
		Petrol	
		Natural gas	
3	Excavation	Electricity	
		Diesel	
		Petrol	
		Natural gas	
4	Substructure work	Electricity	
		Diesel	
		Petrol	
		Natural gas	
5	Superstructure work	Electricity	
		Diesel	
		Petrol	
		Natural gas	
6	External works (excluding landscape works)	Electricity	
		Diesel	
		Petrol	
		Natural gas	
7	Site accommodation	Electricity	
		Diesel	
		Petrol	
		Natural gas	

* Use the same units as in Table 8 or the latest official factor issued by relevant agency.

3.3.3 Baseline

The primary energy source is shown in Table 7.

Table 7. Primary energy source of construction activities

No	Activities	Energy Sources for Baseline
1	Site clearing	Diesel
2	Earthwork	Diesel
3	Excavation	Diesel
4	Substructure work	Diesel, electricity
5	Superstructure work	Diesel, electricity
6	External works (excluding landscape work)	Diesel, electricity
7	Site accommodation	Electricity

Emissions associated with fuel and natural gas shall be calculated by multiplying the quantity of fuel with their respective emission factors shown in Table 8:

Table 8. Conversion factors by energy source

Energy Source/ Fuel (unit)	Emission Factor Peninsular	Emission Factor Sabah	Emission Factor Sarawak
Electricity (kWh)	0.643 $kgCO_2$/kWh	0.966 $kgCO_2$/kWh	0.561 $kgCO_2$/kWh
Diesel (tonne)	3.37 tCO_2/tonne		
Petrol (litre)	2.30 $kgCO_2$/litre		
Natural gas (tonne)	0.06 tCO_2/tonne		

NOTE:

1. Sources:
   i. 2017 CDM Electricity Baseline For Malaysia
   ii. Environmental Agency 2007
2. Use the emission value in Table 8 or the latest official factor issued by relevant agency.

3.4 Water

3.4.1 Intent

To ensure the effective use of water in construction activities and site accommodation on building sites

3.4.2 Requirement

Provide water bills for the duration of the project until its completion in Table 9.

Table 9. Actual water consumption

Sources	Volume (m^3)
Water consumption (mains water) throughout the project duration	

3.4.3 Baseline

a) Water consumption in construction sites is estimated at 29.6 m^3/ RM million contractors output at constant price.

b) Water consumption on site accommodation is estimated as 20 Litres/ person/ day for full time employee.

The carbon emission factor for processed water is 0.419 kg CO_{2e}/ m^3 (MGTC 2011) or the latest official value issued by relevant agency.

NOTE:

1. Use the emission value of 0.419 kg CO2e/ m3 or the latest official factor issued by relevant agency.

3.5 Waste

3.5.1 Intent

To divert waste from the landfill through reduction, reused and recycling.

3.5.2 Requirement

Identify the types of waste material and specify the amount diverted by weight or volume, as well as the distance and the main mode of transport in Table 10. The information will be used to calculate the carbon emission from the waste disposal by using Eq 2.

$$E = (W_{waste} * EF_{waste\ treatment}) + (W_{waste} * D_{sd} * EF_{v}) \quad \text{..... Eq. 2}$$

Where,

E Emissions from waste treatment and transportation in a construction (kg CO_2e)

W_{waste} Weight of waste (kg)

$EF_{waste\ treatment}$ Emission factor of waste treatment material (Table 12) (kWhr/kg)

D_{sd} Distance from construction site to disposal destination (km)

EF_v Emission factor of vehicle transporting the waste (g CO_2e/ ton.km)

Table 10. Transportation of waste to landfill, incineration, composting and recycling sites

Category	Types of Waste	W_{waste} (total waste generated) (t)	Mode of Disposal	Waste (tonne)	D_{sd} (site to disposal destination)	Main Transportation Mode (road/ rail)
Schedule	Used oil		Recycled			
			Landfilled			
			Combusted			
			Composted			
	Paint		Recycled			
			Landfilled			
			Combusted			
			Composted			
	Batteries		Recycled			
			Landfilled			
			Combusted			
			Composted			
Recyclable	Glass		Recycled			
			Landfilled			
			Combusted			
			Composted			
	Metal		Recycled			
			Landfilled			
			Combusted			
			Composted			

	Aluminium		Recycled			
			Landfilled			
			Combusted			
			Composted			
	Cardboard		Recycled			
			Landfilled			
			Combusted			
			Composted			

Table 10. Transportation of waste to landfill, incineration, composting and recycling Sites *(concluded)*

Category	Types of Waste	W_{waste} (total waste generated) (t)	Mode of Disposal	Waste (tonne)	D_{sd} (site to disposal destination)	Main Transportation Mode (road/ rail)
Residual			Recycled			
			Landfilled			
			Combusted			
			Composted			
Biodegrad-able			Recycled			
			Landfilled			
			Combusted			
			Composted			
Inert	Concrete		Recycled			
			Landfilled			
			Combusted			
			Composted			
	Wood		Recycled			
			Landfilled			
			Combusted			
			Composted			
	Cement		Recycled			
			Landfilled			
			Combusted			
			Composted			
	Tiles		Recycled			
			Landfilled			
			Combusted			
			Composted			
Mixed Municipal Solid	Food		Recycled			
			Landfilled			
			Combusted			
			Composted			
	Food packaging		Recycled			
			Landfilled			
			Combusted			
			Composted			
Reusable			Recycled			
			Landfilled			
			Combusted			
			Composted			

3.5.3 Baseline

a) Mode of transportation is road.

b) Conventional waste disposal is through 100 % landfilled.

The volume of different types of waste produced can be converted into mass using standardised volume to mass conversion factors as shown in Table 11 or the latest official value issued by relevant agency. These conversion factors take into account the density of the material, void spaces and bulking factor (WRAP 2011).

Table 11. Conversion of waste volume to mass

Type of Waste	Volume (m^3)	Tonne
Construction (mixed)	1	0.87
Demolition (mixed)	1	0.87
Excavation	1	1.25

NOTE:
1. Source from WRAP 2011
2. Use the emission value in Table 11 or the latest official factor issued by relevant agency.

Table 12 uses life cycle conversion factors for waste disposal. Only transported emission will be taken into account in relation to waste which is being reused or recycle. The potential for energy recovery through combustion or anaerobic digestion and composting are excluded from this calculation.

Table 12. Lifecycle conversion factors for waste disposal

Life Cycle Conversion Factors for Waste Disposal tCO_2/ Tonne of Waste		tCO_2e/ t Waste
Aggregates (rubble)	Reuse/ Recycling*	0
	Landfill	0
Batteries (post consumer non automotive)	Reuse/ Recycling*	0
	Landfill	0.075
Glass	Reuse/ Recycling*	0
	Landfill	0.026
Metal: scrap metal	Reuse/ Recycling*	0
	Landfill	0.02
Mixed commercial and industrial waste	Reuse/ Recycling*	0
	Landfill	0.199
Mixed municipal waste	Reuse/ Recycling*	0
	Landfill	0.29
Organic waste: garden waste	Reuse/ Recycling*	0
	Landfill	0.213
Paper and board: board (average board: 78 % corrugate, 22 % carton board)	Reuse/ Recycling*	0
	Landfill	0.58
Plasterboard	Reuse/ Recycling*	0
	Landfill	0.072
Plastics: Average plastics	Reuse/ Recycling*	0
	Landfill	0.034
Silt/ soil	Reuse/ Recycling*	0
	Landfill	0.02
Wood	Reuse/ Recycling*	0

	Landfill	0.792

NOTES:
1 Transport of waste included only
2. Source from Environmental Agency
3. Use the emission value in Table 12 or the latest official factor issued by relevant agency.

The emissions from transportation of waste are calculated from the amount of fuel used to operate the vehicles from construction site to disposal destination.

SECTION 4. ASSESSMENT FOR BUILDING OPERATIONS

4.1 **Indoor Environmental Quality** (IEQ)

4.1.1 Intent

To provide an environment that is conducive to the health and well being of the building's occupants.

IEQ is described as the overall comfort of a building's interior and comfort of its occupants. Chemical, biological, and physical agents that come from the occupants' activities, building materials or the ambient environment will influence IEQ. The factors contributing to the building's IEQ are mainly thermal condition, ventilation, lighting and acoustics.

a) Thermal Comfort

The condition of mind, which expresses satisfaction with the thermal environment. It describes a person's psychological state of mind and is referred to in terms of whether someone is feeling too hot or too cold.

b) Indoor Air Quality

Refers to the presence or absence of air pollutants in buildings. The presence of indoor air pollutants or conditions that promote poor indoor air quality have the potential to affect the occupants' health and well-being.

c) Indoor Lighting

The requirements vary with the building functions and indoor activities. Considerations on the quality of light include specific requirements for glare, brightness ratio, and integration of day lighting.

d) Indoor Acoustics

A good acoustic environment keeps noise at levels that do not interfere with activities within the indoor environment. The main elements that impact indoor noise involve indoor and outdoor noise sources.

e) Indoor Landscape

Indoor Landscape Refer to presents of real indoor landscape material and design to promote better human psychological state in a space and enhance indoor acoustic by absorbing noise and echo.

4.1.2 Requirements

a) IEQ is a prerequisite of Green PASS.

b) All projects must satisfy the requirements of the Green PASS Occupants' Satisfaction Survey, which assesses the building occupants' comfort and overall satisfaction with workspace, office layout, furnishings, thermal comfort, air quality, lighting, acoustic quality, cleanliness and maintenance performances. The Green PASS Occupants' Satisfaction Survey requirements are shown in Table 13A.

   Green PASS sets a minimal requirement whereby the survey must indicate that at least 80 % of the participating occupants are satisfied with the indoor environmental quality of the building. If the survey indicates a lesser percentage than the minimal requirement stated above then, the applicant (building owner) must undertake the necessary corrective measures to achieve the required indoor environment quality for gaining satisfaction from at least 80 % of the occupants.

   A Green PASS appointed assessor will be responsible for all related works associated with the preparation and conducting of survey.

c) The assessor will obtain on-site data measurement of IEQ parameters (Table 13B) at least one week after the completion of the Occupant Satisfaction Survey. Corrective measures must be undertaken by the applicant in the event that any parameter does not meet the benchmark indicated in Table 13B.

Table 13A. Occupants' satisfaction survey

OCCUPANT SATISFACTION SURVEY		
	Background	
1.	How many years have you conducted in this building?	Less than 1 year 1-2 years 3-5 years More than 5 years
2.	How long have you been working at your present workspace?	Less than 3 months 4-6 months 7-12 months More than 1 year
3.	In a typical week, how many hours do you spend in your workspace?	10 or less 11-30 More than 30
4.	How would you describe the activity you do?	Administrative support Technical Professional Managerial/ supervisory Other
5.	What is your age?	30 or under 31-50 Over 50
6.	What is your gender?	Female Male

Table 13A. Occupants' satisfaction survey *(continued)*

OCCUPANT SATISFACTION SURVEY		
	Personal Acvity Space Location	
7.	On which floor is your activity space located?	..... floor
8.	In which area of the building is your activity space located?	North East West South Core Do not know
9.	To which direction do the windows closest to your space face?	North East West South No windows Do not know
10.	Are you near to an exterior wall (within 15 feet)?	Yes No
11.	Are you near a window (within 15 feet)?	Yes No
12.	Which of the following best describes your personal activity space?	Enclosed activity space, private Enclosed activity space, shared with other people Cubicles with high partitions (about five or more feet high) Cubicles with low partitions (lower than five feet high) Activity space in open activity space with no partitions (just desks) Other
	Activity Space Layout	
13.	How satisfied are you with the amount of space available for individual activity and storage?	1 Very Satisfied □ 2 3 4 5 Very Dissatisfied □
14.	How satisfied are you with the level of visual privacy?	1 Very Satisfied □ 2 3 4 5 Very Dissatisfied □

Table 13A. Occupants' satisfaction survey *(continued)*

OCCUPANT SATISFACTION SURVEY		
15.	How satisfied are you with the ease of interaction with Co-Occupants?	1 Very Satisfied □ 2 3 4 5 Very Dissatisfied □
16.	Overall, does the layout enhance or interfere with your ability to get your activity done?	1 Enhances □ 2 3 4 5 Interferes □
17.	How satisfied are you with the amount of space available for individual activity and storage?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
18.	How satisfied are you with the level of visual privacy?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
19.	How satisfied are you with ease of interaction with Co-Occupants?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
20.	Overall, does the activity space layout enhance or interfere with your ability to get your activity done?	1 Enhances □ 2 3 4 5 Interferes □
	Activity Space Furnishings	
21.	How satisfied are you with the comfort of your activity space furnishings (chair, desk, computer, equipment, etc.)?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
22.	How satisfied are you with your ability to adjust your furniture to meet your needs?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □

Table 13A. Occupants' satisfaction survey *(continued)*

OCCUPANT SATISFACTION SURVEY		
	Thermal Comfort	
23.	How satisfied are you with the colours and textures of flooring, furniture and surface finishes?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
24.	Do your activity space furnishings enhance or interfere with your ability to get your activity done?	1 Enhances □ 2 3 4 5 Interferes □
25.	Which of the following do you personally adjust or control in your activity space? (check all that apply)	Window blinds or shades Operable window Thermostat Room air-conditioning unit Portable fan Ceiling fan Adjustable air vent in wall or ceiling Adjustable floor air vent (diffuser) Door to interior space Door to exterior space None of the above Other
26.	How satisfied are you with the temperature in your activity space?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
27.	Overall, does your thermal comfort in your activity space enhance or interfere with your ability to get your activity done?	1 Enhances □ 2 3 4 5 Interferes □
	Air Quality	
28.	How satisfied are you with the air quality in your activity space (i.e. stuffy/stale air, cleanliness, odours)?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □

Table 13A. Occupants' satisfaction survey *(continued)*

OCCUPANT SATISFACTION SURVEY		
	Lighting	
29.	Overall, does the air quality in your activity space enhance or interfere with your ability to get your activity done?	1 Enhances □ 2 3 4 5 Interferes □
30.	Which of the following controls do you have over the lighting in your activity space? (check all that apply)	Light switch Light dimmer Window blinds or shades Desk (task) light None of the above Other
31.	How satisfied are you with the amount of light in your activity space?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
32.	How satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
33.	Overall, does the lighting quality enhance or interfere with your ability to get your activity done?	1 Enhances □ 2 3 4 5 Interferes □
	Acoustic Quality	
34.	How satisfied are you with the noise level in your activity space?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
35.	How satisfied are you with the sound privacy in your activity space (ability to have conversations without your neighbours overhearing and vice versa)?	1 Very satisfied □ 2 3 4 5 Very dissatisfied □
36.	Overall, does the acoustic quality in your activity space enhance or interfere with your ability to get your activity done?	1 Enhances □ 2 3 4 5 Interferes □

Table 13A. Occupants' satisfaction survey *(concluded)*

OCCUPANT SATISFACTION SURVEY		
	Cleanliness and Maintenance	
37.	How satisfied are you with general cleanliness of the overall building?	1 Very satisfied 2 3 4 5 Very dissatisfied
38.	How satisfied are you with cleaning service provided for your activity space?	1 Very satisfied 2 3 4 5 Very dissatisfied
39.	How satisfied are you with general maintenance of the building?	1 Very satisfied 2 3 4 5 Very dissatisfied
40.	Does the cleanliness and maintenance of this building enhance or interfere with your ability to get your activity done?	1 Enhances 2 3 4 5 Interferes

Table 13B. IEQ parameters benchmark

Parameter	Measure	Unit of Measure	Acceptable Range/ Limits
1. Thermal comfort	i. Temperature	°C	23 - 26
	ii. Relative humidity	%	55 - 70
2. Indoor air quality	i. Air movement	m/ s	0.15 - 0.5
	ii. Carbon dioxide	ppm	1000
	iii. Carbon monoxide	ppm	10
	iv. Formaldehyde	ppm	0.1
	v. Particulate matters	mg/ m^3	0.15
	vi. Total volatile organic compounds (TVOC)	ppm	3
3. Indoor lighting	Illuminance	lux	300 - 400
4. Indoor acoustic	Ambient sound	db(A)	40 - 50

NOTE:

1. Sources:
   i. Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings, MS: 1525.
   ii. Guidelines on Occupational Safety and Health, DOSH Malaysia

4.2 Energy

4.2.1 Intent

To minimize the energy consumption for building operations

4.2.2 Requirements

a) Provide information about building types, gross floor area and weekly operations hours as in Table 14.

b) Provide energy (electricity) bills for a 52 weeks period after occupancy to estimate the the Building Energy Intensity of the building.

Building Energy Intensity (BEI) = (TBEC – CPEC) x (52) / ($GFA_{exclude\ carpark}$ x WOH)

Where

TBEC denotes Total Building Energy Consumption in kWh/year;
CPEC denotes Car Park Energy Consumption in kWh/year;
GFA denotes Gross Floor Area in m^2 ; and
WOH denotes Weighted Weekly Operation Hour in h/week

4.2.3 Baseline

a) The energy performance of building types were established from the Common Carbon Metric for buildings in Putrajaya [KeTTHA, MGTC (2010)] and MS1525:2019. Table 15 displays the building energy intensity and carbon intensity in 2010.

b) Where information is available, the baseline for energy performance can be calculated from elements making up the system category and system configuration.

Table 14. Energy consumption in buildings

Month	Building Type (as in Table 15)	Gross Floor Area exclude carpark (m^2)	Weekly Operational Hours (hrs)	Number of Computers (units)	Number of Occupants	Monthly Energy Bills (12 consecutive months) (kWh)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Table 15. Common carbon metrics: energy intensity for building typologies

Building Types	Energy Intensity (kWh/ m^2/ yr)	Carbon Emission Intensity* (kg CO_2e/ m^2/ yr)
Office	200	128.6
Hospital	357	229.6
Hotel	521	335.0
Building Types	**Energy Intensity (kWh/ m^2/ yr)**	**Carbon Emission Intensity* (kg CO_2e/ m^2/ yr)**
School	43	27.6
Residential ● Bungalow ● Semi-detached ● Double-storey terrace ● Apartments/condominium (multi-storey) ● Affordable homes (multi-storey)	 87 58 24 33 62	 55.9 37.3 15.4 21.2 39.9

NOTE:
1. Source of Energy Intensity for office: MS1525:2019
2. Source of Energy Intensity: MGTC, KeTTHA, Malaysia 2010
3. Based on emission factor 0.643 kg CO2 / kWh generation of electricity for peninsular of Malaysia

4.3 Water

4.3.1 Intent

To maximise water consumption efficiency in buildings and reduce the use of supplied processed water

4.3.2 Requirements

a) Provide information on building types, gross floor area and number of occupants in Table 16 and Table 17.

b) Provide water bills for a 12-month period for the building.

c) Provide the landscape information in Table 18.

Table 16. Water consumption in residential and office buildings

Building Types	Gross Floor Area (m^2)	No. of Occupants	Facilities type (Flow rate or capacity)						Annual Water Usage (m^3)
			Kitchen	Shower Heads	Bath	Water Closets	Urinals	Washing Machine	
Residential Building ● Bungalow ● Semi-detached ● Double-storey terrace ● Apartments/ condominium (multi-storey)									

• Affordable homes (multi-storey									
Office									

Table 17: Water consumption in hotels

Building Types	Total Number of Rooms	Annual average Occupancy Rate %	Annual Water Usage (m^3)
Hotel			

Table 18. Landscape surface area

Building Types	Landscape			
	No. of Trees	No. of Palm Trees	Shrubs Surface Area (m^2)	Ground Cover Surface Area (m^2)
Residential buildings				
Office				
Hotels				

4.3.3 Baseline

a) Indoor water consumption

Tables 19, 20 and 21 indicate the benchmark/ baseline for indoor water consumption for various types of buildings.

Table 19. Water consumption categories and usage (domestic)

Consumption Categories	Average Benchmark (litres/ person/ day)
Domestic	226
Outdoor (not including irrigation)	5

NOTE: 1. Source: SPAN, 2019
2. Use the average water consumption benchmark in Table 19 or the latest official issued by relevant agency.

The alternative baseline for indoor water consumption can be based on the facilities available in the building.

Table 20. Average industry water benchmark

Building Types	Average Industry Benchmark (litres/ room/ day)
Hotel	26.72

NOTE: Source: Water Scan, UK 2011

Table 21. Annual water consumption in office per employee

Office Type	Floor Area (m^2)	Target Water Use (litres/ employee/ year)
Small offices	Under 1 000	4 400
Small offices with cafeteria	Under 1 000	5 900
Larger offices	Greater 1 000	6 800
Larger offices with cafeteria	Greater 1 000	8 300

NOTE: Source: www.green.office.org.uk

b) Outdoor water consumption

The amount of water required for landscape irrigation depends on the soil type, available water content in soil, rooting depth, and the vegetation evapotranspiration rate. The baseline for landscape irrigation calculated using the United Nations Food and Agriculture Organization (FAO) approach is given in Table 22.

Table 22. Landscape irrigation

Plant Types	Average Evapotranspiration Rate	Water Requirement
Tree	4.33 mm/ number/ day	24 litres/ number/ day
Palm	3.57 mm/ number/ day	7.1 litres/ number/ day
Shrub	22.65 mm/ m^2/ day	6.3 litres/ m^2/ day
Ground cover and lawn	121.75 mm/ m^2/ day	3.1 litres/ m^2/ day

NOTE: Source: Putrajaya, Malaysia

SECTION 5: ASSESSMENT AND CERTIFICATION

5.1 Green PASS assessment

The Green PASS assesses the performance of a building project during construction stage and post construction by evaluating the carbon emission reduction and qualitative measures undertaken for sustainable construction.

The assessment system is divided into two categories:

a) Building Construction; and

b) Building Operations

5.2 Performance for building construction

Green PASS measures carbon reduction in terms of CO_2e, based on performance related provisions for five elements: site, material, energy, water and waste. The certification shall be awarded only once during the construction of the building.

The CO_2e carbon values of the assessed element in Section 3 shall be tabulated in Table 23 to give the total carbon emissions baseline (column a), actual carbon emissions (column b) and average percentage of carbon emission reduction for the whole building construction (column c).

Table 23. Building construction carbon emissions

Element	Carbon Emissions Baseline (tCO_2e) [a]	Actual Carbon Emissions (tCO_2e) [b]	Percentage of Carbon Emissions Reduction (%) c = [(a-b) /a]*100 [c]
Site			
Material			
Energy			
Water			
Waste			
Total carbon emission			
Percentage of Carbon Emission Reduction = (Total Col. a- Total Col. b) /Total Col. a *100			

5.3 Performance for building operations

Green PASS for building operation measures carbon reduction in terms of CO_2e, based on performance related provisions for energy and water compared to the baseline. The assessment is based on actual data related to the performance the building over the last 12 months.

The certification for an assessment is valid for one year. The assessment for the subsequent year follows the standard procedures of Green PASS application.

The CO_2e carbon values of the assessed element in Section 4 shall be tabulated in Table 24 to give the total carbon emissions baseline (column a), actual carbon emissions (column b) and average percentage of carbon emission reduction for the whole building operations (column c).

Table 24. Building operations carbon emissions

Element	Carbon Emissions Baseline (tCO_2e/ yr) [a]	Actual Carbon Emissions (tCO_2e/ yr) [b]	Percentage of Carbon Emissions Reduction (%) c = [(a-b)/ a]*100 [c]
Energy			
Water			
Total carbon emissions			
Percentage of Carbon Emission Reduction = (Total Col. a- Total Col. b)/ Total Col. a *100			

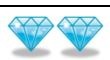
5.4 Diamond rating scheme

The percentage of carbon reduction achieved by the building construction category and operations category is matched with the diamond rating scheme in Table 25.

Table 25 shows the diamond rating scheme with levels of achievement for CO_2e reduction. The higher the level of achievement the more number of diamonds will be awarded. The scheme rates any project from one to six diamonds starting from 1 % carbon reduction (one diamond) up to 100 % carbon reduction (six diamonds). A 100 % carbon reduction is designated carbon neutral and represented by six diamonds. The diamond is chosen as it is symbolical of the finest form of carbon.

A building construction shall be considered unsustainable when there is evidence of non-compliance to relevant mandatory requirements. In the event of any infringements, a penalty shall be imposed that may result in the downgrading of the diamond rating, at the discretion of CIDB.

Table 25. Green PASS diamond rating scheme

Level Of Achievement (% of CO_2e Reduction)	Diamond Rating Scheme (without bonus rating)	Diamond Rating Scheme (with bonus rating)
Carbon Neutral 100 %		 +
≥ 70 to < 100		 +
≥ 50 to < 70		 +
≥ 30 to < 50		 +
≥ 10 to < 30		 +

≥ 1 to < 10		 +

Notes:

a) (<) = less than

b) (≥) = Equal or greater than

c) Green PASS Building operation certification is **ONLY** entitled for Diamond Rating Scheme without Bonus Reward.

5.5 Bonus rewards for building construction

Besides carbon reduction, Green PASS gives recognition to sustainable construction practices by awarding bonus rewards to projects implementing the following CIDB Construction Industry Standards (CIS):

a) Industrialised Building System (IBS);

b) Safety and Health Assessment System in Construction (SHASSIC) and

c) Quality Assessment System in Construction (QLASSIC).

Any project with carbon reduction measures mentioned in Section 3 and implementing ALL three standards listed above will be awarded with a diamond rating and bonus reward. This is signified by a diamond and accompanied with a plus sign (+).

The eligibility of the bonus reward (+) for any project is subjected to the fulfilment of the minimum requirement of each standard as summarised in Table 26.

The Bonus Reward is applicable to Building Construction Certification only.

Table 26. Requirements for bonus rewards

Reference Standards	Submittal Documents	Minimum Requirement
IBS	Declaration of IBS Score by Architect	70 points and above for government project 50 points above for private project
SHASSIC	Copy of SHASSIC certificate	3 star and above
QLASSIC	Copy of QLASSIC certificate	70 % and above

The diamond rating is independent of the Bonus Rewards in which the eligible diamond rating can be awarded singly, in the case where the project does not implement the IBS, SHASSIC and QLASSIC standards.

Example:

If the carbon reduction achievement is 3 - Diamonds and it is not supported by evidence of the use of IBS, SHASSIC and QLASSIC, then project will be rated at 3 Diamonds.

ANNEX A
(Informative)

Abbreviations

ANSI	-	American National Standards Institute
ASHRAE	-	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	-	Business as usual
BS EN	-	British Standard (if EN is found as part of a BS, then it means that the standard was developed as a European standard and then adopted by the UK as a British Standard)
CCC	-	Certificate of Completion and Compliance
CIDB	-	Construction Industry Development Board
CIS	-	Construction Industry Standard
CO_2e	-	Carbon Dioxide Equivalent
COP	-	Conference of the Parties
DOE	-	Department of Environment
DOSH	-	Department of Occupational Safety and Health
FOG	-	Fat, Oil and Grease
GHG	-	Greenhouse Gas
Green PASS	-	Green Performance Assessment System in Construction
GWP	-	Global Warming Potential
IBS	-	Industrialised Building System
ICE	-	Inventory of Carbon and Energy
IEQ	-	Indoor Environmental Quality
ISO	-	International Organisation for Standardisation
LCA	-	Life Cycle Assessment
LCCF&AS	-	Low Carbon City Framework and Assessment System
MSMA	-	Manual Saliran Mesra Alam
NFA	-	Net Floor Area
OTTV	-	Overall Thermal Transfer Value
PAS	-	Publicly Available Specification
PE	-	Population Equivalent
PPSPPA	-	Perbadanan Pengurusan Sisa Pepejal dan Pembersihan Awam
PSP	-	Principal Submitting Person
QLASSIC	-	Quality Assessment System in Construction
SHASSIC	-	Safety and Health Assessment System in Construction
SO	-	Superintending Officer
SRI	-	Solar Reflective Index
tCO_2e	-	Tons of CO_2 equivalent
TNB	-	Tenaga Nasional Berhad
UBBL	-	Uniform Building By-Laws
UNEP	-	United Nations Environment Programme
UNFCCC	-	United Nations Framework Convention on Climate Change
WBCSD	-	World Business Council for Sustainable Development
WELS	-	Water Efficiency Labelling Scheme: Australia
WRI	-	World Research Institute

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