GREEN$^{SL®}$ RATING SYSTEM FOR NEW CONSTRUCTIONS

Version 2.1

Green Building Council of Sri Lanka

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PREFACE FROM GREEN BUILDING COUNCIL SRI LANKA

The natural environment together with our economy, health and productivity are immensely affected by the performance of the built environment. According to the Global Status Report 2020, CO_2 emissions from the operation of buildings have increased to their highest level yet at around 28% of total global energy-related CO_2 emissions. With the inclusion of emissions from the buildings construction industry, this share increases to 38% of total global energy-related CO_2 emissions while the total final energy consumption of the global buildings sector is 35%. Thus efficient design, construction and maintenance of our built environment are the responsibility of all stakeholders.

The GREEN$^{SL®}$ Rating System of Green Building Council Sri Lanka (GBCSL) offers the valuable opportunity to respond positively to the greatest challenge of the day. It is a voluntary scheme where designers, builders and owners can achieve recognition for their valuable interest to build green.

History shows how our forefathers built great cities, irrigation systems and religious monuments that coexisted with nature and yet provided a sustainable economy and lifestyle to the citizens. This initiative of the GBCSL is one humble step towards making our society to that glorious past which we are still proud of as Sri Lankans.

The built environment sustainability will be upgraded with the new changes of the rating tool while supporting to achieve Sustainable Development Goals as well. With all these efforts, it is expected to move Sri Lanka towards a net-zero carbon-built environment by the year 2050.

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CHAIRMAN'S MESSAGE

Sri Lanka, like most other countries around the world, is facing an immense challenge, to create sustainable buildings for the future. Buildings continue to be a major source of demand for energy and construction materials produce a significant amount of by-product greenhouse gases. Studies show that the building sector accounts for 35% of the world's energy requirements. A large percentage of the present energy consumption and carbon dioxide generation could be reduced by applying certification standards such as the one presented in this document, to new and refurbished buildings.

The public's perception of the importance of sustainable design is dramatically increasing. Developers of buildings of all types and the consultants involved in the design of those buildings now recognize the need for sustainable designs to add value to their investments. Design, for design's sake, is no longer an option. Design for higher performance is our path to a better future for Mother Nature.

A green building is designed to use less energy, reduce dependency on virgin materials, enhance water conservation during construction & operation and improve indoor air quality while reducing the life-cycle environmental impacts of the materials used. The rating system would fundamentally change the built environment by creating energy-efficient, healthy, productive buildings that reduce or minimize the significant impacts of buildings on the environment. This is achieved through the allocation of different credits to the selection of a proper site, better and efficient design, material selection, construction, operation, maintenance, removals, and possible reuses, etc.

The world is moving at different paces, many advanced green technologies and upgraded green products have been introduced to the market. Therefore, periodic revisions to embrace new standards to the rating tool is a necessity. Version 2.1 is a tremendous effort of technical committee members and research committee members to keep pace with current standards and technologies and to make our platform more accessible and user friendly. Although the rating system is based on the world's best practices for Green Buildings, the committee members have very attentively incorporated local conditions. A local certification system will continue to be less expensive and will attract more local developers.

Several independent studies confirm that buildings certified by green building councils around the world consume up to 50% less energy and 60% less potable water and

send 69% less waste to landfills than non-certified buildings. The Green Building Council of Sri Lanka also has been actively involved in encouraging energy-efficient, eco- friendly and productive buildings ever since. As a result, it has over a hundred buildings around the island by now.

This revised rating system for Sri Lanka provides a rigorous road-map to building greener and there is no doubt that it will continue to receive support from both public and private sectors and become the rating tool of choice.

Prof. Ranjith Dissanayake
Chairman,
Green Building Council of Sri Lanka

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As a condition of use, you covenant not to sue and agree to waive and release the Green Building Council of Sri Lanka, its members, its partners and the Sri Lankan government from any and all claims, demands and causes of action for any injuries, losses or damages (including, without limitation, equitable relief) that you may now or hereafter have a right to assert against such parties as a result of your use of, or reliance on, the GREEN$^{SL®}$ Rating System for Built Environment, Version 2.1.

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TRADEMARK

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ACKNOWLEDGEMENTS

The GREEN$^{SL®}$ Rating System for Built Environment, Version 2.1 has been made possible only through the efforts of many dedicated volunteers, committee members and others in the GBCSL community. The drafting was managed and implemented by GBCSL staff and consultants and included with reviews and suggestions by the GBCSL Core Committee and many members. Expert guidance was provided by the Chairman Prof. Ranjith Dissanayake, Vice Chairman Eng. Shiromal Fernando and Director Lionel Nawagamuwa.

GBCSL acknowledge the support of the Project Engineer, Eng (Ms). Upeksha Virajini in coordinating the project and preparing the draft with the support from Dr Tharindu Samarasinghe, Eng Rashmi Tharaka, Eng Nanda Abeysekara, Ms Samantha Manawadu, and Ms Tharisha Nandasena.

We mention with gratitude the technical committee members for the expert advice and reviews given to the draft;

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  Secretary, State Ministry of Rural Roads and other Infrastructures/

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- Eng. Madhawa Habarakada
- Eng. Anuja Mendis
- Eng. Prabath Indika
- Eng. Upeksha Virajini

GREENSL® RATING SYSTEM FOR NEW CONSTRUCTIONS
VERSION 2.1 CHECKLIST
100 Total Points Available

Criteria		**Points**
1.0 MANAGEMENT		4 Total Points Available
☑ Prerequisite 1	Green Building Accredited Professional	Required
☑ Prerequisite 2	Commissioning Clauses	Required
☑ Prerequisite 3	Building users guide	Required
☐ Credit 1.1	Integrative Design Process	1 Point
☐ Credit 1.2	Green Facility Manager	1 Point
☐ Credit 1.3	Responsible Construction Practices [2 Points]	
	Credit 1.3.1 Involvement of an expert in Ecology	1 Point
	Credit 1.3.2 Environmental Management Plan	1 Point
2.0 SUSTAINABLE SITES		25 Total Points Available
☑ Prerequisite 1	Erosion and Sedimentation Control	Required
☐ Credit 2.1	Site Selection	4 Points
☐ Credit 2.2	Site Assessment and development	2 Points
☐ Credit 2.3	Development Density and Community Connectivity	2 Points
☐ Credit 2.4	Reuse of Previously Developed sites and Allowance for Connectivity of Green Lands	2 Points
☐ Credit 2.5	Alternative Transportation [3 Points]	
	Credit 2.5.1 Public Transportation Access	1 Point
	Credit 2.5.2 Parking Capacity	1 Point
	Credit 2.5.3 Encourage use of green modes of transport	1 Point
☐ Credit 2.6	Reduced Site Disturbance [6 Points]	
	Credit 2.6.1 Protect or Restore Habitat	2 Points
	Credit 2.6.2 Greenery Provisions	2 Points
	Credit 2.6.3 Development footprint	2 Points
☐ Credit 2.7	Storm Water Design, Quantity and Quality Control	3 Points
☐ Credit 2.8	Heat Island Effect, Non – Roof	1 Point
☐ Credit 2.9	Heat Island Effect, Roof	1 Point
☐ Credit 2.10	Light Pollution Reduction	1 Point

3.0 WATER EFFICIENCY	14 Total Points Available	
☑ Prerequisite 1	Water Efficient landscaping	Required
☑ Prerequisite 2	Indoor Water Use Reduction	Required
☑ Prerequisite 3	Building Level Water Metering	Required
☐ Credit 3.1	Water Efficient Construction	1 Point
☐ Credit 3.2	Cooling tower Water Efficiency in air – conditioning system	1 Point
☐ Credit 3.3	Indoor water use reduction	1-5 points
☐ Credit 3.4	Innovative Wastewater Technologies [1-5 Points]	
	Credit 3.4.1: Reduce Potable Water Use	1 Point
	Credit 3.4.2: Reduce Potable Water Use or Treat Wastewater	1 Point
	Credit 3.4.3: Harvested rainwater	2 Points
	Credit 3.4.4: Aquifer Recharge	1 Point
☐ Credit 3.5	Innovative Water Transmission	1 Point
☐ Credit 3.6	Water Sub Metering	1 Point
4.0 ENERGY AND ATMOSPHERE	22 Total Points Available	
☑ Prerequisite 1	Fundamental Building Systems Commissioning and Verification	Required
☑ Prerequisite 2	Minimum Energy Performance	Required
☑ Prerequisite 3	CFC Reduction in HVAC & R Equipment	Required
☑ Prerequisite 4	Energy Metering	Required
☐ Credit 4.1	Optimize Energy Performance	1-10 Points
☐ Credit 4.2	On-site Renewable Energy	1-5 Points
☐ Credit 4.3	Enhanced Commissioning	1 Point
☐ Credit 4.4	Enhanced Refrigerant Management	1 Point
☐ Credit 4.5	Measurement & Verification	1-2 Points
☐ Credit 4.6	Off-site Renewable Energy	1 Point
☐ Credit 4.7	Certified Energy Auditor	1 Point
☐ Credit 4.8	Greenhouse Gas Emissions Management	1 Point
5.0 MATERIALS, RESOURCES & WASTE MANAGEMENT	14 Total Points Available	
5.1 MATERIALS AND RESOURCES		
☑ Prerequisite 1	Operational Solid waste Management	Required
☐ Credit 5.1.1	Building Reuse	1-2 Points

☐ Credit 5.1.2	Reused and Recycled Materials/ Products	1-2 Points
☐ Credit 5.1.3	Local/ Regional Materials	1 Point
☐ Credit 5.1.4	Rapidly Renewable materials	1 Point
☐ Credit 5.1.5	Certified wood	1 Point
☐ Credit 5.1.6	Green Labeled Products	1 Point
☐ Credit 5.1.7	Upfront Carbon Emissions	1 Point
☐ Credit 5.1.8	Sustainable Building Systems	1-2 Points
5.2 WASTE MANAGEMENT		
☐ Credit 5.2.1	Construction and Demolition Waste Management	1 Point
☐ Credit 5.2.2	Waste materials to construction materials	1 point
☐ Credit 5.2.3	Storage, Collection and safe disposal of hazardous wastes	1 Point
6.0 INDOOR ENVIRONMENTAL QUALITY	13 Total Points Available	
☑ Prerequisite 1	Minimum IAQ Performance	Required
☑ Prerequisite 2	Smoke (ETS) Control	Required
☑ Prerequisite 3	Minimum Acoustic Performance	Required
☐ Credit 6.1	Outdoor air delivering Monitoring	1 Point
☐ Credit 6.2	Increased Ventilation	1 Point
☐ Credit 6.3	Construction IAQ Management Plan	1 Point
☐ Credit 6.4	Low- Emitting Materials [1-3 Points]	
	Credit 6.4.1 Adhesives and Sealants	1 Point
	Credit 6.4.2 Paints and Coatings	1 Point
	Credit 6.4.3 Carpet Systems Composite Timber and Agrifibre Products	1 Point
☐ Credit 6.5	Indoor Chemical & Pollutant Source Control	1 Point
☐ Credit 6.6	Lighting and Comfort Controls [1-2 Points]	
	Credit 6.6.1 Lighting controls	1 Point
	Credit 6.6.2 Comfort controls	1 Point
☐ Credit 6.7	Thermal comfort, design and Verification	1 Point
☐ Credit 6.8	Air Purification and Disinfection	1 Point
☐ Credit 6.9	Daylight & Views [2 Points]	
	Credit 6.9.1 Daylight	1 Point
	Credit 6.9.2 Views	1 Point

7.0 INNOVATION & DESIGN PROCESS		4 Total Points Available
☐ Credit 7.1	Innovation in Design [1-4 Points]	
	Credit 7.1.1 Innovation in design	1-2 Points
	Credit 7.1.2 Exemplary Performance	1-2 Points
8.0 SOCIAL & CULTURAL AWARENESS		**4 Total Points Available**
☑ Prerequisite 1	Archaeological sites & Heritage buildings	Required
☐ Credit 8.1	Social Wellbeing, Public Health & Safety	
	Credit 8.1.1 Public Health and Safety	1 Point
	Credit 8.1.2 Social Wellbeing	1 Point
☐ Credit 8.2	Cultural Identity	1-2 Points

Ratings given will be as follows:

- Certified 40–49 points
- Silver 50–59 points
- Gold 60–69 points
- Platinum 70 points and above

Certified Green Building

40-49 Points

Silver Green Building

50-59 Points

Gold Green Building

60-69 Points

Platinum Green Building

Over 70 Points

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INTRODUCTION TO GREEN BUILDING COUNCIL OF SRI LANKA (GBCSL)

The concept of "Green Buildings" aims at increasing the efficiency with which buildings use resources such as energy, water and materials while reducing the impact of buildings on human health and its surrounding environment during their lifecycle, through better design, construction, operation, maintenance and removal and recycling of waste.

Going green is no strange concept to us Sri Lankans having a proud history of great civilizations with structures and monuments together with irrigation systems that impress the entire world even today. The balanced lifestyle and coexistencewith nature, which is provided to the human society is the ultimate goal of *GBCSL*'s endeavour.

GBCSL came into existence as a result of an emerging trend towards applying greener concepts to the built environment.

GBCSL launched in November 2009 as a non-profit organization that is committed to developing a sustainable building industry for Sri Lanka by encouraging the adoption of green building practices. It is uniquely supported by both industry and government institutions across the country.

The *GBCSL* is now granted with "Emerging Member Status" by the *World Green Building Council*, which represents about 80 countries ranging from developed to developing nations worldwide.

Prof. Ranjith Dissanayake leads the *GBCSL* as the chairperson while the board comprises expert academic advisors and industry agents.

Board Members

- **Prof. Ranjith Dissanayake (Chairman)**

  Secretary, State Ministry of Rural Roads and other Infrastructures

- **Prof. Priyan Mendis (Founder Chairman)**

  Professor, Department of Civil and Environmental Engineering, University of Melbourne

- **Eng. Shiromal Fernando (Vice-Chairman)**

  Managing Director, Civil and Structural Engineering Consultants (Pvt) Ltd

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  Past President, Sri Lanka Institute of Architects

- **Archt. Chandana Edirisuriya (Vice Chairman)**

  Past President, Sri Lanka Institute of Architects

- **Brig. Madura Wijeyewickrema (Vice-Chairman)**

  CEO, M & SC – National Construction Association of Sri Lanka

- **Archt. Plnr. Piyal Silva (Vice Chairman)**

  President, Institute of Town Planners, Sri Lanka

- **Mr. Lionel Nawagamuwa (Director)**

  Accountant and Management Consultant

- **Dr. Locana Gunarathna (Director)**

  Past President, National Academy of Sciences, Institute of Town Planners, & Institute of Architects

- **Prof. Chithra Wedikkara (Director)**

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- **Ms. Janaki Kuruppu (Director)**

  Former Chairperson, Sri Lanka Tea Board

- **Mr. T.B. Siriwardena (Director)**

  Head of Management & Staff Development, Asian Aviation Center

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  Sr. Energy Consultant & CEO, EnergySolve International

- **Eng. Chandana Dalugoda (Director)**

  ASHRAE Distinguished Lecturer, Managing Partner at Chandana Dalugoda Consultants, Sri Lanka

Committees of the Council

- Green Environmental Rating System & Life Cycle Assessment
- Transport Infrastructure in Built Environment
- Education & Training
- Awareness & Publicity
- International Relations
- Membership
- Volunteer Force

Institutions that have taken leadership in establishing GBCSL

- Sri Lanka Standards Institute (SLSI)
- Sri Lanka Institute of Architects
- The Institution of Engineers Sri Lanka
- Society of Structural Engineers Sri Lanka
- National Construction Association of Sri Lanka
- Institute of Quantity Surveyors of Sri Lanka
- National Academy of Sciences Sri Lanka
- Sri Lanka Institute of Nanotechnology
- Institute of Town Planners Sri Lanka
- Department of Civil Engineering, Department of Mechanical Engineering and Faculty of Architecture - University of Moratuwa
- Department of Civil Engineering - University of Peradeniya
- Department of Civil & Environmental Engineering - University of Melbourne

VISION OF GREEN BUILDING COUNCIL OF SRI LANKA

Our Vision is to transform the construction industry in Sri Lanka with traditional building practices and fully adopt sustainability as the means by which our environment flourishes, the economy prospers and society grows to ensure the future wellbeing of our motherland.

MISSION OF GREEN BUILDING COUNCIL OF SRI LANKA

The Mission is to develop the sustainability of the built environment by transforming the way it is planned, designed, constructed, maintained and operated and drive the adoption of green building practices through market-based solutions while helping to forge a new partnership between government, industry and other stakeholders.

WORLD EMPHASIS ON THE GREEN BUILDING CONCEPT

Working against climate change and/or global warming have been given priority in almost all development and economic forums due to their immense impact on the environment, particularly on humans. The main cause of climate change is human activities on the natural environment of the world surface. Over thepast half a century, the temperature increase has been due to the escalation of greenhouse gases mostly due to the burning of fossil fuels which emanates CO_2 (carbon dioxide) as one of the largest contributors of greenhouse gases.

How do buildings contribute to this fact?

Every year more than a million buildings are constructed and over the years new insights into building material are introduced and used, forgetting the old methods of construction that have lasted for many years. Today, in the world, concrete is considered to be the most consumed commodity after water. Cement is one of the most important ingredients of concrete and an estimated amount of one tons of CO_2 is released to the atmosphere. Cement industry accounts for around 5 percent of global carbon dioxide (CO_2) emissions.

To minimize this upsurge, the Green Building notion has been introduced to confront this issue by ensuring sustainable performance throughout the existence of buildings and thereby minimizing the *'adverse"* influence of buildings on climate change.

The World Green Building Council, being the Union of National Green Building Councils throughout the world has taken action to support local and global leadership and empower the community to drive change towards sustainability, as a measure to alleviate the influence on the environment due to building construction.

The contribution of the Green Building Council of Sri Lanka (GBCSL)

The tendency in Sri Lanka in incorporating green building practices have galvanized in the recent past and are rapidly escalating in various industries as building operators are looking for energy-efficient buildings for their habitation. This perception is advantageous to the predominance of society and is eventually procuring a high demand

The Green Building Council of Sri Lanka (GBCSL) was established in 2009 since a clear framework and governing body for green rated buildings in the country did not exist in the past. The Council has been actively involved in encouraging energy-efficient, eco-friendly and productive buildings from its inception assessing over 100 buildings around the island.

Some of the buildings include Oceanfront condos – Galle, Barberyn Waves Ayurveda Resort in Weligama, Specialised Pediatric Ward Complex of the Ampara District General Hospital are some Platinum awarded certification in Green Rating. Institute of Technology of the University of Moratuwa and Heritance Aarah in Maldivesare some Gold awarded certification in Green Rating.

This reflects the achievement the GBCSL has made to strengthen the effort of making Sri Lanka a sustainable country with the ultimate goal of healing the Earth. The main purpose is to develop a rating system and manage it effectively and efficiently to provide remarkable service in assessing the buildings in terms of environmental acceptability whilst providing leadership to develop green solutions in the future for new developments and incorporate such concepts to existing buildings by transforming them to make them sustainable.

Furthermore, the GBCSL has set up several targets to be achieved by the year 2030 to improve the sustainability aspect of the building sector in Sri Lanka. It is envisaged that at least 30% of the buildings in Sri Lanka will be carbon neutral buildings, 50% will be Green buildings with Platinum, Gold or Silver certification and 100% of the buildings are estimated to be at least green-certified buildings.

If this approach is maintained, a considerable amount of energy will be saved. While adopting renewable energy and water efficiency techniques, the potable water consumption and local manufacturing materials used for construction will reduce embodied carbon which would eventually lead to a ‘Greener’ Sri Lanka.

Why Green Rating is important for Sri Lanka…

The main purpose of the GREEN$^{SL®}$ Rating System is to encourage the design of buildings in an environmentally acceptable approach. This is the foremost step towards adopting a sustainable practice in the development of buildings to utilize the natural resources and formulate competent designs to utilize nature for the betterment of mankind and thereby minimize the environmental pollution due to the hazardous construction of buildings.

Taking the above facts into consideration, this concept will encourage the development of environmentally friendly building solutions for Sri Lanka.

How does the GREEN Rating System work.…

GREEN$^{SL®}$ Rating System is used as a tool to evaluate the efficiency of the built environment in the aspects such as Management, Energy, Indoor Environmental Quality, Materials etc.

Scores are assigned for each category and the rating is given upon the total marks earned by each design or building solution.

What do we need to do to bridge the gap…

In the development process of making Sri Lanka sustainable, the establishment of the GREEN$^{SL®}$ Rating System was a critical milestone. Therefore, the Rating System had to be developed for Sri Lanka to ensure that the construction of buildings is conforming to sustainable greener practices.

The future with GREEN Rating System…

GBCSL is the governing body of Sri Lanka responsible for developing, implementing and maintaining the GREEN$^{SL®}$ Rating System. The governing body comprises experts in many different fields who effectively contribute to the functioning of the system. Through the GBCSL the GREEN$^{SL®}$ Accreditation Certificate is issued

for building designers which will then be followed up with continuous monitoring to ensure that the originally agreed design work is carried out simultaneously.

The Government will provide incentives to builders and the building product solutions which achieve the benchmarks set by GREEN$^{SL®}$ Rating System.

GBCSL appoints personnel who have the authority to rate the buildings. Such authorization may be granted to a person who has the expertise and completed the necessary technical qualification acceptable to GBCSL.

Goals of the GREEN Rating System

- Sustainable Site Planning
- Safeguarding water and water efficiency
- Energy efficiency and use of renewable energy
- Conservation of materials and resources
- Enhancing Indoor environmental quality
- Enhancing social and cultural Values
- Providing Leadership
- Educating the End Users

Benefits to the owners

- Lower operating costs
- Higher return on investment
- Provision of healthy interior spaces for occupants
- The greater attraction of tenants
- Reduced liability and risk
- Enhanced marketability
- Demonstration of Corporate Social Responsibility
- Future-proofed assets
- Competitive advantage

Prof. Priyan Mendis,
Founder Chairman,
Green Building Council of Sri Lanka

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GREENSL® RATING SYSTEM FOR BUILT ENVIRONMENT

The GREEN[SL®] Rating System for Built Environment is a set of performance standards for certifying Built Environments in the form of commercial or institutional buildings and high-rise residential buildings of all sizes, both public and private. The intent is to promote high performance, healthy, durable, affordable, and environmentally sound practices for new and existing buildings.

Prerequisites and credits in the GREEN[SL®] Rating System for Built Environment address eight aspects;

- Management (MN)
- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy and Atmosphere (EA)
- Materials and Resources (MR)
- Indoor Environmental Quality (EQ)
- Innovation and Design Process (ID)
- Social and Cultural Awareness (SC)

The Certifications from the GREEN[SL®] Rating System for Built Environment will be awarded according to the following scales;

- Certified 40–49 points
- Silver 50–59 points
- Gold 60–69 points
- Platinum 70 points and above

GBCSL will recognize buildings that achieve one of these rating levels with a formal letter of certification.

All structures defined as Built Environments in standard building codes, are eligible for certification under the GREEN [SL®] Rating System for Built Environment and include offices, factories, retail and service establishments, institutional buildings (libraries, schools, museums etc.) hotels and residential buildings. The project can apply for GREEN SL® Rating System for Built Environment certification if the project can meet all mandatory requirements and achieve the minimum required points stated in the rating tool.

The GREEN SL® Rating System for Built Environment encourages owners and operators of buildings to implement sustainable practices and reduce the negative environmental impacts of their buildings over the functional lifetime. The rating system specially addresses building site maintenance programmes, water and energy use, usage of environmentally preferred products and practices for cleaning and alterations, sustainable purchasing policies, waste stream management and indoor environmental quality.

The GREEN SL® Rating System for Built Environment provides owners and operators of buildings an entry point into the GREEN SL® Certification process. The system is applicable to the following;

Building designs, processes, systems upgrades, minor space-use changes and minor facility alterations and/or additions; and

Building designs new to GREEN SL® Certification as well as buildings previously certified under GREEN SL® Accreditation for major renovations, schools or core and shell; these may be either new constructions or buildings that have undergone major renovations.

PROJECT REGISTRATION

Organisations interested in registering their projects under GREEN SL® Rating System for Built Environment Certification are advised to send the project registration inquiry via grs.gbcsl@gmail.com / greenrating.gbcsl@gmail.com. The GBCSL website (www.srilankagbc.org) also includes information on project registration and its process.

Registration is the first step that helps establish initial contact with GBCSL and provides access to the required documents, fees, templates, important communications and other necessary information.

PROJECT CERTIFICATION

To earn a green certification, a project must meet all mandatory requirements and minimum credit points. The project team will need to provide supporting documents for all mandatory requirements and credits attempted in the final submission stage. The final evaluation will be done by an independent panel and any determination,

opinion, or valuation made by the independent panel during the final evaluation shall be the final decision.

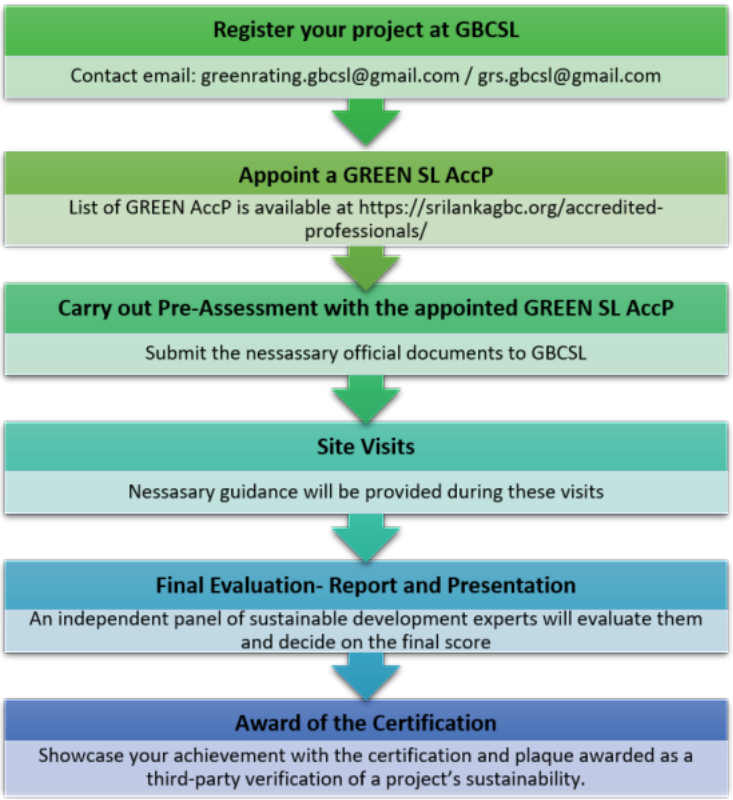
The project needs to submit the following;

- Basic project information
- Construction or as Built drawings
- Filled templates
- Supportive documents to each pre-requisite and credits.

PROJECT AWARDING

GBCSL will recognize projects that have reached one of the qualification levels through an official certificate and plaque.

CERTIFICATION PROCESS



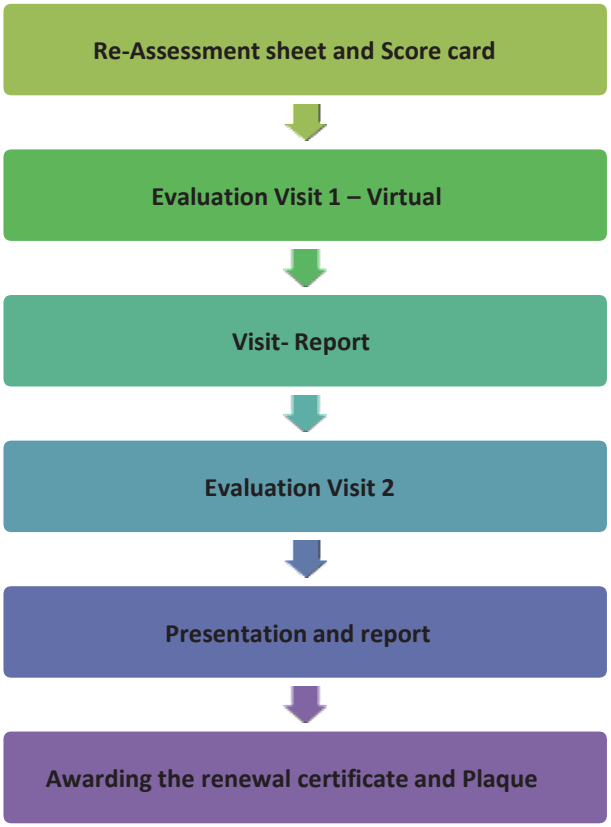
APPEAL

Sometimes pre-requites or credits are denied due to misinterpretation of the intent or less supportive documents. If the Applicant undertakes to challenge or contest any such determination, opinion or valuation shall need to submit an appeal mentioning the reason with supportive documents.

PROJECT RENEWAL

The building license is valid for three years and the renewal should be performed by the end of the validity period.

The renewal process is mentioned below.



ROADMAP TOWARDS HEALING THE EARTH

Sri Lanka, a teardrop-shaped island known as the pearl of the Indian Ocean is enriched with a phenomenal breathtaking nature flavoured with palm-fringed beaches and lush mountainous greenery nestled further inland, which relaxes the human mind and body and has attracted many tourists the world over.

Over the years, Sri Lanka has moved forward setting the pace for development, transforming this beautiful island into a new trend. Development is mostly focused in cities like Colombo, Jaffna, Kandy, Galle, Anuradhapura, Polonnaruwa and Hambanthota where the majority of the population reside. Ironically, while development work is enriched in one aspect, we are also depleting in other aspects. It is sad to realize that the industrialization which empowered the globe with new technology has laid the path towards the destruction of the globe as well.

Population increment is one of the main issues along with industrialization. The current global population is over 7.8 Billion and the United Nations estimates that it will reach a value of approximately 9.5 Billion by the year 2050. Also, it is envisaged that 60% of the world population will live in urban areas by the year 2030. This rapid population growth results in more demand for food, water, shelter and other basic necessities in this imperfect world and will generate more waste proving the saying; “All our environmental problems become easier to solve with fewer people and harder and ultimately impossible to solve with ever more people.” (Sir David Attenborough, renowned Naturalist & Population Matters patron).

Environmental Strategies

The development rate has paved the way towards the most popular environmental crisis - climate change which has resulted due to the incessant emission of greenhouse gases including CO_2, Methane, CFC etc, which absorb and retain heat in the atmosphere leading to global warming. Temperature controls the movement of air and air movement is the direct controller of the climate. The current level of CO_2 has reached up to 416 ppm by August 2021 (*NASA*) which is the highest level that has ever been recorded and it has resulted in a 1.02-degree rise in global temperature. If the level of emissions is not controlled then regrettably, it will lead to over 2-degree rise in global temperature by the year 2050. The graph in Fig. 1, indicates how the relentless increase in CO_2 levels in our atmosphere will lead to a catastrophe in the future.

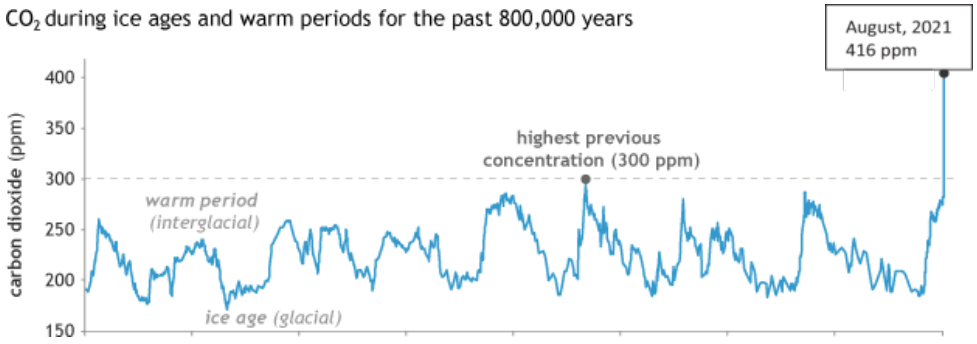


Figure 1: The variation of the level of CO_2

Source: NASA and the IPCC (Intergovernmental Panel on Climate Change)

Tropical rainforests which maintain the CO_2 balance of the atmosphere is at risk due to deforestation. This impacts people's livelihoods and threatens a wide range of plant and animal species. 30.8% of the land area of the planet is covered with forests, but we're losing 18.7 million acres of forests annually, equivalent to 27 soccer fields every minute.

Trees play a critical role in mitigating climate change acting as carbon sinks, soaking excess CO_2 along with the trapped heat. It is amazing that one native tree will fix around 0.16 tons of CO_2 per year while 1 ton of CO_2 will be fixed by around six trees. The average person generates approximately 2.3 tons of CO_2 per year requiring at least 15 trees per person to balance the emissions. However, this is a difficult task as the forest area is less than 31% of the Earth's surface. Sri Lanka loses around 15% of forest cover annually. Trees do not only support balancing CO_2 levels but combined with the sun's energy, the captured carbon is converted into trunks, branches, roots and leaves via the process of photosynthesis. It is stored in this "biomass" until being returned back into the atmosphere through natural processes or human interference, thus completing the carbon cycle.

Many of the water systems that keep ecosystems thriving and feed a growing human population have become stressed and result in difficulty in obtaining sources of fresh water. Earth's surface is covered only 3% of fresh water that is fit for human consumption but the pathetic phenomenon is that only around 1% of that fresh water is accessible to be used even with an uneven distribution around the planet. While a part of the planet is gifted with plenty of fresh water, another set of regions are highly stressed on water. An average one of three persons in every continent of the globe is affected by this water scarcity.

Waste generation is an unavoidable phenomenon that comes along urbanization resulted due to the rapid growth of population and increasing ecological demand. Every year we dump a massive 2.12 billion tons of waste as a globe. This stunning amount of waste is partly because 99 percent of the stuff we buy goes to trash within 6 months. In the Sri Lankan context, around 7000 tons of solid waste are generated per day and urban areas are responsible for 80% of them. The worst fact is that only around 2500 tons are collected daily by local authorities and the rest ends up in water bodies, canals, roads, public spaces and open burning. Even from the waste, plastic is the worst. Around 46,000 pieces of plastic are floating on every square mile of the ocean and as a whole being 1/6th of the weightof fish in the ocean. It is alarming to note that the total plastic debris weight in theocean will exceed the weight of fish by 2050 if the same habits are continued.

The truth is, the Earth has finite resources. This year (2021), it takes around 1.7 Earths to support humanities' demand on nature and we must remember the Native American proverb, *"we do not inherit the Earth from our forefathers, but, we borrow it from our children".* The concept of 'Earth Overshoot Day', calculated by the organization "Global Footprint Network" based on the continuous research done worldwide, marks the date when humanity's demand for ecological resources and services in a given year exceeds what the Earth can regenerate in that year. As Fig.2 clearly demonstrates, the consumption level is increasing yearly occurrence of the 'Overshoot Day'. It reveals that our planet is leading towards a catastrophe and we must do the right things with what's left on the planet.

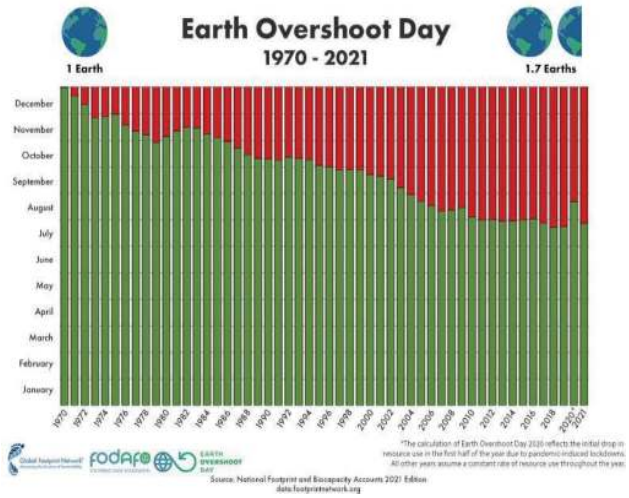
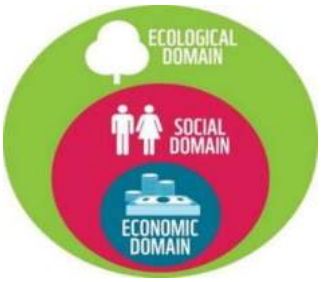


Figure 2: Variation of Earth Overshoot days from 1969 – 2021

July 29 – Earth Overshoot Day of 2021
(Source: Global Footprint Network National footprint accounts 2021)

However, if an action is taken today, the goal of having a sustainable world is not impossible. We need to move from the traditional triple bottom line concept (weak sustainability model) to the strong sustainability model (Fig.3) where ecology is the prime domain. It considers that the economy is a subset of the society and the society is a subset of the environment where both social and economic components are subsets of ecology or environment. This is a comprehensive concept as the environment is the component that sustains all living forms.

Weak Sustainability Model



Strong Sustainability Model

Figure 3: Sustainable development models

Source: *WWF- Living Planet Report 2014*

Who Disturbs the Balance?

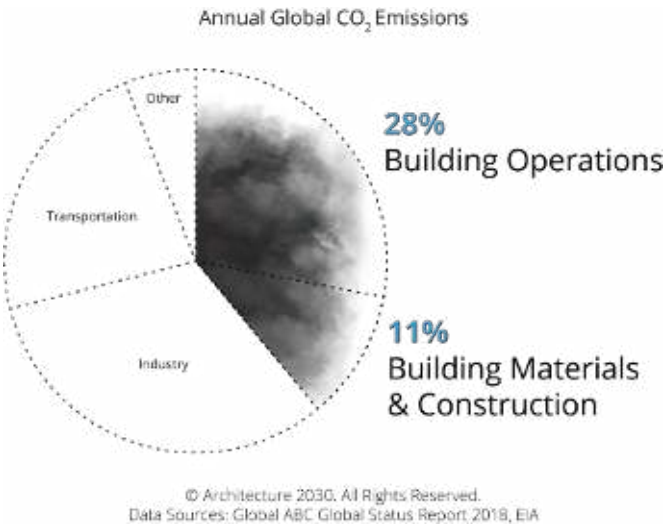


Figure 4: Annual Global Carbon Emission by sector

The built environment is one of the most crucial sectors for the remainder of the Earth. The lifespan contribution of buildings to the global CO_2 emissions is nearly 40%, being the largest single contributor to global warming. It has been premeditated that one ton of cement production contributes to approximately one ton of CO_2 emissions. Considering the total energy usage, the building sector is responsible for more than one third. Furthermore, it is responsible for about 12% of the water usage and 40% of the waste material that ends up in landfills and water resources.

The dream of a sustainable community or a community that is economically, environmentally, socially healthy and resilient can be achieved through several key components while improving the indoor and local environmental quality. Zero use of fossil fuel, zero potable water consumption, zero waste and zero carbon embedded material usage are the key components of creating such a sustainable community.

As Prof. Richard Reed from Deakin University, Australia very correctly stated; *"Of all things humans build, buildings last the longest, so we have to get buildings right"*.

Green Buildings

Green building design and development is the practice of building and operating structures with processes that are environmentally responsible with minimum resources. Sustainability shall become one of the main criteria of building design is an adequate strength, stability and serviceability. We are gifted with natural light for 12/7 and ventilation for 24/7, and therefore the buildings shall be designed with minimized energy consumption. Innovative technologies and renewable energy sources can be combined in green buildings to achieve sustainable design. Furthermore, the building materials can be replaced with recyclables such as steel, timber and waste products such as pozzolanic admixtures for concrete and should be designed with more emphasis on durability. Prefabricated components that can be dismantled and reused in the future is also another solution for buildings. Green roofs and green walls or vertical gardens in buildings, which maintain or increase green space, can be used to restore the balance between the built environment and nature. The green cover will reduce the carbon footprint of the building.

Green High-rise Buildings

Figure 5: Natural environment on a high-risebuilding (Source: Newton Suites, Singapore)

All human beings love to live the nature. It is really important to make occupantsfeel that they are not too far away from nature. Nature is adopted in buildings just assuming that "Mankind" is an activerecipient and plants are just a visualantidote", but there is a relationship between man and nature beyond that visual stimulation. The green plot ratio which defines the green coverage per unit area of the total built area provides a guide to keep that relationship. The rapid growth of population and the land scarcity restrict the level of linear development leading towards vertical development with a high-density living environment. Butstill, the concept of living with nature is applicable as a natural environment can becreated at high levels accommodating the required green plot ratio. The elementssuch as green walls, sky courts, parks and sky streets blended with nature will create this environment and people will create a vertical garden.

Figure 6: Integrating the greenery in high-rises - Source: Bosco Verticale (Vertical Forest), Milan

The established urban population in Colombo Municipal Council Region (37.3 km^2) will increase to 5.8 Billion by 2050. That is a 170% increment compared to the present situation confirming that the only solution is vertical living. One square kilometre vertical city development shall be encouraged as people in the city can live within a walkable distance.

Living in an era experiencing a Global Pandemic, COVID-19, adopting green building concepts is now more crucial than ever before. As the spread of the COVID-19 virus occurs via airborne particles and droplets, Indoor Air Quality (IAQ) has become a prime concern to mitigate the spread of the virus. The interior layout of the building, natural ventilation strategies, occupancy, heating, ventilation and air-conditioning (HVAC) systems, can all impact the airborne transmission of the virus. Introducing more outdoor air to occupied spaces, air filtration and disinfection are some of the engineering controls recommended to mitigate the airborne spread of the virus. These recommendations are all characteristics of a green building with improved IAQ. Learnings from COVID-19 will change the way we design our buildings and systems. Air purification technologies such as Bi-polar Ionization (BPI) and Ultraviolet Germicidal Irradiation (UVGI), will be essential in HVAC systems in new buildings, as it will prevent the rapid spread of such viruses in the future.

The Pandemic has also had an economic impact, where the latest estimates anticipate a drop of 6% in construction market value compared to 2019. This has also become an opportunity to adopt more sustainable buildings as sustainable construction is vital for economic recovery after the COVID-19 crisis.

Finally, it would be delightful to conclude that the trend of the going green conceptis rapidly growing day by day supporting a sustainable living condition that conserves the planet for the generations to come.

LET'S GO GREEN TO SAVE THE WORLD!

Eng. Shiromal Fernando,
Vice-Chairman,
Green Building Council of Sri Lanka.

GLOSSARY

Adapted plant - vegetation that is not native to a particular region but that has characteristics that allow it to live in the area. Adapted plants do not pose the same problems as invasive species.

Albedo - The fraction of light that is reflected by a body or surface.

Aquifer Recharge - Water that moves from the land surface or unsaturated zone into the saturated zone

Base building - Materials and products that make up the building or are permanently and semi-permanently installed in the project (e.g., flooring, casework, wall coverings)

Baseline Building Performance - The annual energy cost for a building design, used as a baseline for comparison with above-standard design

Basis of Design - The information necessary to accomplish the owner's project requirements, including system descriptions, indoor environmental quality criteria, design assumptions, and references to applicable codes, standards, regulations, and guidelines

Biomass – All materials of recent plant or animal origin such as trees, grass etc.

Blackwater – Wastewater that is generated through human and/or animal bodies, and/or water that has been contaminated by such

Building Envelope – The outer structure of a building (walls, doors, windows, roof and floor), also called building shell

Building Footprint - The area on a project site used by the building structure, defined by the perimeter of the building plan. Parking lots, landscapes, and other nonbuilding facilities are not included in the building footprint.

Built Environment – The man-made surroundings that provide the setting for human activity, ranging from personal shelter to neighbourhoods to the large-scale civic surroundings

Carbon Footprint - The total amount of greenhouse gases produced to, directly and indirectly, support human activities. usually expressed in equivalent tons of carbon dioxide (CO_{2eq}).

Carbon Management Plan – A carbon management plan is a documented strategy and set of actions to help an organisation meet their carbon reduction objectives. Typically it will include a summary of previous carbon footprint assessments, carefully identified carbon reduction targets and defined actions to achieve the goals set by the organisation.

Certified Assessor – A GREENSL® Accredited Professional who is independent of the Client, Designer and Contractor engaged directly by GBCSL to undertake the certification of a GREENSL® Rating Application

CFCs – Chlorofluorocarbons; refrigerants that cause depletion of the Ozone layer when released to the atmosphere

Charrettes - A charrette is a type of participatory planning process that assembles an interdisciplinary team—typically consisting of planners, citizens, city officials, architects, landscape architects, transportation engineers, parks and recreation officials, and other stakeholders—to create a design and implementation plan for a specific project.

Climate Change – Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates.

Commissioning – The process of putting Building Services Systems into active service; includes testing and adjusting systems such as HVAC, plumbing and electrical systems and ensuring proper functionality and adherence to design guidelines/ standards

Constructed wetlands – Artificial marshes or swamps, created for anthropogenic discharge such as wastewater, stormwater runoff or sewage treatment, also commonly as habitat for wildlife

Daylight Factor – The proportion of internal illuminance compared to the external illuminance, expressed as a percentage; represents the percentage of external which illuminates a given internal surface

Development Density - Entire building gross floor area (Sqm) divided by the site area in acres

Development Footprint - The total land area of a project site covered by buildings, streets, parking areas, and other typically impermeable surfaces constructed as part of the project.

Expert in Ecology - An expert in or student of ecology with academic and/or professional qualifications accepted by the GBCSL

Green Labeled Products - The accreditation activities of products in line with the specific environmental standards of authority.

Greywater – Wastewater which is recovered from showers, washing machines, sinks etc. that does not contain human waste or food.

Green Plot Ratio – The average LAI of the greenery on site and it is a scientific ratio of plant coverage onsite to determine the ideal amount of greenery for creating sustainability in urban design

Gross Floor Area (GFA) - The sum of the floor areas of the spaces within the building, including basements, mezzanine and intermediate-floored tiers, and penthouses with headroom height of 7.5 ft (2.2 meters) or greater.

Measurements must be taken from the exterior faces of exterior walls OR from the centreline of walls separating buildings, OR from the centreline of walls separating spaces. Excludes non-enclosed (or non-enclosable) roofed-over areas, such as exterior covered walkways, porches, terraces or steps, roof overhangs, and similar features. Excludes air shafts, pipe trenches, chimneys and floor area dedicated to the parking and circulation of motor vehicles.

Hardscape - The inanimate elements of the building landscaping. It includes pavement, roadways, stonewalls, wood and synthetic decking, concrete paths and sidewalks, and concrete, brick, and tile patios.

Heat Island Effect - The elevated temperature compared to the rural environment due to thermal absorption by hardscape, such as dark, non-reflective pavement and buildings and its subsequent radiation to surrounding areas.

Holistic – Relating to or concerned with wholes or with complete systems rather than with the analysis of, treatment of, or dissection into parts; complete

Integrative Design Process – A method for realizing high-performance buildings that contribute to sustainable communities

Impervious Surface - An area of ground that development and building have modified in such a way that precipitation cannot infiltrate downward through the soil. Examples of impervious surfaces include roofs, paved roads and parking areas, sidewalks, and soils that have been compacted either by design or by use.

Leaf Area Index – The ratio of one-sided leaf area per unit ground area.

Life cycle – All stages associated with the life of a product or substance; i.e. design, creation, distribution/sale, installation, use, disposal/reuse/recycle etc.

Light Trespass - Obtrusive illumination that is unwanted because of quantitative, directional or spectral attributes. Light trespass can cause annoyance, discomfort, distraction, or loss of visibility.

Mechanical ventilation – Ventilation systems which use electricity/ mechanically operated air movement devices such as fans to provide ventilation to a building

Natural ventilation – Ventilation carried out by natural means; through windows, louvres, openings in façade etc.

Occupied Space - Enclosed space intended for human activities, excluding those spaces that are intended primarily for other purposes such as storage rooms and equipment rooms and that are only occupied occasionally and for short periods of time.

On-Site Wastewater Treatment - The transport, storage, treatment and disposal of wastewater generated on the project site.

Open-Grid Pavement System - Pavements that consist of loose substrates supported by a grid of a more structurally sound grid or webbing. Pervious concrete and porous asphalt are not considered open grids as they are considered bounded materials. Unbounded, loose substrates do not transfer and store heat like bound and compacted materials do.

Ozone layer – A protective layer in earth's stratosphere made up of ozone and at a level of approximately 24km above earth's surface; absorbs most harmful radiation coming from the sun such as ultraviolet rays and prevents from them reaching the earth's surface

Phytoremediation – The use of plants and associated soil microbes to reduce the concentrations or toxic effects of contaminants in the environment.

Potable water – Water that is safe to be consumed; drinking quality water

Recycled Content – Materials that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process (pre-consumer) or after being used by the consumer (post-consumer)

Relative Humidity (RH) – Ratio as a percentage of the amount of water vapour in the air at a specific temperature to the maximum capacity of the air to hold moisture at that temperature

Renewable energy – Energy generated from a source that is continually replenished at a rate greater than or equal to its rate of depletion

Salvaged Material - A construction component recovered from existing buildings or construction sites and reused. Common salvaged materials include structural beams and posts, flooring, doors, cabinetry, brick, and decorative items.

Stakeholders - Individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion.

Solar Reflectance Index (SRI) - A measure of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. It is defined such that a standard black surface (initial solar reflectance 0.05, initial thermal emittance 0.90) has an initial SRI of 0, and a standard white surface (initial solar reflectance 0.80, initial thermal emittance 0.90) has an initial SRI of 100.

Upfront Carbon – The emissions caused in the materials production and construction phases (A1-5) of the lifecycle before the building or infrastructure begins to be used.

Virgin materials – Materials that are previously unprocessed

ABBREVIATIONS

ASHRAE –American Society of Heating, Refrigeration and Air-conditioning Engineers

ASTM – American Society of Testing and Materials

BIM – Building Information Modelling

BMS – Building Management System

BREEAM – Building Research Establishment Environmental Assessment Method

BOD – Basis of Design

CIDA – Construction Industry Development Authority

CIBSE – Charted Institution of Building Services Engineers

ECVP – Environmental Claim Validation Procedure

GBCSL – Green Building Council of Sri Lanka

GHG – Greenhouse Gas

GPR – Green Plot Ratio

HVAC&R – Heating, ventilation and air-conditioning and Refrigeration systems

IAQ – Indoor air quality

IESNA – Illuminating Engineering Society of North America

IPCC – Intergovernmental Panel on Climate Change

IPMVP – International Performance Measurement & Verification Protocol

LEED – Leadership in Energy and Environmental Design

Lpf – Liters per flush

Lpm – Liters per minute

MEP – Mechanical, Electrical and Plumbing

MERV – Minimum Efficiency Reporting Value

OPR – Owner's project requirements

SEA – Sri Lanka Sustainable Energy Authority

SLSI – Sri Lanka Standards Institution

SMACNA – Sheet Metal and Air Conditioning National Contractors Association

UVGI – Ultraviolet germicidal irradiation

VOC – Volatile Organic Compounds

WGBC – World Green Building Council

GREEN$^{SL®}$ RATING SYSTEM
FOR NEW CONSTRUCTIONS

1.0 MANAGEMENT

Prerequisite 1 – Green Building Accredited Professional

Required

Intent

To encourage and recognize the engagement of professionals who can assist the project team with the integration of Green Building aims and processes throughout the design and construction phases

Requirements

A principal participant in the design team is a Green Building Accredited Professional engaged by the building owner to provide sustainability advice from the schematic design phase through to construction completion.

Ensure that the submission adheres to all provisions of the submission requirements document found on the GBCSL website.

To be deemed engaged, in line with the aim of credit, the Green Building accredited professional must contribute substantially.

The Accredited Green Profession should;

- Attend at least **50%** of project design meetings and **75%** of all building services meetings.
- Participate in site visits and site meetings at least once a month.
- Prepare site inspection report and forward to project consultant/owner/GBCSL **(Specific format to be introduced).**
- Before construction, **Green Rating Proposal Report** is to be submitted to the GBCSL.

Potential Technologies & Strategies

The Green Building accredited professional must remain assigned to the project, from the schematic design stage to construction completion.

The role of the Green Building Accredited Professional can be fulfilled by different individuals throughout the project based on their expertise, the evidence above must be submitted for each Accredited Professional. As the certified assessor will seek to validate that the value to the project was not compromised by the handover, the

project must also provide a description of the handover procedures for all of the roles of the original Green Building Accredited Professional (Qualified Architect, Engineer, Planner and Quantity Surveyor, or any other professionals recognised by the Construction Industry Development Authority (CIDA).

Prerequisite 2 – Commissioning Clauses

Required

Intent

To encourage and recognize commissioning and handover initiatives to ensure that all building services can operate to optimum design potential.

Requirements

1. Commissioning and Quality Monitoring

Comprehensive pre-commissioning and quality monitoring are contractually required to be performed for all building services (BMS, mechanical, electrical and hydraulic); and the works outlined above to be carried out in exact accordance with CIBSE codes or ASHRAE commissioning guidelines (for services only) and CIBSE commissioning codes for the other services. Commissioning plan to be included in Green Rating Proposal Report.

2. The collaboration of the Design Team and Contractor

The design team and the Contractor are required to transfer project knowledge to the building owner/manager through all of the following;

- Documented design intent
- As-built drawings
- Operations and Maintenance Manual
- Commissioning Report
- Training of building management staff

Potential Technologies & Strategies

Where appropriate, information transferred to the building owner may be in the form of a comprehensive Building User‘s Guide. While this is not required by the referenced standards, the project team is strongly encouraged to consider the implications of commissioning based on indoor air quality, e.g. through establishing an indoor air

quality commissioning plan at the design stage with specific provisions for ensuring that this plan is met during and after commissioning.

For Shell and Core projects

Design and Build

If any component of the project is delivered as shell and core or an integrated fit-out, the scope of commissioning must cover the entire traditional scope of fit-out provided by the base building (e.g. electrical, mechanical, hydraulic and BMS systems even if some elements will be installed by the tenant). Therefore, it may need to be deferred until the completion of the relevant fit-out works. Commissioning must check against the documented base building design and ensure that the building operates to its design potential.

Prerequisite 3 – Building Users' Guide

Required

Intent

Encourage and recognize information management that enables building users to optimize the building's environmental performance

Requirements

A simple and easy-to-use Building User's Guide, which includes information relevant for the building users, occupants and tenants' representatives, is developed and made available to the building owner. It may contain some useful information that willallow the building users to understand the reason for some procedures included in the Building User's Guide.

Potential Technologies & Strategies

The Building Users' Guide must include the following information:

- Energy and Environmental Strategy
- Monitoring and Targeting
- Building Services (Ventilation, Heating and cooling system,
- Electrical systems, Lighting, Domestic hot water)
- Transport facilities
- Materials and Waste Policies
- Expansion/Re-fit Consideration (Include list of environmental recommendations for consideration, highlighting, in particular, the areas covered in the Building Users' Guide).
- References and Further Information

Credit 1.1 – Integrated Design Process

1 Point

Intent

To address and negotiate between the various needs of all stakeholders involved in a building project to achieve common targets in order to have a balanced and optimised sustainable design outcome.

Requirements

Use the Energy and Water-related analyses to inform the owner's project requirements (OPR), basis of design (BOD), design documents, and construction documents.

Conduct charrettes discussions in this process

Document how the analysis informed design and building form decisions in the project's OPR and BOD and the eventual design of the project.

- Reports, documents, correspondences and notes of discussions at the various project stages demonstrating the integrative design process can be provided
- Evidence of the implementation of design optimisation arising from the charrettes discussion can be provided
- BIM Execution Plan showing evidence of BIM Collaboration requirements, and coordinated BIM models of the Architectural, Structural and MEP (Mechanical, Electrical and Plumbing) disciplines also can be provided if available

Potential Technologies & Strategies

Beginning in pre-design and continuing throughout the design phases, identify and use opportunities to achieve synergies across disciplines and building systems.

BIM can be used for coordination and design integration, enabling optimisation of resources and downstream building performance.

Credit 1.2 – Green Facility Manager

1 Point

Intent

To ensure the sustainability practices are maintained throughout the operations stage.

Requirements

- The Green Facility Manager shall possess a minimum qualification "GREEN SL Associate Professional" of the Green Building Council of Sri Lanka or other Green Building Council recognized by WGBC.
- The Facility Manager must ensure the performance of the building as per designed data.
- The Facility Manager should annually report to GBCSL with Progress Report to make sure the sustainability practices are well maintained in the building.
- The Facility Manager shall perform occupant training sessions based on the Building Users Guide.

Potential Technologies & Strategies

A Green Facility Manager appointed by the client can be involved even in the construction stage so that he/she gets complete exposure to the project and will be able to maintain the intended Green Practices during the operations stage.

He/she is encouraged to develop their own green building strategy (aligned to the overall organisational strategy), translate their strategy into operational plans, train their teams on how to deploy and operationalise the facility green building strategy, introduce and monitor KPI's.

A database can be maintained including data related to all the sustainability features in the project.

Credit 1.3 – Responsible construction practices

2 Points

Intent

Encourage and recognize the adoption of a formal environmental management system in line with established guidelines during construction.

Requirements

Credit 1.3.1: Involvement of an expert in Ecology (Point 1)

Involvement of an expert in ecology at the design stage and obtain a report of survey ecosystems and assess the diversity, profusions and behaviour of the different organisms within them relating to the project and their recommendations.

Ecologists, Landscape architects, Botanists, Research Scientists and Research Assistants or any professional with qualifications in the field of ecology or environment can be considered as an Expert in Ecology.

Credit 1.3.2: Environmental Management Plan (Point 1)

The Contractor should implement a comprehensive, project-specific environmental management plan (EMP) aligned with ISO 14001 standards before and throughout the project.

The contractor should submit the EMP to the GBCSL with the initial proposal. It should include the following;

- Construction dust controlling system
- Sound controlling system
- Water pollution controlling in the construction stage
- Waste management system.

Potential Technologies & Strategies

Ecology related experts study the relationship between plants, animals and the environment. They look at how animals and plants inhabit a particular environment and report on the likely impact of any proposed construction works. Specially when

selecting plants for landscaping in different levels of buildings in different locations in the country, the expertise of an ecologist will be highly beneficial.

The commitment to the future provision of the EMP does not meet the credit criteria. The EMP must be fully comprehensive and project specified. The GBCSL expect that EMP has been correctly implemented, and internal audit trail tracking compliance will be evident to ensure that there is ongoing compliance during construction.

- www.cibse.org
- www.ashrae.org

2.0 SUSTAINABLE SITES

Prerequisite 1 – Erosion and Sedimentation Control

Required

Intent

Control / reduce soil erosion and minimize negative impacts of waterway sedimentation and airborne dust generation.

Requirements

Implement a sediment and erosion control plan that conforms to the best engineering practices specified by The Construction Industry Development Authority (CIDA) Protection of Landscape during Construction. The plan shall meet the following objectives:

- Prevent the loss of soil during construction by stormwater run-off and or wind erosion, including protecting topsoil by stockpiling for reuse.

- Prevent sedimentation of storm sewer or receiving streams and/ or air pollution with dust and particulate matter.

Potential Technologies & Strategies

Create an erosion and sedimentation control plan during the design phase of the project. Consider employing strategies such as temporary and permanent seeding, mulching, earth dikes, silt fencing, sediment traps and sediment basins.

Credit 2.1 – Site Selection

4 Points

Intent

Avoid the development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

Requirements

Do not develop buildings, roads or parking areas on portions of sites that meet any one of the following criteria:

- Land that is prime agricultural land.
- Land whose elevation is lower than 1.5m above the elevation of the 50-year flood level.
- Land use along the coastal belt shall comply with the guidelines of the Coast Conservation Department (www.coastal.gov.lk).
- Land which is specifically identified as habitat for any species threatened or endangered species by the Department of Wildlife Conservation – Ministry of Environment.
- Land is within the specified distance of any wetland as defined by Central Environmental Authority, or as defined by local or state rule or law, or the Ramsar Convention, which is the only global environmental treaty. The most stringent condition will apply.
  http://www.cea.lk
  http://www.ramsar.org
  http://dw.iwmi.org/wetland
- Land which was public parkland or land identified as landslide-prone areas prior to acquisition for the project.

Potential Technologies & Strategies

During the site selection process, give preference to those sites that do not include sensitive site elements and restricted land types. Select a suitable building location and design the building with a minimal footprint to minimize site disruption of those environmentally sensitive areas identified above. Plan to maintain natural environmental conditions.

Credit 2.2 – Site Assessment and Development

2 Points

Intent

To Assess site condition before design to evaluate sustainable options and to conserve existing natural areas and restore damaged areas.

Requirements

Complete and document site assessment including the following.

- **Topography -** Contour mapping, unique topographic features, slope stability risks.
- **Hydrology -** Flood hazard areas, delineated wetlands, lakes, streams, shorelines, water table, rainwater collection and reuse opportunities.
- **Climate -** Solar exposure, heat island effect potential, seasonal sun angles, prevailing winds, monthly precipitation, temperature ranges and events of extreme weather conditions.
- **Vegetation -** Primary vegetation types, greenfield area, significant tree mapping, threatened or endangered species, unique habitat, invasive plant species.
- **Soils -** A comprehensive Geotechnical Investigation report and /or details about Healthy soils, previous development, disturbed soils
- **Human use -** Views, adjacent transportation infrastructure, adjacent properties, construction materials with existing recycle or reuse potential.
- **Human health effects -** The proximity of vulnerable populations, adjacent physical activity opportunities, proximity to major sources of air pollution.

AND

Preserve and protect from all development and construction activity 40% of the greenfield area on the site (only if such areas exist)

Potential Technologies & Strategies

Team members, typically consisting of the ecology expert, landscape architect, land planner, and architect should begin by collecting a wide range of information, such as climate data, topographical maps, nearby building types, and soil survey data.

Engage local experts and specialists.

Plan to complete the assessment before the conceptual design starts enabling the findings to inform the location and orientation of major program elements.

Credit 2.3 – Development Density and Community Connectivity

2 Points

Intent

Channel development into urban areas with existing infrastructure, protect greenfields and preserve habitat and natural recourses.

Requirements

Option 1 - Development Density

Construct a building on a previously developed site and in a community with a minimum density of 20,000 square feet per acre net. Use the following equations for the calculation.

First, calculate the development density for the project.

$$Development\ Density\ (Sqft/acre) = \frac{Gross\ Building\ Area\ (Sqft)}{Site\ Area\ (Acres)}$$

Then determine the appropriate density radius removing effects of site shape.

$$Density\ Radius\ (ft) = 3 \times \sqrt{[Site\ Area\ (Acres) \times 43{,}569\ (sqft/acre)}$$

Finally, calculate the average property density within the density boundary. This value must be 20, 000 sq ft or more per acre.

$$Average\ Property\ Density\ within\ Density\ Boundary = \frac{\sum Square\ Footage}{\sum Site\ Area}$$

OR

Option 2 – Community Connectivity

Construct a building on a **previously developed site** within 1 km of a residential neighbourhood with an average density of **10 units per acre net** and **with pedestrian access** between the building and **at least 10 basic services.**

The Basic services include, but are not limited to:

Places of Worship, Hospitals, Pharmacy, Post office, Police Station, Schools, Banks, Super Markets, Parks, Grocery Stores, Day-care Centres, Hardware, Theatre, Laundry, Library, Restaurants, Community Centres, Salons etc.

Potential Technologies & Strategies

During the site selection process, give preference to urban sites or planned industrial zones with pedestrian access to a variety of services.

Credit 2.4 – Reuse of Previously Developed sites and Allowance for Connectivity of Green Lands

2 Points

Intent

To rehabilitate damaged sites/previously developed sites reducing pressure on undeveloped land and improving a percentage of land as reservations to support biodiversity.

Requirements

Develop on a previously developed site with necessary site improvements.

AND

Restore 30% (including the building footprint) of all portions of the site identified as previously developed, using native or adapted vegetation.

Restore all disturbed or compacted soils that will be re-vegetated within the project's development footprint.

Potential Technologies & Strategies

During the site selection process, avoid selecting greenfield. Reduce pressureon undeveloped land by rehabilitating previously used or damaged sites where development is complicated by environmental contamination. These damaged sites would typically involve sites such as old rubbish tips, former mining land, old factory sites, etc.

Adopt a sustainable site reclamation/remediation plan; cautious demolishing, preservation of existing building material for reuse and recycling.

Consider cleaning up the site using remediation strategies such as pump-and-treat, bioreactors, Phytoremediation (make sure the plant disposal is well handled), land farming and in-situ remediation.

Credit 2.5 – Alternative Transportation

3 Points

Intent

Reduce pollution and land development impacts from automobile use.

Requirements

Credit 2.5.1 Public Transportation Access (1 Point)

Locate project within 1 km of a railway station or 500m of two or more public bus routes usable by building occupants.

Credit 2.5.2 Parking Capacity (1 Point)

Size parking capacity to meet, but not exceed, minimum local zoning requirements and provide preferred parking for carpools and/or vanpools capable of serving 10% of the total provided parking spaces

Credit 2.5.3 Encourage use of green vehicles (1 Point)

Encourage the use of low emitting, fuel-efficient vehicles, and encourage the use of bicycles by building users, at least 25% in the quantity of the total vehicles used.

Potential Technologies & Strategies

Perform a transportation survey for future building occupants to identify their transportation needs. Locate the building near public transport facilities and design the building with transportation amenities such as,

- Cost and benefits by sharing vehicles with neighbours.
- Encourage the use of public transport and use of cycles.
- Minimize the parking lot/garage size.
- Consider sharing parking facilities with adjacent buildings and alternatives that will limit the use of single occupied vehicles.
- Provide “preferred parking spots”; parking spaces close to the main entrance of the facility.

Credit 2.6 – Reduced Site Disturbance

6 Points

Intent

To conserve existing natural areas and restore damaged areas, to provide habitat and promote biodiversity.

Requirements

Credit 2.6.1 Protect or Restore Habitat (2 Points)

On Greenfield sites, limit site disturbance including earthwork and clearing of vegetation to 15m beyond the building perimeter, 1.5m beyond primary roadway curbs, walkways, and main utility branch trenches, and 8m beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities and playing fields) that require additional staging areas to limit compaction in the constructed area

OR

On previously developed sites, restore a minimum of 50% of the site area (excluding the building footprint) by replacing impervious surfaces with native or adapted vegetation.

Minimize disturbances or restore the site to reduce long-term negative environmental impacts and thereby promote habitat and biodiversity.

Avoid disturbance to the site by retaining natural topography and/or designing vegetated spaces on the ground, for at least 15% of the site area.

Credit 2.6.2 Greenery Provisions (1- 2 Points)

Provide a green area with native or adapted vegetation within different levels of the building. A combination of Greenery systems such as Green roof, Green Terrace, Green Façade and Living wall, etc. are allowed.

Also, ensure the Green Plot Ratio (GPR) is over 0.5. Consider the LAI values (Leaf Area Index) for different types of greenery systems.

Leaf Area Index is defined as the single-side leaf area per unit ground area.

$$Green\ Plot\ Ratio(GPR) = \frac{Total\ leaf\ area\ of\ greenery\ within\ the\ site}{Development\ site\ area}$$

Table 2.1: Allocated Points

Green Plot Ratio	Points
0.5 – 1.0	1
Above 1.0	2

Credit 2.6.3 Development Footprint (2 Points)

Reduce the development footprint (defined as the entire building footprint, access roads and parking) to exceed the local zoning's open space requirement for the site by 25%. For areas with no local zoning requirements (e.g. some university campuses, military bases), designated open space areas adjacent to the building that is equal to the building footprint.

Potential Technologies & Strategies

Perform a site survey to identify site elements and adopt a master plan to develop the project site. Select a suitable building location and design the building with a minimal footprint to minimize site disruption. Strategies include stacking the building program, tucking under parking and sharing facilities with neighbours to maximize open space on the site. Establish clearly marked construction boundaries to minimize disturbance of existing sites and restore previously degraded areas to their natural state.

On a previously developed or graded site, restore or protect a minimum of 50% of the site area (excluding the building footprint) with native or adaptive vegetation. Plants indigenous to a locality or cultivars of native plants that are adapted to the local climate are considered as Native or Adaptive plants; invasive species or noxious weeds are not considered as such. This is similarly applicable to landscaping on rooftops and roof gardens, as long as the plants meet the definition of native or adaptive vegetation.

- Provide adequate tree-shaded parking to minimize footprint, avoiding separate paved areas for parking.

- Plans for replantation to compromise for footprint as reservations or rooftop gardening.

GPR or the Green Plot Ratio is a new architectural and planning metric for greenery in cities and buildings and it is simply the average LAI of the greenery on site. This is based on a common biological parameter called the leaf area index (LAI), which is defined as the single-side leaf area per unit ground area. Following LAIs can be used for the calculation.

Table 2.2: LAI Values for different Greenery system

Plant Group	Sub Group	LAI
Trees (Nos)	Open Canopy	2
	Intermediate Canopy	3
	Dense Canopy	4
Palms (Nos or m^2)	Solitary (trunk to trunk less than or equal to 2m at 1.5m radius)	2.5
	Cluster	4
Shrubs (m^2)	Monocot	3.5
	Dicot	4.5
Turf (m^2)	Turf	2
Vertical Greenery (m^2)	-	2

Open Intermediate Canopy Dense Solitary Cluster

Dicot Monocot Turf Vertical Greenery

Credit 2.7 – Stormwater Design, Quantity and Quality Control

3 Points

Intent

To limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, and reducing or eliminating pollution from stormwater run-off.

Requirements

If existing imperviousness is less than or equal to 50%:
Implement a stormwater management plan that prevents the post-development, 1.5 years, 24-hour peak[1] discharge rate from exceeding the pre-development, 1.5 years, 24-hour peak discharge rate.

OR

If existing imperviousness is greater than 50%:
Implement a stormwater management plan that results in a 25% decrease in the rate & quantity of stormwater run-off.

AND

Implement a stormwater management plan that reduces impervious cover, promotes infiltration, aquifer recharge and captures and treats the stormwater run-off from 70% of the average annual rainfall using Best Management Practices.

The stormwater treatment systems shall be designed to remove 80% of the average annual post-development total suspended solids (TSS) based on the average annual loadings from all storms less than or equal to the 2-year/24-hour storm. The effectiveness of TSS removal of some of the Best Management Practices is mentioned in the below table.

1 Peak rainfall intensity of 100mm per hour shall be considered for storm water design

Table 2.3: The effectiveness of TSS removal of some of the Best Management Practices

	Average TS Removal	Probable Range of TSS Removal	Factors to Consider
Effectiveness of Management Practices for Total Suspended Solids Removal from Runoff			
Infiltration Basin	75%	50 - 100%	soil percolation rates, trench surface area, storagevolumes
Infiltration Trench	75%	50 - 100%	soil percolation rates, trench surface area, storagevolumes
Vegetated Filter Strip	65%	40 - 90%	runoff volume, slope, soil infiltration rate
Grass Swale	60%	20 - 40%	runoff volume, slope, soil infiltration rates, vegeta-tive cover, buffer length
Porous Pavement	90%	60 - 90%	percolation rates, storage volume
Open Grid Pavement	90%	60 - 90%	percolation rates
Sand Filter Infiltration Basin	80%	60 - 90%	treatment volume, filtration media
Water Quality Inlet	35%	10 - 35%	maintenance, sedimentation storage volume
Water Quality Inlet with SandFilter	80%	70 - 90%	sedimentation storage volume, depth of filter media
Oil/Grit Separator	15%	10 - 25%	sedimentation storage volume, outlet configura-tion
Extended Detention Dry Pond	45%	5 - 90%	storage volume, detention time, pond shape
Wet Pond	60%	50 - 90%	pool volume, pond shape
Extended Detention Wet Pond	80%	50 - 90%	pool volume, pond shape, detention time
Constructed StormwaterWetlands	65%	50 - 90%	storage volume, detention time, pool shape, wet-land's biota, seasonal variation

Source: *LEED Reference Guide for Green Building Design and Construction*

Potential Technologies & Strategies

Strategies to minimize or mitigate stormwater runoff may include using pervious paving materials, harvesting stormwater for reuse in irrigation and indoor nonpotable water applications, designing infiltration swales and retention ponds, planting vegetated filter strips, installing vegetated roofs, and clustering development to reduce paved surfaces such as roads and sidewalks.

Rain gardens, vegetated swales, disconnection of impervious areas, and pervious pavement, can be used to promote infiltration and capture and treat runoff. In this stormwater is allowed to filter naturally into the soil reducing the pollutant load.

Use sustainable design strategies (e.g., low impact development, environmentally sensitive design) to design integrated natural and mechanical treatment systems such as constructed wetlands, vegetated filters, rainwater cisterns, manhole treatment devices, and open channels to treat stormwater run-off.

Credit 2.8 – Heat Island Effect, Non – Roof

1 Point

Intent

Reduce heat islands (thermal gradient differences between developed and undeveloped areas), minimise the impact on microclimate and human and wildlife habitat.

Requirements

Option 1

Use any combination of the following strategies for 50% of the site hardscape (Including roads, sidewalks, courtyards and parking lots):

- Provide shade from the existing tree canopy or within 5 years of landscaping (trees)must be placed at the time of occupancy.
- Provide shade from architectural devices or structures that have a solar reflectance
- index (SRI) of at least 29.
- Provide grass pavers.

OR

Option 2

Place a minimum of 50% of parking spaces underground or covered by structured parking; that have SRI of at least 29.

Notes:

SRI Values of reflectance materials shall be as per ASTM Standards and test certification by a third party agency approved by GBCSL.

OR

Option 3

Use an open-grid pavement system (less than 50% impervious) for a minimum of 50% of the parking lot area.

Potential Technologies & Strategies

Provide shaded construction surfaces using landscape features such as native trees, large shrubs, and non-invasive vines etc. and utilize high-reflectance materials for hardscape.

Consider replacing constructed surfaces (i.e. roof, roads, sidewalks, etc.) with vegetated surfaces such as vegetated roofs and open grid paving or specify high-albedo materials to reduce the heat absorption.

Credit 2.9 – Heat Island Effect, Roof

1 Point

Intent

Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize the impact on microclimate and human and wildlife habitats.

Requirements

Option 1

Use roofing materials having a Solar Reflectance Index (SRI) equal to or greater than the values in the table below for a minimum of 75% of the roof surface.

$$\frac{\text{Area of Roof meeting Minimum SRI}}{\text{Total Roof Area}} \text{ x } \frac{\text{SRI of Installed Roof}}{\text{Required SRI}} \geq 75\%$$

Table 2.4: SRI for different roofs

Roof Type	Slope	SRI
Low-Sloped Roof	≤ 2:12	78
Steep-Sloped Roof	≥ 2:12	29

OR

Option 2

Install a vegetated roof for at least 50% of the roof area.

OR

Option 3

Install high-albedo and vegetated roof surfaces that, in combination, meet the following criteria:

$$\frac{\text{Area of Roof meeting Minimum SRI}}{0.75} + \frac{\text{Area of vegetated Roof}}{0.5} \geq \text{Total Roof Area}$$

Potential Technologies & Strategies

Consider installing high-albedo and vegetated roofs to reduce heat absorption. SRI is calculated according to ASTM E 1980. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emission is measured according to ASTM E 408 or ASTM C 1371.

Credit 2.10 – Light Pollution Reduction

1 Point

Intent

Minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction, and reduce development impact on nocturnal environments.

Requirements

The project team must comply with one of the 2 options for the interior for interior lighting and the requirement for exterior lighting.

For Interior Lighting

Option 1

Reduce the input power (by an automatic device of) all nonemergency interior luminaries with a direct line of sight to any openings in the envelope (translucent or transparent) by at least 50% between 10 p.m. and 5 a.m. The after-hours override may be provided by a manual or occupant-sensing device provided the override lasts no more than 30 minutes.

OR

Option 2

All non-emergency interior lighting shall be turned off during non-business hours.

AND

For Exterior Lighting

Only light areas as required for safety and comfort. Do not exceed 80% of the lighting power densities for exterior areas and 50% for building facades and landscape features as defined in ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments.

All projects shall be classified under one of the following zones, as defined in IESNA RP-33, and shall follow all of the requirements for that specific light zone (LZ):

LZ1 - Dark (Park and Rural Settings)

Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than 0.1 horizontal and vertical lux at the site boundary and beyond. Document that 0% of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down).

LZ2 - Low (Residential Areas)

Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than **1.0** horizontal and vertical lux at the site boundary and no greater than **0.1** horizontal lux **3m** beyond the site boundary. Document that no more than **2%** of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site boundaries about public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.

LZ3 - Medium (Commercial / Industrial, High-Density Residential)

Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than **2.0** horizontal and vertical lux at the site boundary and no greater than **0.1** horizontal lux **5m** beyond the site. Document that no more than **5%** of the total initial designed fixture lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.

LZ4 - High (Major City Centres)

Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than **6.0** horizontal and vertical lux at the site boundary and no greater than **0.1** horizontal lux **5m** beyond the site. Document that no more than **10%** of the total initial designed site lumens are emitted at an angle of 90 degrees or higher from nadir (straight down). For site boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.

Potential Technologies & Strategies

Adopt site lighting criteria to maintain safe light levels while avoiding off-site lighting and night sky pollution. Minimize site lighting where possible. Technologies to reduce light pollution include full cut-off luminaries, low-reflectance surfaces and low-angle spotlights.

3.0 WATER EFFICIENCY

Prerequisite 1 – Water Efficient Landscaping

Required

Intent

To eliminate the use of potable water (from NWSDB) for landscape irrigation.

Requirements

Eliminate potable water requirement for landscape irrigation through plant species selection, irrigation system efficiency, harvested rainwater, recycled wastewater or groundwater.

Potential Technologies & Strategies

In the landscape design stage, plan water use zones as high, moderate and low and try to increase the low water use zone which is watered only through natural rainfall.

Plant turf grasses only for functional benefits such as recreational areas, pedestrian use, or specifically for soil conservation.

Perform a soil and climate analysis to determine appropriate landscape typesand design the landscape with indigenous plants to reduce or eliminate irrigation requirements.

Use high-efficiency irrigation systems such as drip, micro-mist, and subsurface irrigation systems where applicable with smart irrigation

controllers throughout.

Keep landscape areas mulched to prevent evaporative water loss from the soil surface to reduce the need for supplemental irrigation during dry periods.

Also consider using stormwater or treated greywater, and/or air conditioner condensate water for irrigation. Note that invasive plants may grow due to the use of greywater for irrigation. Therefore, under no circumstances should encourage colonization of non-indigenous and/or invasive plants.

Prerequisite 2 – Indoor water use reduction

Required

Intent

To reduce indoor water consumption.

Requirements

Calculate the baseline consumption (Exclude irrigation) for the fixtures in the following table and reduce the water consumption by **20%** from the baseline.

Table 3.1: Current baselines for commercial fixtures fittings and appliances

Commercial Fixtures, Fittings and Appliances	Current Baseline
Commercial toilet	6 litres per flush(lpf)
	Except for blow-out fixtures: 12 (lpf)
Commercial urinals	4.0(lpf)
Commercial toilet (restroom) faucets	9 litres per minute(lpm) at 4 bar, private applications only
	(hotel or motel guest rooms, hospital patient rooms)
	2 (lpm) at 4bar all others except private applications
	1 liter per cycle for metering faucets
Commercial pre-rinse spray valves(for food service applications)	Flow rate ≤ 6 (lpm)
	(no pressure specified; no performance requirement)

Table 3.2: A Current baseline for residential fixtures, fittings & appliances

Residential Fixtures, Fittings and Appliances	Current Baseline
Residential toilet	6 (lpf)
Residential kitchen faucet	8 (lpm) at 4bar
Residential toilet (restroom) faucets	
Residential showerhead	9(lpm) at 5.5bar per shower stall

The following fixtures, fittings and appliances are outside the scope of the water use reduction calculation;

- Commercial Steam Cooker
- Commercial Dishwasher
- Automatic Commercial Ice Maker
- Standard and Compact Residential Dishwashers

Potential Technologies & Strategies

Use high-efficiency fixtures (e.g., water closets and urinals) and dry fixtures, such as toilets attached to composting systems, to reduce potable water demand. Consider using alternative on-site sources of water (e.g., rainwater, stormwater, and air conditioner condensate) and greywater for nonpotable applications such as custodial uses and toilet and urinal flushing. The quality of any alternative source of water used must be taken into consideration based on its application or use.

Prerequisite 3 – Building Level Water Metering

Required

Intent

To support water management and identify opportunities for additional water savings by tracking water consumption.

Requirements

Install permanent water meters that measure the total potable water use for the building and associated processes. Meter data must be compiled into monthly and annual summaries; Manual or automated meter readings is allowed.

Potential Technologies & Strategies

Maintain a proper database in manual and electronic formats to record data. Identify the consumption patterns and potential saving strategies.

Credit 3.1 – Water Efficient Construction

1- 2 Points

Intent

To limit or eliminate the use of potable water (from NWSDB) for construction activities.

Requirements

Reduce over 50% of water requirements for construction activities through the use of alternative water sources.

An Action Plan for reducing water usage must be implemented on construction sites. Water consumption within the site throughout the construction period should be properly monitored through best practices implemented to reduce water consumption and wastages.

Table 3.3: Allocation of Points

Percentage reduction	Points
50% - 75%	1
Over 75%	2

Potential Technologies & Strategies

Dust suppression tools can be used on construction sites. By using energy-efficient water hoses, closed-loop water recycling, or other dust suppression methods, water usage can be greatly reduced. Leakage identification and fixing would also greatly reduce water consumption.

Construction costs may also be lowered by using less water or recycled water systems. Additionally, it can help to cut down on waste that is produced throughout the building process, resulting in lower carbon output and a positive impact on the environment.

Credit 3.2 – Cooling Tower Water Efficiency in Air-conditioning System

1 Point

Intent

Limit or eliminate the use of potable water for Air-conditioning make-up

Requirements

Reduce potable water consumption for air-conditioning make-up by 50%.

Potential Technologies & Strategies

Select energy-efficient chillers and water-efficient cooling towers. It is recommended to use CTI (Cooling Technology Institute) certified cooling towers with reduced evaporation to reduce water requirement for cooling tower make-up. Estimate potable water requirement for cooling tower make-up in the water-cooled chillers. Consider the use of treated rainwater or greywater generated within the site for air-conditioning make-up.

Credit 3.3 – Indoor water use reduction

1-5 Points

Intent

Optimize the water use efficiency within buildings to reduce the burden on potable water supply and wastewater systems.

Requirements

Additional potable water savings can be earned above the prerequisite level using high efficient fixtures and alternative water sources as per table 3.1.

Table 3.4: Point thresholds for overall indoor water reduction

Percentage Reduction	Points
21% - 25%	1
26% - 30%	2
31% - 40%	3
41% - 50%	4
51% or above	5

Potential Technologies & Strategies

Use high-efficiency fixtures. (e.g. water closets and urinals) and dry fixtures, such as toilets attached to composting systems, to reduce the potable water demand. Consider using alternative on-site sources of water.(e.g. rainwater, and air conditioner condensate, greywater) for non-potable applications (e.g., toilet and urinal flushing, custodial uses). The quality of any alternative source of water being used must be taken into considerationbased on its application or use.

Effective ways to reduce water use include installing flow restrictors and/or reduced flow aerators on the lavatory, sink, and shower fixtures; installing and maintaining automatic faucet sensors and metering controls; installing low-consumption flush fixtures, such as high-efficiency water closets and urinals; installing nonwater fixtures; and collecting rainwater.

Credit 3.4 – Innovative Wastewater Technologies

1-5 Points

Intent

Reduce the generation of wastewater and potable water demand, while increasing the local aquifer recharge.

Requirements

Credit 3.4.1 Reduce Potable Water Use (1 Point)

Reduce the use of NWS&DB provided potable water for building sewage conveyance by a minimum of 50%

Credit 3.4.2 Treat Wastewater (1 Point)

Treat 100% of wastewater on-site to tertiary standards.

Credit 3.4.3 Harvested Rainwater (2 Points)

Harvested rainwater use in toilet flushing and reduce 75% the use of portable water for toilet flushing.

Credit 3.4.4 Aquifer recharge (1 Point)

Balance treated wastewater and harvested rainwater after indoor and outdoor usage to be directed to wetland recharge well/pits etc. to increase the local aquifer recharge

Potential Technologies & Strategies

Consider reusing stormwater or greywater for sewage conveyance or on-site wastewater treatment systems (mechanical or natural). Options for on-site wastewater treatment include packaged biological pollutant removal systems, constructed wetlands (with indigenous plants and plants that can bind pollutants in [redox insensitive] forms), and high-efficiency filtration systems (aerobic or anaerobic).

The plumbing system should be designed to incorporate the separation of greywater from black water.

Credit 3.5 – Innovative Water Transmission

1 point

Intent

Limit the use of non-renewable energy for water transmission

Requirements

Reduce 50% of non-renewable energy consumption in water transmission by using renewable energy including solar wind, low impact hydro and biogas strategies

Potential Technologies & Strategies

In addition to the use of alternative onsite sources of water, use high-efficiency fixtures. (eg. water closets and urinals). Dry fixtures, such as toilets attached to composting systems, reduce the potable water demand.

Credit 3.6 –Water Sub- Metering

1 point

Intent

To support water management and identify opportunities for additional water savings by tracking water consumption.

Requirements

Install permanent water meters for the subsystems such as Indoor plumbing fixtures and fittings, irrigation and Domestic hot water etc.

Or

Install water meters at a few locations covering the whole project and monitor the water consumption patterns.

Potential Technologies & Strategies

Maintain a proper record of each water meter and analyse the data to identify potential water-saving opportunities.

4.0 ENERGY & ATMOSPHERE

Prerequisite 1 – Fundamental Building Systems commissioning and verification

Required

Intent

Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate to meet the owner's project requirements for energy, water, indoor environmental quality, and durability

Requirements

Implement or have a contract in place to implement the following fundamental best practice commissioning procedures in accordance with the ASHRAE Guideline 0-2016 and ASHRAE Guideline 1.1–2016 for HVAC&R and other energy Systems.

- Engage a **third-party** commissioning agent/team that does not include individuals directly responsible for project design or construction management
- Review owner's project requirements (OPR) and the basis of design (BOD) documentation
- Incorporate commissioning requirements into the construction documents
- Develop and implement a commissioning plan
- Develop construction checklist
- Verify installation, functional performance, training, operation and maintenance documentation
- Complete a commissioning report and make it available to GBCSL
- Commission to include the following energy systems:
    - Heating, Ventilation, Air Conditioning, and Refrigeration systems (HVAC&R) and associated controls
    - Lighting and Daylighting systems
    - Renewable Energy Systems

Document all findings and recommendations and report directly to the owner throughout the process.

Potential Technologies & Strategies

Engage a Commissioning Authority and adopt a commissioning plan. Include commissioning requirements in bid documents and task the commissioning agent to produce a commissioning report once commissioning activities are completed.

Prerequisite 2 – Minimum Energy Performance

Required

Intent

Establish the minimum level of energy efficiency for the base building and systems to reduce the environmental and economic impacts of excess energy usage

Requirements

Design the building project to comply with both –

- The mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) of ASHRAE / IESNA Standard 90.1 – 2016 (without amendments)

AND

- The prescriptive requirements (Sections 5.5, 6.5, 7.5, and 9.5) or performance requirements (Section 11) of ASHRAE / IESNA Standard 90.1 – 2016 / (without amendments)

and make available the proof documents such as building envelop U values, equipment efficiency values for GBCSL.

The project should comply with the final version of the Code of Practice on Energy Efficient Buildings of Sri Lanka, published by Sustainable Energy Authority (SEA), as and when it is released.

Potential Technologies & Strategies

Design the building envelope, HVAC, lighting and other systems to maximize energy performance. The ASHRAE 90.1-2016 user's manual contains worksheets that can be used to document compliance with this prerequisite. For projects pursuing points under EA Credit 1, the computer simulation model may be used to confirm satisfaction with this prerequisite.

Code of practice on Energy Efficient Buildings of Sri Lanka, published by SEA may be used to satisfy this prerequisite in lieu of ASHRAE 90.1-2016. SEA code of practice on the energy-efficient building can be found at www.energy.gov.lk/.

Prerequisite 3 – CFC Reduction in HVAC&R Equipment

Required

Intent

Reduce ozone layer depletion.

Requirements

Zero use of CFC-based refrigerants in new buildings Heating Ventilation Air Conditioning and Refrigeration systems. When reusing an existing base building HVAC equipment, complete a comprehensive CFC phase-out conversion before project completion.

Existing small HVAC&R units containing less than 225 grams (0.5 pounds) of refrigerants and other equipment such as standard refrigerators, small water coolers and any other equipment with refrigerants less than 225 grams are exempt.

Potential Technologies & Strategies

When reusing existing HVAC systems, conduct an inventory to identify equipment that uses CFC refrigerants and adopt a replacement schedule for these refrigerants. For new buildings, specify new HVAC equipment that uses no CFC refrigerants.

Prerequisite 4 – Energy Metering

Required

Intent

To support energy management and identify opportunities for additional energy savings by tracking building-level energy use.

Requirements

Install new or use existing building-level energy meters or submeters that canbe aggregated to provide building-level data representing total building energy consumption (electricity, chilled water, steam, fuel oil, biomass, etc.).

Commit to sharing with GBCSL the resulting energy consumption data for three years beginning on the date the project accepts GREEN SL certification. At a minimum, energy consumption must be tracked at one-month intervals.

Potential Technologies & Strategies

Maintain a proper database and analyse the data to identify potential savings in different sectors in the building.
Utility-owned meters capable of aggregating building-level resource use are acceptable.

Credit 4.1 – Optimize Energy Performance

1-10 Points

Intent

Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use.

Requirements

Select one of the three compliance path options described below. Project teams documenting achievement using any of the three options are assumed to comply with [EA] Prerequisite 2.

Option 1 - Whole Building Energy Simulation (1–10 Points)

Demonstrate a percentage improvement in the proposed building performance rating compared to the baseline building performance rating per ASHRAE/IESNA Standard 90.1-2016 (without amendments) by a whole building project simulation using the Building Performance Rating Method in Appendix G of the Standard (comfort temperatures of 24 + 2 deg C.).

Building simulation input and output data should be made available to GBCSL.

The project should comply with the final version of the Code of Practice on Energy Efficient Buildings published by the Sri Lanka Sustainable Energy Authority, as and when it is released.

The minimum energy cost savings percentage for each point threshold is as follows (Table 4.1);

Table 4.1: Minimum energy cost savings percentage for each point threshold

Energy Cost Savings Percentage	Points Awarded
5% - 10%	1
10%- 15%	2
15% - 20%	3
20% - 25%	4
25% - 30%	5
30% - 35%	6
35% - 40%	7
40% - 45%	8
45% - 50%	9
Over 50%	10

Appendix G of ASHRAE/IESNA Standard 90.1-requires that the energy analysis done for the Building Performance Rating Method includes all of the energy costs within and associated with the building project. To achieve points using this credit, the proposed design, (Appendix G of Standard 90.1-2016)

Must comply with the mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) in Standard 90.1-2016 (without amendments).

Must include all the energy costs within and associated with the building project.

AND

Must be compared against a baseline building that complies with Appendix G to Standard 90-1-2016 (without amendments). The default process energy cost is 25% of the total energy cost for the baseline building. For buildings where the process energy cost is less than 25% of the baseline building energy cost, the GREEN submittal must include supporting documentation substantiating that process energy inputs are appropriate.

For the purpose of this analysis, process energy is considered to include, but is not limited to, office and general miscellaneous equipment, computers, elevators and escalators, kitchen cooking and refrigeration, laundry washing and drying, lighting exempt from the lighting power allowance (ex., lighting integral to medical equipment) and other (ex., waterfall pumps). Regulated (non-process) energy includes lighting

(such as for the interior, parking garage, surface parking, façade, or building grounds, except as noted above), HVAC (such as for space heating, space cooling, fans, pumps, toilet exhaust, parking garage ventilation, kitchen hood exhaust, etc), and service water heating for domestic or space heating purposes.

For [EA] Credit 1, process loads shall be identical for both the baseline building performance rating and the proposed building performance rating. However, project teams may follow the Exceptional Calculation Method (ASHRAE 90.1-2016 G 2.5) to document measures that reduce process loads. Documentation of process load energy savings shall include a list of the assumptions made for both the base and proposed design while theoretical or empirical information supporting these assumptions.

OR

Option 2 — Prescriptive Compliance Path (4 Points)

Comply with the prescriptive measures of the ASHRAE 50% Advanced Energy Design Guide and climate zone for Small to Medium Office Buildings 2004. The following restrictions apply:

- Buildings must be less than 20,000 square feet.
- Buildings must be office occupancy.
- Project teams must fully comply with all applicable criteria as established in the Advanced Energy Design Guide for the climate zone in which the building is located.

OR

Option 3 – System Optimization (1 Point)

Comply with the Basic Criteria and Prescriptive Measures of the Advanced Buildings Benchmark™ Version 1.1 with the exception of the following sections: 1.7 Monitoring and Trend-logging, 1.11 Indoor Air Quality, and 1.14 Networked Computer Monitor Control. The following restrictions apply:

Project teams must fully comply with all applicable criteria as established in Advanced Buildings Benchmark for the climate zone in which the building is located.

Potential Technologies & Strategies

Design the building envelope and building systems to maximize energy performance. Use a computer simulation model to assess the energy performance and identify the most cost-effective energy efficiency measures. Quantify energy performance as compared to a baseline building.

Credit 4.2 – Onsite Renewable Energy

1-5 Points

Intent

Encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use.

Requirements

Supply at least 1% or more of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems other than Solar Photovoltaic technology

OR

Supply at least 5% of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of Solar Photovoltaic technology

Points earned for non-solar and solar energy in the following table may be added up to a total of 5 points.

Table 4.2: Points earned for percentage use of on-site renewable energy systems

Percentage of Solar Photovoltaic Energy	Percentage of Renewable Energy (Non Solar PV)	Points Awarded
5% - 10%	1%	1
10% - 20%	2%	2
20% - 30%	4%	3
30% - 40%	6%	4
Over 40%	8%	5

Potential Technologies & Strategies

Assess the project for potential renewable energies including solar, wind, geothermal, biomass, hydro, and bio-gas strategies. When applying these strategies, take advantage of the net metering with the local utility.

However, note that due consideration has been given to the increasing ease of applying Solar PV to projects while continuing to value the impact of non-solar renewable energy sources by creating separate point systems for Solar PV and other technologies.

Credit 4.3 – Enhanced Commissioning

1 Point

Intent

Verify and ensure that the entire building is designed, constructed, and calibrated to operate as intended.

Requirements

In addition to the Fundamental Building Systems Commissioning prerequisite, implement the following additional commissioning tasks;

- Conduct a focused review of the design before the construction documents phase.
- Conduct a focused review of the construction documents when close to completion.
- Conduct a selective review of contractor submittals of commissioned equipment. The above three reviews must be performed by a firm other than the designer.
- Develop a re-commissioning management manual.
- Have a contract in place for a near-warranty end or post-occupancy review.

Qualifications of Commissioning Agent:

- Must have documented commissioning process experience on at least two building projects with a similar scope of work. The experience must extend from the early design phase through at least 10 months of occupancy.
- Maybe a qualified employee of the owner, an independent consultant, or a disinterested subcontractor of the design team.

Potential Technologies & Strategies

Engage the Commissioning Authority (CA) early in project design phases. Task the commissioning agent to conduct project reviews before and after construction documents are complete. The CA must also create a re-commissioning manual for the building and review the project at the near-warranty end.

Credit 4.4 – Enhanced Refrigerant Management

1 Point

Intent

Reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing the direct contribution to climate change.

Requirements

Option 1

Do not use refrigerants

OR

Option 2

Use only refrigerants that have Ozone Depletion Potential (ODP) of zero and a Global Warming Potential (GWP) of less than 50.

OR

Option 3

Select refrigerants and heating, ventilation, air conditioning, and refrigeration (HVAC&R) that minimizes or eliminate the emission of compounds that contribute to ozone depletion and global climate change. The building HVAC&R equipment must comply with the following formula, which sets a maximum threshold for the combined contributions to ozone depletion and global warming potential:

$$LCGWP + LCODP \times 10^5 \leq 13$$

(SI units)

LCGWP	Lifecycle Direct Global Warming Potential (kg CO_2/kW-year)
LCODP	Lifecycle Ozone Depletion Potential (kg CFC 11/(Kw-year))
LCGWP =[GWPr ×(Lr×Life+Mr)×Rc]/Life	
LCODP =[ODPr ×(Lr×Life+Mr)×Rc]/Life	
GWPr	Global Warming Potential of Refrigerants (0 to 12,000 kg CO_2/kg r)
ODPr	Ozone Depletion Potential of Refrigerants (0 to 0.2 kg CFC 11/kg r)
Lr	Refrigerant Leakage Rate (2%)
Mr	End of Life Refrigerant Loss (10%)
Rc	Refrigerant Charge (0.065 to 0.65 kg of refrigerant per Kw OF AHRI or Eurovent rated cooling capacity)
Life	Equipment Life (10 years; default based on equipment type, unless otherwise demonstrated)

For multiple types of equipment, a weighted average of all base building HVAC&R equipment must be calculated using the following formula:

$$\frac{[\sum(LCGWP + LCODP \times 10^5) \times Qunit]}{Qtotal} \leq 13$$

(SI Units)

Q_{unit}	Eurovent Certified cooling capacity of an individual HVAC or unit (kW)
Q_{total}	Total Eurovent certified cooling capacity of all HVAC or refrigeration (kW)

For all Options

Small HVAC units (defined as containing less than 0.25 kg of refrigerant) and other equipment such as standard refrigerators, small water coolers, and any other cooling equipment that contains less than 0.25 kg of refrigerant, are not considered part of the base building system and are not subject to the requirements of this credit

Do not operate or install fire suppression systems that contain CFCs, hydrochlorofluorocarbons (HCFCs) or halons.

Potential Technologies & Strategies

Design and operate the facility without mechanical cooling and refrigeration equipment. Where mechanical cooling is used, utilize base building HVAC and refrigeration systems for the refrigeration cycle that minimizes direct impact on ozone depletion and global warming. Select HVAC&R equipment with reduced refrigerant charge and increased equipment life. Maintain equipment to prevent leakage of refrigerant to the atmosphere. Utilize fire suppression systems that do not contain HCFCs or Halons.

Credit 4.5 – Measurement and verification

1-2 Points

Intent

Provide the building energy consumption performance over time, for the ongoing accountability.

Requirements

Develop and implement a Measurement & Verification (M&V) Plan consistent with

Option 1: Measurement & Verification Plan (1 Point)

Develop and implement a Measurement & Verification (M&V) Plan consistent with either Option B (ECM Isolation) or Option D (Whole-Building Calibrated Simulation) as specified in the International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003. The M&V period shall cover a period of no less than one year of post-construction occupancy.

OR

Option 2 Building Management System (2 Points)

In addition to the M&V plan detailed above, install a centralized Building Management System (BMS) that monitors and records the energy consumption patterns of the building for further analysis and optimization. The BMS must comply with the following requirements:

- Record at intervals of one hour or less
- Must record both consumption and demand
- Whole-building electricity meters should record the power factor
- The system must be capable of reporting hourly, daily, monthly, and annual energy use
- The system must be capable of storing all meter data for at least 36 months

Potential Technologies & Strategies

Develop an M&V Plan to evaluate the building and/or energy system performance. Characterize the building and/or energy systems through energy simulation or engineering analysis. Install the necessary metering equipment to measure energy use. Track performance by comparing predicted performance to actual performance, broken down by component or system as appropriate. Evaluate energy efficiency by comparing actual performance to baseline performance.

While the IPMVP describes specific actions for verifying savings associated with energy conservation measures (ECMs) and strategies, this GREEN credit expands upon typical IPMVP M&V objectives. M&V activities should not necessarily be confined to energy systems where ECMs or energy conservation strategies have been implemented. The IPMVP provides guidance on M&V strategies and their appropriate applications for various situations.

A building management system (BMS) or building automation system (BAS) provides the building operator with a clear picture of the building's energy use over time and may also provide for the automation of many systems. This can lead to energy savings and optimization.

Credit 4.6 – Off-Site renewable energy

1 Point

Intent

Encourage investments in off-site renewable energy technologies for export purposes to the National Grid.

Requirements

Demonstrate that the company has installed green power equivalent to 50% of the total energy requirement of the building, anywhere in the country. This investment should be allocated only for the rated building and should be 50% of the building consumption. Therefore, the green power generated should be counted only once.

Potential Technologies & Strategies

Estimate the energy needs of the building on annual basis. Invest in green power plants in the country, which meets 50% of the total energy requirement of the building. Green power is derived from solar, wind, geothermal, biomass, or low-impact hydro sources.

Credit 4.7 – Certified Energy Auditor

1 Point

Intent

Ensure that a qualified person on staff manage the building energy systems and seek to optimize performance over time.

Requirements

Option 1:

A person on staff designated the energy manager must be a full-time employee of the building or organization and must have been awarded the 'Energy Manager' certification from the Sustainable Energy Authority (SEA) of Sri Lanka.

OR

Option 2:

Where no certified person on staff can be designated, a third party person with a valid contract for 1 year, with a commitment to extending up to 3 years can be appointed as the building energy manager.

All Options

The building energy manager must present an annual report on building energy consumption and energy management to the building/organizational management team.

Potential Technologies & Strategies

Seek to manage and optimize the building energy management by employing a qualified person, by encouraging an employee to undergo the energy manager training and certification process, or by hiring a qualified 3rd party to meet the requirements.

Credit 4.8 - Greenhouse Gas Emissions Management

1 Point

Intent

To reduce the impact on the environment due to the GHG Emissions during the operations stage of the building.

Requirements

Quantify the amount of Carbon emissions to the environment in **CO_{2eq}** (Carbon Dioxide Equivalent) within a period of 1 year in accordance with Greenhouse Gas Protocol and ISO14064- Part 1 Standard.

A Carbon Management Plan should be submitted along with the calculations and target should be set to reduce GHG Emissions annually.

Potential Technologies & Strategies

"Seek to manage and optimize GHG Emissions in the building by calculating the annual GHG emissions in the building in scopes 1 and 2; Direct Emissions, and Indirect emissions from purchased electricity as per the GHG Protocol. GHG Protocol is available at https://ghgprotocol.org/sites/default/files/standards /ghg-protocol-revised.pdf. When selecting emission factors priority should be given to local factors."

Table 4.3: Scope 1 types of emissions and relevant emission factors

Type of emission	Emission factor
Emissions from company facilities (boiler, furnace, driers, kilns, ovens, etc.)	https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
Company vehicles (on road, non road, water borne, air)	https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Scope 2 types of emissions and relevant emission factors

Type of emission	Emission factor
Purchased electricity (electricity, steam, heat or cooling)	**0.5845 kgCO_2/kWh** Source: energy-balance-2017.pdf

All the other emission factors used for the calculations must be used from a global/ national standard and the source must be given.

5.0 MATERIALS & RESOURCES AND WASTE MANAGEMENT

5.1 Materials and Resources

Prerequisite 1 - Operational Solid Waste Management

Required

Intent

Ensure effective operational solid waste management, to avoid operational (domestic and industrial) wastes being sent to the landfills and to improve sanitation, health and reduce environmental pollution.

Requirement

- The provision of facilities for the collection and storage of different common recyclables.
- Buildings with large volumes of food wastes have provisions for food waste management and recycling.

The implementation of the waste management plan which is also adhered to the National Waste Policy and Standards shall include built plans highlighting the recycling facilities, the waste collection contracts, methods.

Monitoring the amount and types of wastes collected from each category in weight and/or volumes and amount reused/recycled by each category is a must. (Selling the waste to an outside party would be considered as a reuse process.)

Potential technologies and strategies

- Waste management plan detailing the separation of waste expected within the building based on its use.
- Buildings should be designed with the provision of facilities for waste separation and sorting, and short-term storage at appropriate locations. (Eg. Composting facility, Bio gas facility, etc.)

- Layout plan showing the location of the recycling facilities, for the collection and storage of different common recyclables such as paper, glass, metal, plastic.
- Consider employing cardboard balers, aluminium can crushers, recycling chutes, and collection bins at individual workstations to further enhance the recycling program
- Facilities or systems for the placement of horticultural or wood waste for recycling.
- For buildings with large volumes of organic food waste, the provision systems for the segregation of food waste for separate collection or the provision of an onsite food waste recycling system.

In house recycling facilities will be able to reduce the landfills and wastes released to the environment hence reducing the pressure to the environment. Well managed facilities for the recycling of solid waste encourage recycling and results in reductions in the disposal at landfill sites.

Credit 5.1.1 – Building Reuse

1-2 Points

Intent

Extend the life cycle of the existing building stock, conserve resources, retain cultural resources, reduce waste, and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Ensure at least 75% (by area) of the structural and/or at least 25% (by area) of the non-structural (interiors) elements of the existing building area are retained.

Points are awarded as below:

Table 5.1: Allocation of Points

Building Element	Percentage Retained	Points
Structural and shell	≥75%	1
Non- Structural (Interior) and Non-shell	≥25%	1

Structural elements include columns, beams, floor slabs, exterior walls, structural glazing, etc.,

Non-structural (interiors) elements include interior walls, ceiling, flooring materials, doors, windows, etc.,

Potential Technologies & Strategies

Consider reuse of existing, previously occupied buildings, including structure, envelope and interior non-structural elements. Remove elements that pose a contamination risk to building occupants and upgrade components that would improve energy and water efficiency, such as mechanical systems and plumbing fixtures. Quantify the extent of building reuse.

Credit 5.1.2 – Reused and Recycled Materials/ Products

1-2 Points

Intent

To reduce the demand for virgin materials and to reduce solid wastes to landfills through the usage of recycled materials and/or resource reuse.

Requirements

Ensure at least 10% of the total building materials (by cost) used in the building are a combination of Recycled, Salvaged, reused or refurbished materials, products and furnishings.

Recycled content can be calculated using the following equation.

$$\text{Recycled content} = \frac{\text{Post consumer recycled content value} + \frac{1}{2}\text{Pre consumer recycled content value}}{\text{Total value of materials}} \times 100$$

Table 5.2: Allocation of Points

Percentage of recycled, Salvaged, reused or refurbished materials used (by Cost)	Points
≥10%	1
≥20%	2

Potential Technologies & Strategies

Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

Identify opportunities to incorporate salvaged materials into the building design and research potential material suppliers. Consider salvage materials such as beams and posts, flooring, panelling, doors and frames, cabinetry and furniture, brick and decorative items.

Refurbishing includes renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality or value of the product.

Excavated earth and stones shall not be considered under “reuse of salvaged materials” as they are natural resources.

When selecting the materials required for the project, consider using materials that include waste materials that are not being recycled in the processes in which the wastes are generated. (eg. Paddy husk, fly ash, wood scraps, sawdust, waste soil/ mud)

Examples for such materials: Bricks made out of waste soil/mud, wooden boards made out of processed wood wastes like chips and sawdust, etc.

Credit 5.1.3 – Local / Regional Materials

1 Point

Intent

Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation.

Requirements

Use a minimum of 50% of the total value of the building materials and products that are manufactured[2] locally[3].

Potential Technologies & Strategies

Establish a project goal for locally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

The cost of electrical, mechanical and plumbing equipment, systems and appliances and movable materials and furniture shall not be considered in the total materials cost.

Temporary materials such as materials used for the framework, scaffolding, etc., should not be considered for this credit calculation.

2 Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesmen. The final assemble location will be counted for evaluation

3 Sri Lanka

Credit 5.1.4 – Rapidly Renewable Materials

1 Point

Intent

Reduce the use and depletion of finite raw, and long-cycle renewable materials by replacing them with rapidly renewable materials.

Requirements

Use rapidly renewable building materials and products *(made from plants that are typically harvested within a twenty-year cycle or shorter)* for 5% of the total value of all building materials and products used in the project.

Potential Technologies & Strategies

Establish a project goal for rapidly renewable materials and identify products suppliers that can support the achievement of this goal. Consider materials such as bamboo, cotton, insulation, agrifiber and strawboard. During construction, ensure that the specified rapidly renewable materials are installed.

Credit 5.1.5 - Green Labelled Products

1 Point

Intent

To use Green labelled materials and products, certified as environmentally friendly products and equipment, to reduce dependence on materials that have associated negative environmental impacts.

Requirements

Ensure that at least 10% of materials (by Cost) used in the project are passive or active green building materials, products and equipment that are certified by GBCSL under the Green Product Labelling Program or by a third-party agency approved by the WGBC.

Potential Technologies & Strategies

Consider using certified passive products such as glazing, insulation, paints & coatings, adhesives & sealants, fly ash blocks, cement, concrete, composite wood, housekeeping chemicals, false ceiling materials, flooring materials, furniture, gypsum-based products, high reflective materials & coatings, etc.

Consider using active products such as electrical systems (lighting systems & controls, pumps & motors, etc), mechanical systems, (unitary air conditioners, etc), plumbing fixtures (faucets, showers, etc)

Credit 5.1.6 – Certified Wood

1 Point

Intent

To encourage environmentally responsible forest management.

Requirements

Use a minimum of 50% of wood-based materials certified in accordance with the Department of Forest Conservation and State Timber Cooperation of Environment Ministry for wood building components including, but not limited to structural framing and general dimensional framing, flooring, finishes, furnishings, and non- rented temporary construction applications such as bracing, concrete formwork and pedestrian barriers.

Potential Technologies & Strategies

Establish a project goal for certified wood products and identify products and & suppliers that can achieve this goal. During construction, ensure that the certified wood products are installed and quantify the total percentage of certified wood products are installed.

Credit 5.1.7 – Upfront Carbon Emissions

1 Point

Intent

To quantify the environmental impact of the building due to carbon emissions during the building material production stage and construction stages. Carbon emissions refer to all emissions of greenhouse gases.

Requirements

Quantify the Upfront Carbon Emissions in tCO_{2eq}/m^2 /yr, the emissions caused in the materials production (A1-A3), transport and construction Installation processes (A4-A5) of the lifecycle before the building or infrastructure begins to be used.

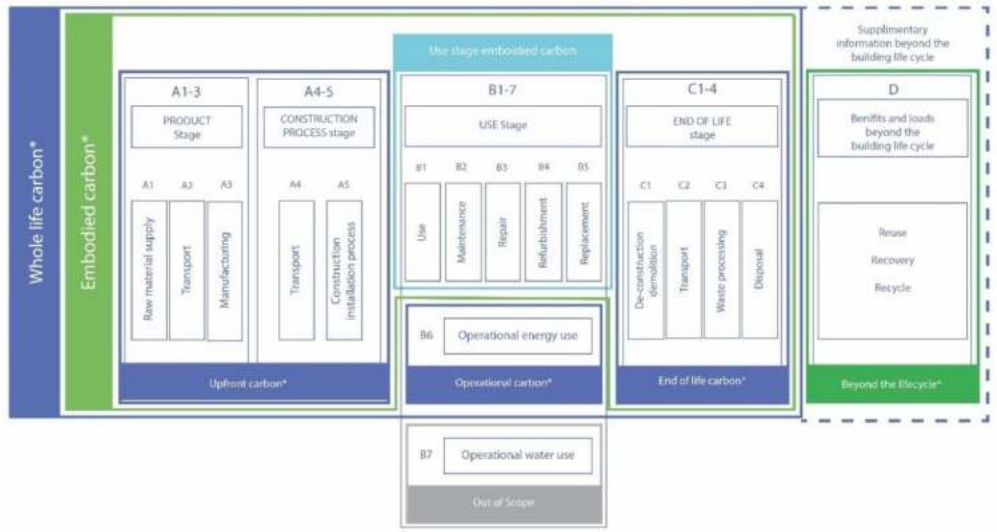


Figure 7: Life Cycle Stages of a building - Bringing Embodied Carbon Upfront Report - WGBC

Potential Technologies & Strategies

A Whole Building Life Cycle Assessment should be conducted using the Bill of Materials (BOM), Bill of Quantities (BOQ) and construction/structural/architectural drawings as applicable, covering the lifecycle stages A1 – A5 using appropriate methods. Manual calculations are accepted while the use of appropriate LCA software tools is preferred. If manually calculating, environmental product declarations / ecolabel data with data validity beyond the year of assessment complying with data standards as per ISO or EN is recommended. Use of Local data (complying with ISO/EN) should be given priority. In the absence of such data, the data from other countries may be

used.

Recommended data sources;

EPD libraries-EPD International, ÖKOBAUDAT Database, Bau EPD GmbH, EPDs of Specific countries such as EPD NORGE/AUSTRALASIA etc. Data (as per ISO/EN standards) arising from SCI indexed journals etc. may also be acceptable.

$$C_{up} = C_{mp} + C_{con}$$

C_{up} – **Total Upfront Carbon emission** (tCO_{2e})

C_{mp} – **Total Carbon emission at material production stage** (tCO_{2e})

C_{con} – **Total Carbon emission at construction stages** (tCO_{2e})

$$C_{mp} = \sum_i Q_{m,i}.EF_{m,i}$$

$Q_{m,i}$ – Quantity of the ith building material (t)

$EF_{m,i}$ – Emission factor for ith building material (t/t)

$$C_{con} = C_{mt} + C_{pr}$$

C_{con} – Total Carbon emission at construction stages (tCO_{2e})

C_{mt} – Total carbon emission during material transportation(tCO_{2e})

C_{pr} – Total CO_2 emission during Construction processes (tCO_{2e})

$$C_{mt} = \sum_i Q_{m,i}.EF_{m,i}.D_i$$

$Q_{m,i}$ – Weight of the ith building material (t)

$EF_{m,i}$ – Emission factor for ith building material transportation method($tCO_{2e}/t.km$)

D_i – Distance from the production site to the construction site (km)

$$C_{pr} = \sum_i Q_{pr,i}.EF_{pr,i}$$

$Q_{m,i}$ – Fuel or electricity consumption for ith process (liters or kwh)

$EF_{m,i}$ – Emission factor for ith process(tCO_{2e}/liter or kwh)

Credit 5.1.8 – Sustainable Building Systems

1-2 Points

Intent

To encourage the adoption of building designs, building structures and construction practices that are environmentally friendly and sustainable.

Requirements

Adopt sustainable building systems throughout at least a total coverage of 25% of the constructed floor area (CFA). Sustainable building systems are the following but not limited to.

- Pre-stressed Concrete Elements
- Hollow Core or Voided Concrete Elements
- Light Weight Concrete Elements
- High Strength Concrete Elements (Concrete grade >60MPa)
- Structural Steel Elements
- Composite Structural Elements
- Engineered Timber Elements
- Prefabricated Prefinished Volumetric Construction units
- Precast Concrete Elements
- Leave-in Formwork
- Modular Construction
- Others (to be accepted on a case-by-case basis)

Table 5.3: Allocation of Points

Percentage of the Constructed Floor Area (CFA)	Points
25% - 50%	1
Over 50%	2

Potential Technologies & Strategies

Use BIM model (if applicable), architectural and structural plan layout, elevation and sectional plans to show 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 systems can be used to calculate the percentage Constructed Floor Area for each building system.

5.2 Waste Management

Credit 5.2.1 Construction and Demolition Waste Reuse

1 Point

Intent

Divert construction, demolition, and land-clearing debris from landfill disposal, redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate uses in construction.

Requirements

Develop and implement a waste processes / sorting plan, quantifying material diversion goals.

Recycle and/or salvage at least **50%** of construction, demolition, and land clearing waste. Calculations can be done by weight or volume but must be consistent throughout.

Potential Technologies & Strategies

Establish goals for diversion from disposal in landfills and incinerators and adopt a construction waste management plan to achieve these goals. Consider recycling cardboard, metal, brick, acoustical tile, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Designate a specific area(s) on the construction site for segregated or commingled collection of recyclable material, and track recycling efforts throughout the construction process. Identify construction hauliers and recyclers to handle the designated materials.

Note that diversion may include the donation of materials to charitable organizations and salvage of materials on-site.

Also, if materials are given to external parties/service providers for recycling or reusing (sold or free), they are also considered.

Credit 5.2.2 Waste Materials to Construction Materials

1 Point

Intent

To reduce the demand for virgin materials by diverting different industry wastes to construction practices while avoiding wastes being sent to the landfills.

Requirements

Replace at least 2.5% (by cost) of the total cost of conventional building material requirement by of different industry waste for construction activities.

Potential Technologies & Strategies

Natural resources are depleting worldwide, while at the same time the generated wastes from the industries are increasing substantially. Studies have now revealed the possibility of replacing some of the construction materials like fine aggregates.

Quantify the usage (weight/volume) of industrial waste such as fly ash, quarry dust, rice husk ash, glass waste, fabric waste and etc. in construction.

Also, quantify the conventional materials (cost) that are being replaced with the waste materials. This replacing total cost should be at least 2.5% of the total material cost of the project.

Credit 5.2.3 – Storage, Collection & Safe disposal of hazardous wastes

1 Point

Intent

Facilitate the safe disposal of hazardous waste generated by building occupants which cannot be released to the environment.

Requirements

Take appropriate measures for the safe collection, storage, and disposal of hazardous wastes. (e.g.: batteries, mercury-containing lamps, electronic waste, etc.)

Potential Technologies & Strategies

Collect all hazardous waste by identifying hazardous elements or categories and coordinate with hazardous waste collection and recycling facilities to carry out necessary actions to mitigate the adverse effects of hazardous wastes by eliminating the release of those wastes to the environment.

Characteristic hazardous wastes are materials that are known or tested to exhibit one or more of the following four hazardous traits:

- Ignitability
- Reactivity
- Corrosivity
- Toxicity

Hazardous wastes

- Batteries (e.g. lithium, nickel-cadmium, or button cell batteries, dry cells)
- Paints and solvents
- Automotive wastes (used motor oil, antifreeze, etc.)
- Pesticides (insecticides, herbicides, fungicides, etc.)
- Mercury-containing wastes (thermometers, switches, fluorescent lighting, etc.)
- Electronics (computers, televisions, cell phones)

- Aerosols / Propane cylinders
- Caustics / Cleaning agents
- Refrigerant-containing appliances
- Ammunition
- Radioactive wastes

Methods of management

- Safe collection and handing over them to possible recycling plants/waste handling centres

6.0 INDOOR ENVIRONMENTAL QUALITY

Prerequisite 1 – Minimum IAQ Performance

Required

Intent

Establish minimum indoor air quality (IAQ) performance to prevent the development of indoor air quality problems in buildings, thus contributing to the comfort and well-being of the occupants.

Requirements

Meet the minimum requirements of voluntary consensus standard ASHRAE 62.1-2016 Ventilation for acceptable indoor sections 4 through 7, of Air Quality. Mechanical ventilation systems shall be designed using the ventilation rate produced or the applicable local code, whichever is more stringent. Naturally ventilated buildings shall comply with ASHRAE 62.1-2016 or Local building regulations which are published by Housing and Town Improvement Ordinance No, 19 of 1915 (chapter 268) and Urban Development Authority.

Calculation results and proof for complying with ASHRAE 62.1 shall be made available for GBCSL.

Potential Technologies & Strategies

1.0 Mechanical Ventilated spaces

Design ventilation systems to meet or exceed the minimum outdoor air ventilation rates as described in the ASHRAE 62.1-2016 and /or Local building regulations which are published by Housing and Town Improvement Ordinance No, 19 of 1915 (chapter 268) and Urban Development Authority standard, whichever is more stringent. Balance the impacts of ventilation rates on energy use and indoor air quality to optimize energy efficiency and occupant health. Use the ASHRAE - 62 User's Manual and Local Building regulations for detailed guidance on meeting the referenced requirements.

2.0 Naturally Ventilated Spaces

For naturally ventilated spaces determine the minimum outdoor air opening and space configuration requirements using the natural ventilation procedure from ASHRAE Standard 62.1–2016 or local building regulations, whichever is more stringent.

Confirm that natural ventilation is an effective strategy for the project by following the flow diagram in the Chartered Institution of Building Services Engineers (CIBSE) Applications Manual AM10, March 2005, Natural Ventilation in Non-domestic Buildings, Local Building Regulations, whichever is more stringent

Prerequisite 2 – Smoke (ETS) Control

Required

Intent

Minimize exposure of building occupants, indoor surfaces and ventilation air distribution systems to Environmental Tobacco Smoke (ETS).

Requirements

Prohibit smoking inside the building.

Prohibit smoking outside the building except in designated smoking areas located at least 25 feet (7.5 meters) from all entries, outdoor air intakes, and operable windows. Also, prohibit smoking outside the property line in spaces used for business purposes.

If the requirement to prohibit smoking within 25 feet (7.5 meters) cannot be implemented because of code, provide documentation of these regulations.

Signage must be posted within 10 feet (3 meters) of all building entrances indicating the no-smoking policy.

Potential Technologies & Strategies

Smoke-free buildings can limit the liability of a property owner or manager due to several reasons such as reducing the maintenance cost, reducing fire risk and minimal health risks of the occupants.

Prerequisite 3 - Minimum Acoustic Performance

Required

Intent

Minimize noise and vibration from mechanical and electrical equipment can ensure a basic level of acoustic comfort for occupant health and wellbeing

Requirement

Internal Noise

Achieve a maximum background noise level as per ANSI / ASA S12.2 2008 American standard Criteria for Evaluating Room Noise. Follow the recommended methodologies and best practices for mechanical system noise control in CIBSE Guide A, chapter 1.9.3 and the 2011 HVAC Applications ASHRAE Handbook, Chapter 48, Sound and Vibration Control (with errata); AHRI Standard 885–2008;

Exterior Noise

For high-noise sites use noise levels mentioned in gazette notification no. 924/12 dated 21st May 1996 published by Central Environment Authority Sri Lanka, National environmental Act, No 47 of 1980- Regulations No: 1 of 1996, implement acoustic treatment and other measures to minimize noise intrusion from exterior sources and control sound transmission between buildings spaces. Projects at least one-half mile (800 meters) from any significant noise source (ex., aircraft overflights, highways, trains, industry) are exempt.

Reverberation Time

Adhere to the following reverberation time requirements.

Option 1

For each room, confirm that the total surface area of acoustic wall panels, ceiling finishes, and other sound-absorbent finishes equals or exceeds the total ceiling area of the room (excluding lights, diffusers, and grilles). Materials must have an NRC of 0.70 or higher to be included in the calculation.

OR

Option 2

Confirm through calculations described in S12.2-2008 that rooms are designed to meet reverberation time requirements as specified in that standard.

Credit 6.1 – Outdoor Air Delivery Monitoring

1 Point

Intent

Provide capacity for ventilation system monitoring to help sustain occupant comfort and well-being.

Requirements

Install permanent CO_2 monitoring systems that provide feedback on ventilationsystem performance to ensure that ventilation systems maintain design minimum ventilation requirements.

Configure all monitoring equipment to generate an alarm when the conditions vary by 10% or more from setpoint, via either a building automation system alarm to the building operator or via a visual or audible alert to the building occupants.

For Mechanically Ventilated Spaces

- Monitor CO_2 concentrations within all densely occupied spaces (those with a design occupant density greater than or equal to 25 people per 1000 sq.ft.).
- CO_2 monitoring locations shall be between 3 feet and 6 feet above the floor.
- Calculate appropriate CO_2 set-points using methods in ASHRAE 62.1– 2016, Appendix C.

For Naturally Ventilated Spaces

Follow CIBSE AM10, Section 4, Design Calculations, to predict that room-by-room airflows will provide effective natural ventilation and/or design all openings to satisfy the minimum requirement of ventilation mentioned in the UDA building regulations.

Potential Technologies & Strategies

Install CO_2 and airflow measurement equipment and feed the information to the HVAC system and/or Building Automation System (BAS) to trigger corrective action, if applicable. If such automatic controls are not feasible with the building systems, use the measurement equipment to trigger alarms that inform building operators or occupants of a possible deficiency in outdoor air delivery.

Credit 6.2 – Increased Ventilation

1 Point

Intent

Provide additional outdoor air ventilation to improve indoor air quality for improved occupant comfort, well-being and productivity.

Requirements

For Mechanically Ventilated Spaces

Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2016 and/or Local building regulations as determined in EQ Prerequisite 1.

OR

For Naturally Ventilated Spaces

Design natural ventilation systems for occupied spaces to meet the recommendations set forth in the Carbon Trust “Good Practice Guide 237” [1998],62.1-2010 or Local building regulations

AND

Design the project to minimize and control the entry of pollutants into the building. Ensure through the results of computational fluid dynamics modelling. Refer ASHRAE Standard 62.2 - 2016 Informative Appendix I / National Ambient Air Quality Standards (NAAQS)

OR

For spaces where air contaminants are likely, evaluate potential sources of additional air contaminants besides CO_2. Develop and implement a materials-handling plan to reduce the likelihood of contaminant release. Install monitoring systems with sensors designed to detect the specific contaminants. An alarm must indicate any unusual or unsafe conditions.

OR

Follow CIBSE AM10, Section 4, Design Calculations, to predict that room-by-room airflows will provide effective natural ventilation.

Potential Technologies & Strategies

For Mechanically ventilated Spaces: Use heat recovery, where appropriate, to minimize the additional energy consumption associated with higher ventilation rates.

For Naturally ventilated Spaces: Follow the eight design steps described in the Carbon Trust Good Practice Guide 237;

- Develop design requirements,
- Plan airflow paths
- Identify building uses and features that might require special attention
- Determine ventilation requirements
- Estimate external driving pressures
- Select types of ventilation devices
- Size ventilation devices
- Analyze the design.

Use public domain software such as NIST's CONTAM, Multi-zone Modelling Software, along with LoopDA, Natural Ventilation Sizing Tool, to analytically predict room-by-room airflows

Credit 6.3 – Construction IAQ Management Plan

1 Point

Intent

Prevent indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.

Requirements

Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and preoccupancy phases of the building as follows:

Credit 6.3.1 Construction IAQ Management Plan Before and After Construction (1 Point)

- During construction meet or exceed the recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008–2008, Chapter 3.

- Protect stored on-site or installed absorptive materials from moisture damage

- If air handlers must be used during construction, filtration media with a Minimum Efficiency Reporting. Value (MERV) of 8 must be used at each return air grill, as determined by ASHRAE 52.2–2012

  AND

- After construction ends and prior to occupancy conduct a minimum two-week building flush-out with new Minimum Efficiency Reporting Value (MERV) 8 filtration media at 100% outside air.

- After flush-out, a new filter with a minimum MERV 8 value, must replace all filters except those solely processing outside air.

Note these filters must be MERV 13 or better when a project plans to earn EQ credit 5, Indoor Chemical and Pollutant Source Control.

Potential Technologies & Strategies

- Adopt an IAQ management plan to protect the HVAC system during construction, control pollutant sources, and interrupt pathways for contamination.

- Sequence installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile, and gypsum wallboard.

- Prior to occupancy, perform a two-week building flush-out or test the contaminant levels in the building.

Credit 6.4 – Low - Emitting Materials

1-3 Points

Intent

Reduce the quantity of indoor air contaminants that are odorous or potentially irritating harmful to the comfort and well-being of installers and building occupants.

Requirements

Credit 6.4.1 Adhesives and Sealants (1 Point)

All adhesives and sealants used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the requirements of the reference guide.

Table 6.1: VOC Limits of adhesives: Architectural Applications

Architectural Applications	VOC Limit (g/L less) water)
Indoor Carpet Adhesives	50
Carpet Pad Adhesive	50
Wood Flooring Adhesives	100
Rubber Floor Adhesives	60
Sub Floor Adhesives	50
Ceramic Tile Adhesives	65
VCT And Asphalt Tile Adhesives	50
Dry Wall and Panel Adhesives	50
Cove Base Adhesive	50
Structural Glazing Adhesives	100
Multipurpose Construction Adhesives	70

Table 6.2: VOC Limits of adhesives: Substrate Specific Applications

Substrate Specific Application	VOC Limit (g/L less water)
Metal to Metal	30
Plastic Foams	50
Porous Material (Except Wood)	50
Wood	30
Fiber Glass	80

Table 6.3: VOC Limits of adhesives: Specialty Applications

Speciality Application	VOC Limit (g/L less water)
PVC Welding	510
Top and Trim Adhesive	250
Contact Adhesive	80
Special Purpose Contact Adhesive	250

Table 6.4: VOC Limits of Sealants

Sealants	VOC LImit (g/L less water)
Architectural	250
Non-membrane roof	300
Roadway	250
Single-ply roof membrane	450
Other	420

Table 6.5: VOC Limits of Sealant Primers

Sealant Primers	VOC Limit (g/L less water)
Architectural, nonporous	250
Architectural, porous	775
Other	750

Credit 6.4.2 Paints and Coatings (1 Point)

Paints and coatings used on the interior of the building defined as inside of the weatherproofing system and applied on-site shall comply with the requirements of the reference guide.

The VOC (Volatile Organic Compounds) content of paints, coatings and primers used must not exceed the VOC content limits mentioned below;

Table 6.6: VOC Limits of Paints

Paints	VOC Limit (g/L less water)
Non-flat	150
Mat (fat)	50
Anti Corrosive / Anti Rust	250

Table 6.7: VOC Limits of coatings

Coating	VOC Limit (g/L less water)
Clear Wood Finishes -	
Varnish	350
Lacquer	550
Floor Coatings	100
Stains	250
Sealers -	
Waterproofing Sealer	250
Sanding Sealer	275
Other Sealers	200

Credit 6.4.3 Carpet Systems and Composite Wood and Agrifiber Products (1 Point)

Carpet systems must meet or exceed the requirements of the Carpet and Rug Institute's Green Label Indoor Air Quality Test Program. All carpet cushions installed in the building interior shall meet the requirements of Carpet and Rug Institute's Green Label Indoor Air Quality Test Program. All carpet adhesive shall meet the requirements of EQ Credit 6.4.1: VOC limit of 50 g/L.

Composite wood and agrifiber products used on the interior of the building must contain no added urea-formaldehyde resins. Composite wood and agrifiber products are defined as particleboard, medium-density fibreboard (MDF), plywood, wheatboard, strawboard, panel substrates and door cores.

Potential Technologies & Strategies

Specify low-VOC materials in construction documents. Ensure that VOC limits are clearly stated in each section where adhesives, sealants, paints, coatings, carpet systems, and composite woods are addressed.

Credit 6.5 – Indoor Chemical & Pollutant Source Control

1 Point

Intent

Minimize exposure of building occupants to potentially hazardous particulates and chemical pollutants.

Requirements

Design to minimize and control pollutant entry into buildings and later cross-contamination of regularly occupied areas:

- Employ permanent entryway systems at least 6 feet long in the primary direction of travel to capture dirt and particulates from entering the building at all entryways that are directly connected to the outdoors.
- Acceptable entryway systems include permanently installed grates, grilles, or slotted systems that allow for cleaning underneath.
- Roll-out mats are only acceptable when maintained on a weekly basis by a contracted service organization.
- Qualifying entryways are those that serve as regular entry points for building users.
- Where hazardous gases or chemicals may be present or used (including garages, housekeeping/laundry areas and copying/printing rooms), exhaust each space sufficiently to create negative pressure with respect to adjacent spaces with the doors to the room closed.
- For each of these spaces, provide self-closing doors and deck–to–deck partitions or a hard lid ceiling.
- The exhaust rate shall be at least 0.50 cfm/sq.ft, with no air re-circulation.
- The pressure differential with the surrounding spaces shall be at least 5 Pa (0.02 inches of water gauge) on average and 1 Pa (0.004 inches of water) at a minimum when the doors to the rooms are closed.

In mechanically ventilated buildings,

- Provide regularly occupied areas of the building with air filtration media prior to occupancy that provides a Minimum Efficiency Reporting Value (MERV) of 13 or better.

- Filtration should be applied to process both return and outside air that is to be delivered as supply air.

Potential Technologies & Strategies

Design facility cleaning and maintenance areas with isolated exhaust systems for contaminants. Maintain physical isolation from the rest of the regularly occupied areas of the building.

Install permanent architectural entryway systems such as grills or grates to prevent occupant-borne contaminants handling units can accommodating required filter sizes and pressure drops from entering the building.

Install high-level filtration systems in air handling units processing both return air and outside air that is to be delivered as supply air.

Credit 6.6 – Lighting and Comfort Controls

1-2 Points

Intent

Provide a high level of lighting system control by individual occupants or by specific groups in multi-occupant spaces (i.e., classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants.

Requirements

Credit 6.6.1 Lighting Controls (1 Point)

Provide individual lighting controls for 90% (minimum) of the building occupants to enable adjustments to suit individual task needs and preferences.

AND

Provide lighting system controllability for all shared multi-occupant spaces to enable lighting adjustment that meets group needs and preferences including the following.

- Lighting for any presentation or projection wall must be separately controlled.
- Switches or manual controls must be located in the same space as the controlled luminaires. A person operating the controls must have a direct line of sight to the controlled luminaires.

Credit 6.6.2 Thermal Comfort Controls (1 Point)

Provide individual comfort controls for 50% (minimum) of the building occupants to enable adjustments to suit individual task needs and preferences.

Operable windows can be used in lieu of comfort controls for occupants in natural ventilation in areas that are 20 feet inside of and 10 feet to either side of the operable part of the window. The areas of the operable window must meet the requirements of ASHRAE 62.1-2016, paragraph 6.4, Natural Ventilation.

AND

Provide comfort system controls for all shared multi-occupant spaces to enable adjustments to suit group needs and preferences.

Conditions for thermal comfort are described in ASHRAE Standard 55-2017 to include the primary factors of air temperature, radiant temperature, air-speed and humidity. Comfort system control, for the purposes of this credit, is defined as the provision of control over at least one of these primary factors in the occupant's local environment.

Potential Technologies & Strategies

Design the building and systems with comfort controls to allow ASHRAE Standard 55-2017 identifies the factors of thermal comfort and a process for developing comfort criteria for building spaces that suit the needs of the occupants involved in their daily activities.

Control strategies can be developed to expand on the comfort criteria to allow adjustments to suit individual needs and preferences.

These may involve system designs incorporating operable windows, hybrid systems integrating operable windows and mechanical systems, or mechanical systems alone.

Individual adjustments may involve individual thermostat controls, local diffusers and grills at overhead levels or other means integrated into the overall building, thermal comfort systems, and energy systems design.

In addition, designers should evaluate the closely tied interactions between thermal comfort (as required by ASHRAE Standard 55-2017) and acceptable indoor air quality (as required by ASHRAE Standard 62.1-2016, whether natural or mechanical ventilation).

Credit 6.7 – Thermal Comfort, Design and Verification

1 Point

Intent

Provide a comfortable thermal environment that supports the productivity and well-being of building occupants and monitor the thermal comfort over time.

Requirements

Thermal comfort by design

Design HVAC systems and the building envelope to meet the requirements of ASHRAE Standard 55-2017, Thermal Comfort Conditions for Human Occupancy. Demonstrate design compliance in accordance with Section 6.2 Documentation.

Calculation results and proof for complying with ASHRAE 55-2017 shall be made available for GBCSL.

Thermal comfort by verification

Implement a thermal comfort survey of building occupants within a period of 6 to 18 months after occupancy. This survey should collect anonymous responses about thermal comfort in the building including an assessment of overall satisfaction with thermal performance and identification of thermal comfort-related problems. The survey results shall be made available for GBCSL.

Develop a plan for corrective action if the survey results indicate that more than 20% of occupants are dissatisfied with thermal comfort in the building. This plan should include the measurement of relevant environmental variables in problem areas in accordance with ASHRAE Standard 55-2017.

Potential Technologies & Strategies

Establish comfort criteria per ASHRAE Standard 55-2017 that support the desired quality and occupant satisfaction with building performance. Design building envelope and systems with the capability to deliver performance to the comfort criteria under expected environmental and use conditions. Evaluate

ASHRAE Standard 55-2017 provides guidance for establishing thermal comfort criteria and the documentation and validation of building performance to the criteria. While the standard is not intended for purposes of continuous monitoring and maintenance of the thermal environment, the principles expressed in the standard provide a basis for the design of monitoring and corrective action se4ystems.

Credit 6.8 – Air Purification and Disinfection

1 Point

Intent

Provide a safer environment for occupants in buildings during normal operations and Pandemics to mitigate the transmission of viruses through the use of mechanical systems.

Requirements

Design HVAC systems to the established comfort criteria as per ASHRAE 55-2017, ASHRAE Position Document on Infectious Aerosols - 2020 and use disinfection and purification technologies to mitigate the spread of viruses through HVAC systems. This shall be achieved through an optimum strategy of filtration and disinfection without increasing the energy consumption of HVAC systems. This should overall improve the air quality in space during normal system operation.

Potential Technologies & Strategies

- Enhance filtration (higher Minimum Efficiency Reporting Value - MERV filters over code minimum in densely occupied areas or higher risks spaces. For a green building, the design filtration system efficiency of MERV 13 for air handling systems is part of the compliance.
- Increase the outdoor air change rate from 2 to 6 ACH in commercial and residential air conditioning systems.
- Increase outdoor air ventilation of central systems by opening outdoor air dampers to 100% as indoor and outdoor conditions permit. Disable demand control ventilation systems.
- Bypass energy recovery ventilation systems that leak potentially contaminant exhaust air back into the outdoor air supply.
- Use disinfection technologies such as UVGI (Ultraviolet germicidal irradiation) and Bi-polar Ionization (also referred to as Needle point bi-polar ionization) to disinfect the air delivered through an HVAC system. If you decide to use a device that incorporates bipolar ionization technology, it must meet UL 2998

standard certification (Environmental Claim Validation Procedure (ECVP) for Zero Ozone Emissions from Air Cleaners).

Consider using a combination of the above technologies to achieve the optimum strategy to improve the air quality.

- Use of portable free standing air purifiers with high-efficiency particulate air (HEPA) filters with UVGI lamps.
- Temperature and humidity control of the space

Credit 6.9 – Daylight & Views

2 Points

Intent

Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Requirements

Credit 6.9.1 Daylight: Achieve a minimum Daylight Factor between 2 % and 5 %- (1 Point)

Achieve a minimum Daylight Factor between 2 % and 5 % (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks.

Spaces excluded from this requirement include copy rooms, storage areas, mechanical plant rooms, laundry and other low occupancy support areas. Other exceptions for spaces where tasks would be hindered by the use of daylight will be considered on their merits.

Credit 6.9.2 Views - (1 Point)

Achieve direct line of sight to outdoor environment via vision glazing for building occupants in 90% of all regularly occupied floor areas. Examples of exceptions include copy rooms, storage areas, mechanical, laundry and other low occupancy support areas. Other exceptions will be considered on their merits.

Potential Technologies & Strategies

Design the building to maximize daylighting and view opportunities. Strategies to consider include building orientation, shallow floor plates, increased building perimeter, exterior and interior shading devices, high-performance glazing and photo-integrated light sensors. Model day-light strategies with a physical or computer model to assess foot-candle levels and daylight factors achieved.

7.0 Innovations and Design Process

7.1 Innovation in Design

1-4 points

Intent

To provide design teams and projects with the opportunity to be awarded points for exceptional performance above the requirements set by the GREENSL® Rating System and/or innovative performance in Green Building categories not specifically addressed by the GREENSL® Rating System.

Requirements

In writing, identify the intent of the proposed innovation credit, the proposed requirement for compliance, and the proposed submittals to demonstrate compliance and the design approach (strategies) that might be used to meet the requirements.

Credit 7.1.1 Innovation in Design (1-2 points)

Achieve significant, measurable environmental performance using a strategy not addressed in GREENSL® Rating System for New Construction Version 2.1. Each strategy earns 1 point and up to 2 points in total.

Credit 7.1.2 Exemplary Performance (1-2 points)

Achieve exemplary performance in an existing GREENSL® Rating System for New Construction Version 2.1 prerequisite or credit. An exemplary performance maybe earned by achieving double the credit requirements and/or achieving the next incremental percentage threshold of existing credit. Each exemplary performance earns 1 point up to 2 points in total.

Potential Technologies & Strategies

Engage a commissioning Authority and adopt a commissioning plan. Include commissioning requirements in large documents and task the commissioning agent to produce a commissioning report once commissioning activities are completed.

8.0 SOCIAL & CULTURAL AWARENESS

Prerequisite 1 – Archeological Sites & Heritage Buildings

Required

Intent

Protect archaeological sites and heritage buildings and discourage building constructions that may affect the cultural identity of the site and the heritage value of the building.

Requirements

Do not develop buildings, roads or parking areas on sites define as archaeological sites without prior approval of the Department of Archaeology. The architectural aspects of the building shall conform to the context of the site. All the building designs within an archaeological site shall be approved by a panel of Qualified Archaeologists and Chartered Architects; jointly appointed by the Department of Archaeology Sri Lanka Institute of Architects.

Do not alter any buildings identified as heritage buildings by the archaeological department without prior approval. All the building design alterations within an archaeological site shall be approved by a panel of Qualified Archaeologists and Chartered Architects; jointly appointed by the Department of Archaeology and the Sri Lanka Institute of Architects.

Potential Technologies & Strategies

During site selection avoid developing on archaeologically sensitive sites. All development should conform to the respective heritage policies, laws and regulations;

- Antiquities Ordinance
- Central Cultural Fund Act
- Galle Heritage Foundation Act
- Urban Development Authorities Act
- Housing and Town Improvement Ordinance
- http://www.e.galleheritage.lk
- http://www.archaelogy.gov.lk
- http://www.slia.lk

8.1 – Social Wellbeing, Public Health & Safety

1-2 Points

Intent

Ensure the buildings and developments address the aspects of maintaining and improving public health and social wellbeing. The social benefits of sustainable design are related to improvements in the quality of life, health, and well-being. Thesebenefits can be realized at different levels; buildings, the community, and society in general. At a building level, research on the human benefits of sustainable design hascentred on three primary topics: health, comfort, and satisfaction.

Requirements

Credit 8.1.1 Public Health and Safety – (1 point)

- 90% of the occupied area is capable of being naturally ventilated.
- 90% of the occupied area can achieve direct sunlight.
- Availability of a provision of area (room) with preliminary medical facilities and also with isolation facilities in residential buildings, mixed developed buildings, office buildings and hotels or resorts.
- Providing facilities for shoe and hand sanitizing at the entrance of the building.
- Providing automatically operated or foot-operated water fixtures

OR water fixtures facilitated with automatically sanitizing.

- The public safety requirement as per the local authority guidelines in individual and multi-unit buildings as well as large-area developments
- Building design, layout planning address the issues of privacy and safety of all types of users

Credit 8.1.2 Social Wellbeing– (1 point)

- Provide public recreational areas such as parks, lakes, open-air gyms etc.
- Buildings, especially in residential developments in urban contexts, promote walking and cycling for communities.
- Building design, layout planning address the issues of privacy and safety of all types of users

- Development should address all levels of accessibility requirements
- Provide vegetable garden spaces, vegetable roof gardens to depict the rural lifestyle and our agricultural heritage.
- Provisions for employee/ occupant welfare in the building (medical facilities, health insurance, promoting work-life balance, etc.)
- CSR programs executed with the objective of environmental safety, the wellbeing of the society and economic development

Potential Technologies & Strategies

During design and planning should have a holistic approach, considering the residence's rural and agricultural heritage.

Development should conform to;

- The Accessibility Guidelines of UDA.
- Local Authority Development Guidelines.
- Fire and Safety Regulations of Sri Lanka Fire Department.

References

- http://www.uda.lk
- http://www.slia.lk

Credit 8.2 – Cultural Identity

1-2 Points

Intent

Make sure the building designs and developments contribute to the cultural identity of the regional, community, locality, or neighbourhood settings.

In addition to the social benefits, the cultural values of a country are also equally important. The culture refers to the cumulative deposit of knowledge, experience, beliefs, values, attitudes, meanings, hierarchies, religion, notions of time, roles, spatial relations, concepts of the universe, and material objects and possessions acquired by a group of people in the course of generations through individual and group striving.

To encourage the use, interpretation, and celebration of buildings with cultural heritage.

Requirements

- Justify the building/development designs in terms of the reflection of the cultural values, acceptances, aspirations.
- Promote/provide spaces as required for culturally-based lifestyles of rural and urban settings.
- Create Identity, Sense of Place, and Cultural awareness.
- Promote social empowerment, community participation and access.
- Encourage the adaptive reuse and uptake of heritage-listed buildings and reward those that celebrate the heritage value of the asset.
- Demonstrate how the building is occupied or has been significantly refurbished, in such a manner as to celebrate and make visible heritage elements.
- Make information on the heritage values of the building available to the public visitors to the site through site displays or a context-aware smartphone application.

Potential Technologies & Strategies

Development in Cultural cities defined by the Department of Archaeology such as Kandy, Anuradhapura, Polonnaruwa, Dambulla, etc. to be followed. The design shall be in accordance with the Local authority, Urban Development Authority (UDA), and Department of Archaeology guidelines.

Development should conform to the urban design guidelines of the respective areas approved by UDA. Design buildings with a strong emphasis on the character of the surrounding communities and neighbourhoods with cultural importance.

- http://www.archaeology.gov.lk
- http://www.uda.lk
- http://www.slia.lk
- http://www.nppd.gov.lk
- http://www.e.galleheritage.lk

The Project Team shall provide the following required documentation to support the claims made to prove that initiatives have been taken to celebrate the heritage and cultural value of the asset.

- Template outlining the approach taken to celebrate the heritage and cultural value of the asset. The Template shall also enable project teams to provide feedback on the Innovation Challenge to inform future developments.
- Evidence to demonstrate that the asset is true of heritage and cultural value.
- Evidence to demonstrate how the site/façade has been refurbished and celebrated as a feature of the building.
- Evidence of information on the heritage values of the building is available to public visitors to the site through site displays/context, aware smartphone applications/other.

REFERENCES

1. The American Society of Heating, Refrigerating and Air-Conditioning Engineers official website, www.ashrae.org

2. The Chartered Institution of Building Services Engineers official website, www.cibse.org

3. American Society of Testing and Materials, 1998. *ASTM E1980: Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces*. West Conshohocken, PA: ASTM

4. American Society of Testing and Materials, 1996. *ASTM E903: Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres*. West Conshohocken, PA: ASTM

5. American Society of Testing and Materials, 2006. *ASTM E1918: Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.* West Conshohocken, PA: ASTM

6. American Society of Testing and Materials, 2009. *ASTM C1549*, *Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer*. West Conshohocken, PA: ASTM

7. American Society of Testing and Materials, 2008. ASTM E408, *Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques*. West Conshohocken, PA: ASTM

8. American Society of Testing and Materials, 2004. *ASTM C1371: Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers*. West Conshohocken, PA: ASTM

9. ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section

10. IESNA RP-33

11. Sri Lanka Standard code of practice for the design and construction of septic tanks and associated effluent disposal systems Part 2

12. (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) of ASHRAE / IESNA Standard 90.1 – 2016(without amendments)

13. Final version of Code of Practice on Energy Efficient Buildings of the Sri Lanka, published by Sustainable Energy Authority (SEA),

14. http://www.energy.gov.lk/

15. ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004

16. Basic Criteria and Prescriptive Measures of the Advanced Buildings Benchmark™ Version 1.1

17. U.S. Department of Energy standard process for commercial energy code determination

18. www.energycodes.gov/implement/deter-minations.com.stm

19. International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April, 2003

20. Ministry of Environment

21. www.environmentmin.gov.lk/forest_department.htm

22. State Timber Cooperation

23. www.timco.lk

24. ASHRAE 62.1-2016 Ventilation for acceptable indoor sections 4 through 7 of Air Quality

25. ANSI/ASTM-E779-03

26. Residential Manual for Compliance with California's 2001 Energy Efficiency Standards

27. Carbon Trust "Good Practice Guide 237" [1998].

28. Chartered Institution of Building Services Engineers (CIBSE) Applications Manual 10: 2005, Natural ventilation in non-domestic buildings

29. Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 1995

30. ASHRAE 52.2-2012

31. ASHRAE Standard 55-2017

32. www.archaeology.gov.lk

33. http://www.uda.lk

34. http://www.slia.lk

35. LEED (BD+C) - V4.1

36. GREEN MARK FOR NON-RESIDENTIAL BUILDINGS NRB: 2015

37. CAE reference (central environmental authority)—*sustainable sites chapter*

38. Bath University's Carbon and Energy Database (ICE)

39. Bringing embodied carbon upfront Report – WGBC

40. https://ghgprotocol.org/

41. https://www.gov.uk/government/publications/greenhouse-gas-reporting- conversion-factors-2020