VGBC | Vietnam Green Building Council
Hội đồng Công trình xanh Việt Nam®

LOTUS New Construction V3

Technical Manual

Version updated on December 30, 2019

Acknowledgements

In researching and developing the LOTUS Certification system, the Vietnam Green Building Council (VGBC) conducted a survey of all the world's significant green building rating systems. Several became focal points from which the VGBC has taken inspiration to design LOTUS. These are Australia's Green Star, the USA's LEED and Malaysia's GBI rating systems and to a lesser extent, Britain's BREEAM, Hong Kong's BEAM Plus, Indonesia's Greenship and Singapore's Green Mark systems.

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Preface

VGBC Background Information

The Vietnam Green Building Council (VGBC) is a project of the Green Cities Fund, Inc. (GCF), an international non-profit organization based in Oakland, California, USA. The VGBC's aim is to be the focal point for academia, government and the private sector in order to promote a more sustainable and adaptive built environment in the context of climate change.

The VGBC has been officially recognized by the Ministry of Construction of the Socialist Republic of Vietnam (March 2009) and also took part in the establishment of the WGBC Asia Pacific Network (September 2009).

The VGBC has set the following objectives:

- Raise awareness and advocate for the development of green buildings:
  - Enhance awareness of green building practice through workshops and online resources
  - Support the government in defining green building development policies and codes
  - Strengthen ties with academia, government and private sector partners
- Build capacity:
  - Develop and implement training curricula for academia and government
  - Define and implement an official Green Consultant training and examination program (LOTUS Accredited Professional)
- Define green building metrics for Vietnam:
  - Develop a set of green building systems (LOTUS)
  - Create a Green Database (products and services)
  - Continue long-term research on climate change resilience for the built environment

LOTUS General Information

LOTUS includes a set of market-based green building rating systems developed by the Vietnam Green Building Council specifically for the Vietnamese built environment.

LOTUS Rating Systems share the same goal with existing international green building rating systems (LEED, Green Star, BREEAM, GBI, Green Mark, Greenship, etc.) and aim at establishing standards and benchmarks to guide the local construction industry towards more efficient use of natural resources and more environmentally friendly practices.

LOTUS Rating Systems have been developed through long-term research, with the expert advice of specialists giving particular consideration to Vietnam's economic and natural characteristics and existing Vietnamese standards and policy.

LOTUS Rating Systems currently include:

- LOTUS New Construction V3 (LOTUS NC)
- LOTUS Buildings in Operation V1 (LOTUS BIO)
- LOTUS Homes V1
- LOTUS Small Buildings V1 (LOTUS SB)
- LOTUS Interiors V1
- LOTUS Small Interiors V1 (LOTUS SI)

LOTUS Accreditation for Professional Practitioners

One of the key roles of VGBC is to educate and update practitioners about "green building" design and implementation issues. The core of VGBC's educational offering is the LOTUS Accredited Professional Training Course which allows candidates to undertake an exam in order to achieve the qualification of LOTUS Accredited Professional (LOTUS AP).

LOTUS APs are practitioners within the construction industry who have comprehensive knowledge of the LOTUS Rating Systems philosophy, structure and practical application within the lifecycle of a building project. LOTUS APs are listed on the VGBC website.

LOTUS New Construction Rating System

LOTUS NC Scope

LOTUS NC can be used for any building, including the following building types:

- Residential Buildings with multiple separate dwelling units
- Cultural Buildings (Library, Cinema, Museum, Theatre, Club, Radio Station, Television Station, Exhibition Centre, Community House)
- Educational Buildings (Nursery, Elementary, Secondary and Tertiary School, University, Vocational School, College)
- Health Care Buildings (Clinic, General Hospital, Specialist Federal and Local Hospital, Nursing Home and Temporary Health Care Facility)
- Retail Buildings (Market, Shop, Shopping Centre, Supermarket, Restaurant, Kiosk)
- Office Buildings
- Hotels and Guesthouse Buildings
- Transport Service Buildings (Train/Bus Station, Information Service Centre, Post Office)
- Stadia and Sports Centers
- Factories

LOTUS NC Eligibility

1. Whole distinct buildings

For a project to be eligible for LOTUS NC assessment, it must be a whole distinct building or a group of whole distinct buildings. A portion of a building that has clear separation from other building components may be eligible for assessment under guidance from the VGBC.

2. Major refurbishment

Major refurbishment projects are eligible for assessment under LOTUS NC. Other refurbishment projects should follow LOTUS BIO. A project is considered a major refurbishment when any of the following eligibility requirements is complied with:

- An alteration affects more than 50% of the Gross Floor Area (GFA) of the building at any one time
- An alteration disrupts the operations or relocates more than 50% of the building occupants
- An addition increases the GFA of the building by more than 30%

3. Core & Shell projects

Core & Shell projects (developments where some internal finishes and services are left out, for provision by the tenants or residents) are eligible for assessment under LOTUS NC and should follow requirements provided in Annex 1.

LOTUS NC for Residential and for Non-Residential projects

Residential buildings are buildings designed for people to live in. All other buildings are considered as Non-Residential (NR), including hospitality buildings that provide short-term lodging (on a nightly basis), such as: hotels, guesthouses, resorts, etc. However, hospitality buildings that provide long-term lodging (such as serviced apartments) are considered as Residential.

In LOTUS NC, there are some few differences between requirements for NR projects and requirements for Residential projects. All these differences are clearly marked and described throughout this Technical Manual.

For mixed-use Residential/NR projects combining some NR commercial and Residential components, guidance provided in Section 'Special project situations' should be followed.

LOTUS NC Categories

LOTUS NC is composed of 7 Categories, each containing a varying number of Credits and Prerequisites against which specific criteria have been set carrying individual scoring points.

Energy (E) - To monitor and reduce the energy consumption of a building through high building envelope thermal performance, natural ventilation and energy efficient equipment.

Water (W) - To reduce the water consumption of a building through the use of water-efficient fixtures, water reuse/recycling/harvesting and associated water saving measures.

Materials & Resources (MR) - To reduce the use of high embodied energy materials and to minimize the use of natural resources.

Health and Comfort (H) - To ensure high indoor environmental quality, through maximizing indoor air quality, daylight, thermal comfort and acoustic comfort.

Site and Environment (SE) - To protect the ecology of the site, mitigate the environmental impacts and minimize pollution.

Management (Man) - To ensure that all targets set up for the various stages of the project are competently and effectively managed.

Exceptional Performance (EP) - To reward enhanced performance and innovative solutions not addressed in LOTUS.

LOTUS NC Prerequisites

The following table presents the 9 Prerequisites (PR) included in LOTUS NC. Each prerequisite must be carried out as a minimum requirement for all projects.

In a project with unique constraints, the VGBC recognizes that some prerequisites in LOTUS may not be attainable. Where it can be demonstrated that all reasonable strategies have been considered and a building is still not able to meet a prerequisite, or alternately that the prerequisite is patently unsuitable for that building, the VGBC reserves the right to waive the requirements. Such decisions will only be made through careful consideration by the VGBC.

Table 1: LOTUS NC Prerequisites

Prerequisite	Criteria
E-PR-1 Minimum Energy Efficiency Performance	Project complies with all mandatory requirements of QCVN 09:2017/BXD
E-PR-2 Passive Design	Conduct Passive Design Analysis
E-PR-3 Total Building Energy Use	Demonstrate a 10% reduction of the total building energy use compared to the baseline
W-PR-1 Water Efficient Fixtures	Reduce total building domestic water consumption through fixtures by 20% in comparison to a baseline model
MR-PR-1 Demolition and Construction Waste	Develop and implement a demolition and construction waste management plan
H-PR-1 Indoor Smoking	Prohibit smoking in the building
H-PR-2 Low-Emission Products	Specify and install low-VOC emission interior paints and coatings
Man-PR-1 Maintenance	Provide a Building Operation & Maintenance Manual
Man-PR-2 Green Awareness	Provide a Building User's Guide for occupants

LOTUS NC Credits

LOTUS is a point-based system where projects obtain points for complying with criteria set in the LOTUS credits. Credits are built on the following structure: Intent, Requirements, Overview, Approach & Implementation, Calculations (optional) and Submissions. For a project to be compliant with a credit, the intent of the credit has to be met, the requirements have to be achieved and the required submission documents have to be provided.

For some credits, requirements can encompass different options or strategies. A project can only select one of the proposed options to comply with a credit, but it can implement any of the proposed strategies and cumulate points for the credit (while being restricted by the maximum number of points available for the credit).

LOTUS NC Weighting

The weighting of categories within LOTUS NC (Table 2) has been carefully considered through analysis of other green building rating systems and in response to the environmental issues specific to the construction practices, development and the changing climate of Vietnam.

Table 2: LOTUS NC Weighting

Categories	Non-residential		Residential	
	Weight (%)	Max Points	Weight (%)	Max Points
Energy	32%	32	32%	32
Water	13%	13	13%	13
Materials & Resources	12%	12	13%	13
Health & Comfort	14%	14	14%	14
Site & Environment	21%	21	20%	20
Management	8%	8	8%	8
Total	100 %	100	100 %	100

Additionally, 8 points are allocated to the Exceptional Performance Category.

LOTUS NC Certification Levels

The thresholds for Certification (Figure 1) have been set up after a survey of several certification systems including: LEED (US), Green Star (Australia), GBI (Malaysia), BEAM Plus (Hong-Kong) and Greenship (Indonesia).

As a consequence of this research, the first certification level for LOTUS NC has been benchmarked at 40% (LOTUS Certified) of the total amount of points available (equal to 100 points with the 8 points reserved for the Exceptional Performance Category not being considered). This value reflects a good first level of performance and the minimum required for certification. The following thresholds correspond to 55% (LOTUS Silver), 65% (LOTUS Gold) and 75% (LOTUS Platinum) of the total number of points as shown in Figure 1.

Figure 1: Certification System & Performance levels

Codes and Standards Referenced in LOTUS

LOTUS NC references 10 Vietnamese and 7 International Codes and Standards. These references are included in LOTUS for their relevance to green building construction.

Where a Vietnamese standard exists, LOTUS references or uses it as part of credit criteria, however, the construction sector in Vietnam often relies on International standards as well. VGBC has consciously prioritized the use and awareness of local standards wherever possible.

This list is intended to highlight the different codes and standards that LOTUS expects Applicants to consider as a minimum. This is by no means a comprehensive list of all codes and standards to be applied to New Building Construction. As such, the VGBC does not intend this list to be used as a checklist for construction projects.

Whilst every care has been taken to provide the most current codes and standards at the time of publishing, it is the responsibility of the project team to source the most current codes and standards for their project. When a code or standard becomes outdated in LOTUS, the Applicant will be expected to apply the most current version.

Table 3: Codes and Standards Referenced in LOTUS

Category	Vietnamese/ International	Code or Standard
General	Vietnamese	QCVN 02:2009/BXD – Vietnam Building Code Natural Physical & Climatic Data for Construction
Energy	Vietnamese	QCVN 09:2017/BXD – National Technical Regulation on Energy Efficiency Buildings
	International	VDI-Standard: VDI 4707 Part 1 – Lifts Energy Efficiency.
Water	Vietnamese	QCVN 02:2009/BYT – National technical regulation on domestic water quality
		QCVN 39:2011/BTNMT – National technical regulation on Water Quality for irrigated agriculture
		QCVN 01:2009/BYT – National technical regulation on drinking water quality
	International	NSF/ANSI Standard 350: On-site Residential and Commercial Water Reuse Treatment Systems
Health & Comfort	Vietnamese	TCVN 5687:2010 – Ventilation - Air conditioning - Design standards
		TCXDVN 175:2005 – Maximum permitted noise levels for public buildings – Design standard
		QCVN 24:2016/BYT – National technical regulation on noise – Permissible exposure levels of noise in the workplace
		TCXDVN 277: 2002 – Sound insulation standards of building elements between rooms

	International	ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality
		AS 1668.2 – The use of ventilation and air-conditioning in buildings
		ASHRAE Standard 55-2004 – Thermal Environmental Conditions for Human occupancy
		US EPA Reference Method 24 – Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings
		EN 16516 – Standard for emissions from construction products
Site & Environment	Vietnamese	TCVN 7957:2008 – Drainage and sewerage - External Networks and Facilities - Design Standard

LOTUS NC Updates

LOTUS NC V3 will be regularly updated with changes aiming to improve the system (e.g. to fix mistakes, to provide clearer explanations, to set more relevant requirements, etc.).

Whenever a change is made, a new version of the Technical Manual including the change will be published. Also, the complete list of all changes brought to the Technical Manual since the first published version, that can be found in the Addenda at the end of the manual, will be updated.

Projects will only be required to adhere to all the changes made prior to their registration date.

LOTUS NC Certification Process

Introduction

LOTUS certification is a formal process to independently validate that a project has achieved the environmental performance specified in LOTUS Rating Systems. Documentation-based submissions need to be provided as evidence of this achievement.

The VGBC recommends that LOTUS certification is planned at the earliest possible stage of the project, ideally before the design stage even begins. This allows designers to make changes that not only will improve the project´s overall performance but will also achieve a better LOTUS certification level.

LOTUS NC certification happens in 2 steps:

- LOTUS Provisional Certification
- LOTUS Full Certification

LOTUS Provisional Certification is an optional stage awarded after the completion of the design stage of a project. LOTUS Provisional Certification certifies that the necessary requirements and strategies are in place for the project to be constructed “green”.

LOTUS Provisional Certification is valid for a maximum of 18 months after the completion of construction. Provisional Certification allows for marketing opportunities (refer to marketing package).

LOTUS Full Certification assesses the performance of the as-built building. LOTUS Full Certification can be applied for as soon as handover is completed and must be completed before 18 months of the completion of construction. It demonstrates that all green building strategies and attributes defined at the design stage are incorporated and achieved at the construction stage.
At this stage, points can be lost or gained. Where the construction or installation differs from that which is specified within the LOTUS Provisional Certification, projects must justify how these changes provide an equal or greater environmental benefit for the points to be awarded.

LOTUS Full Certification is valid for 5 years and certified projects are required to provide monthly energy and water consumption data for the building each year during these 5 years.

LOTUS Timeline

The following sections outline the timeline to attain LOTUS certification:

1. Application and Registration
2. LOTUS Provisional Certification
3. LOTUS Full Certification

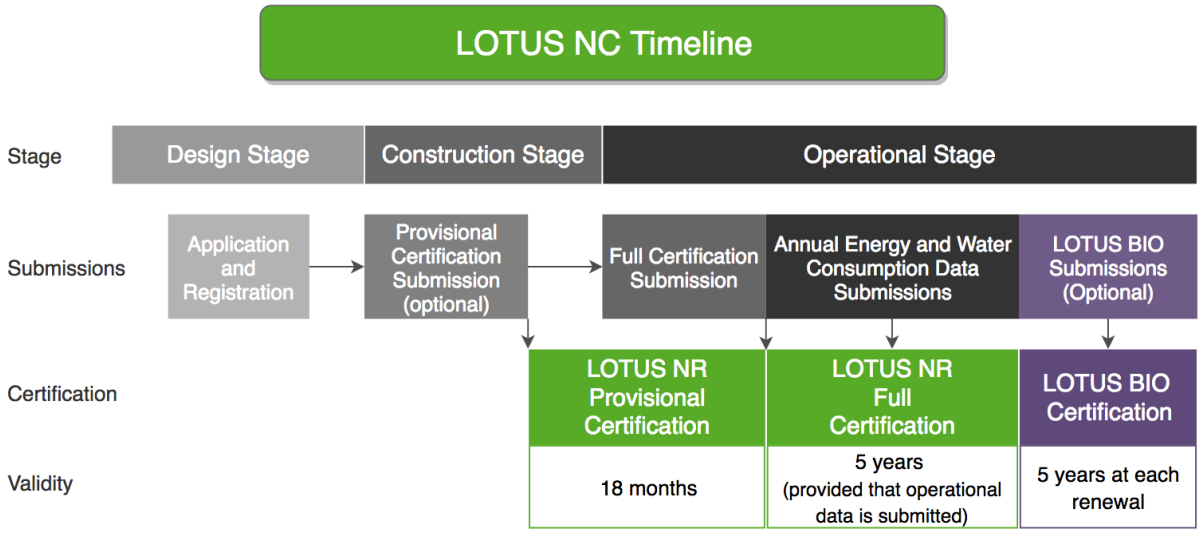

Figure 2: LOTUS NC Timeline

The first step to gain LOTUS certification is to apply and register the project with the VGBC. This should be done at the earliest stage possible as the implementation of sustainable strategies is most effective when they are considered early in the planning and design stage.

During the design stage, the Applicant should prepare the Provisional Certification Submission, which should be submitted at the completion of the design stage. Based on the results of the assessment of the Provisional Certification Submission, LOTUS NC Provisional Certification can be awarded with a validity of up to 18 months after the completion of construction.

At the completion of the construction stage the Applicant should make a Full Certification Submission. To be eligible for Full Certification, this submission must be made within 18 months of the completion of construction. In case that the submission is made more than 6 months after the completion of construction, energy and water consumption data should also be submitted as part of the Full Certification Submission.

Based on the results of the assessment of the Full Certification Submission, a LOTUS NC Full Certificate will be issued. The Full Certificate is valid for 5 years from the issue date. During this validity period the Applicant is required to submit energy and water consumption data annually.

Application and Registration

Registering a project with the VGBC declares the intent to pursue LOTUS certification using a LOTUS Rating System and is the first step in the certification process.

For any building to go through the certification process, all eligibility criteria must be fulfilled. It is the Applicant Representative's responsibility to ensure that only eligible projects are registered for certification. VGBC reserves the right to refuse certification of ineligible projects. If you are in any doubt as to whether a project meets the eligibility requirements, please contact the VGBC.

Applicants must complete an Application Form and submit it to the VGBC. On receipt of the application form, the Assessment Organization will check that it is complete and all supporting information has been provided. In the event of there being some missing or inadequate documentation, the Applicant will be notified and will have the opportunity to provide the missing information.

Once the application form has been confirmed as complete, a Registration Fee will be invoiced and a Certification Agreement with all necessary terms and conditions will be signed by both the Applicant and the Assessment Organization. At this point, the Applicant is to nominate an Applicant Representative for the duration of the project that will be the primary contact for the Assessment Organization.

On receipt of the Registration Fee and a signed copy of the Certification Agreement, the project registration is complete. The Applicant will then be issued with a Project Identification Number (PIN), receive the Project submission folder and be assigned an Assessment Organization Representative for the certification process.

Then, the project should request the Assessment Organization Representative to invoice the Assessment Fee that has to be paid prior to any submission of documentation.

Following registration, the project certification team will have to prepare all of the evidence required by LOTUS NC to demonstrate that all prerequisites and selected credits are achieved. This evidence includes all calculations and documentation as listed in the Submission Section for each prerequisite and credit.

LOTUS Provisional Certification Stage

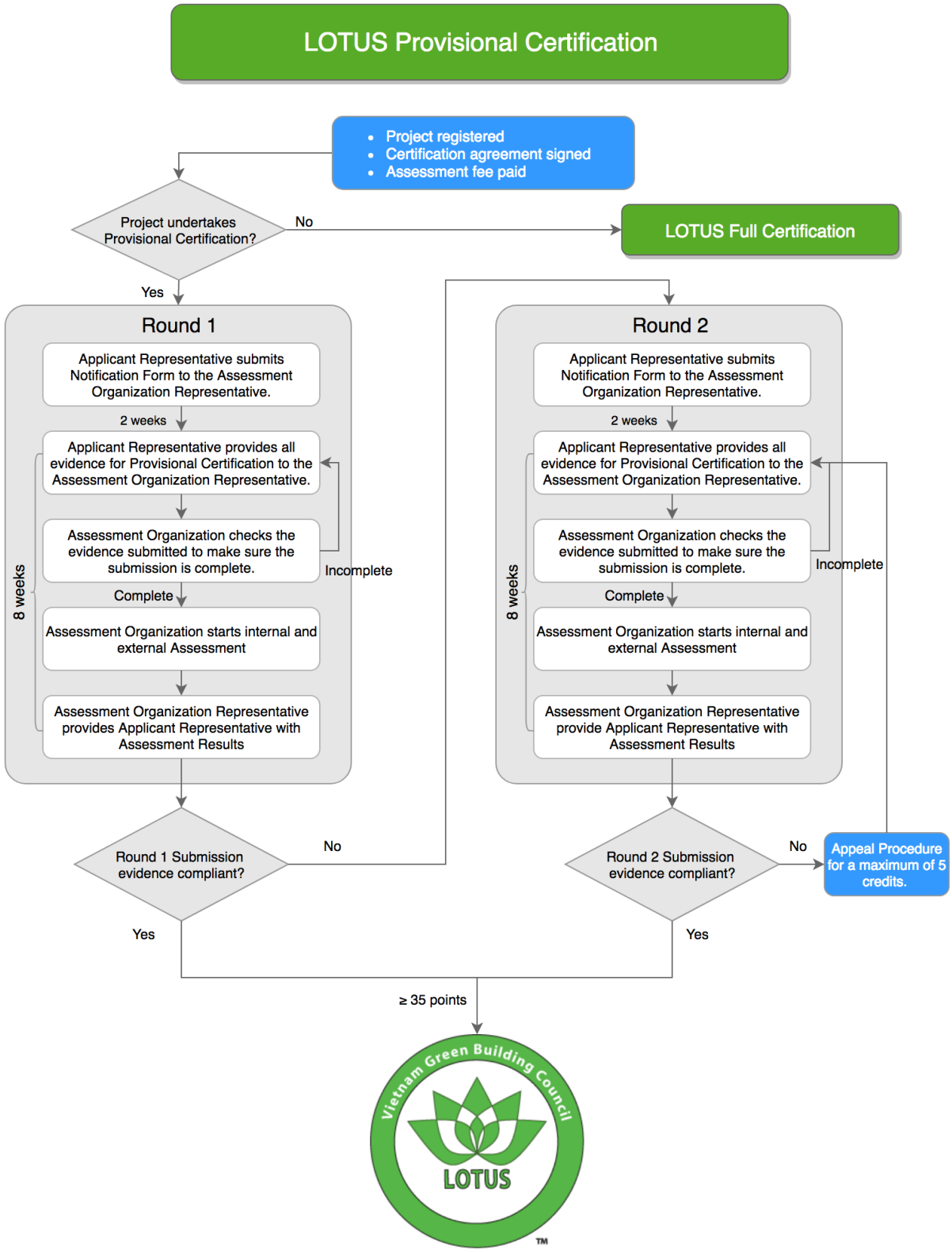

Figure 3: LOTUS NC Provisional Certification

Following registration, the project design team must prepare all of the evidence required by LOTUS NC V3 to demonstrate that all prerequisites and selected credits are achieved. This evidence includes all calculations and documentation as listed in the Submission Section for each prerequisite and credit.

At Provisional Certification stage, the following credits are not available as it is not possible for projects to provide satisfying evidence of compliance in the design stage:

- MR-2 Sustainable Materials
- MR-4 Demolition and Construction Waste
- Man-3 Commissioning (Strategies to ensure a proper handover to the building users and to conduct commissioning activities during the operations of the building)
- Man-4 Maintenance
- Man-5 Green Awareness

As such, projects only need to achieve a total of 35 points to obtain Provisional Certification.

Round 1

Notification Form

Once the project design team has compiled all required evidence for Provisional Certification Assessment, the Applicant Representative submits to the Assessment Organization Representative a Notification Form. This contains the date when all evidence will be submitted to the Assessment Organization. A minimum of a two-week notice must be provided.

Submission

The Applicant Representative submits all evidence to the Assessment Organization Representative. It is recommended to provide these submissions before the beginning of construction work to ensure the most efficient management of the project.
Further information regarding the content of submissions can be found in the Submissions section.

Scan of the submission

The data supplied to the Assessment Organization Representative will be checked to make sure it is complete. In case documentation is missing, the Assessment Organization Representative will request the Applicant Representative to promptly provide the missing data.

Assessment

The data supplied to the Assessment Organization Representative will be assessed by the Project Assessment Committee (PAC). This committee is led by the Assessment Organization project manager and consists of experts from the Assessment Organization and from external independent experts.

Results

An assessment report detailing the results of the round will be issued to the Applicant Representative by the Assessment Organization within 8 weeks of the submission date.

Round 2

If Round 1 submission for any credit or prerequisite is denied, or the Applicant would like the opportunity to score higher for some credits, a second round of submissions for re-assessment is available for projects.

This round will give the possibility to provide further evidence to demonstrate to the PAC that pending credits and prerequisites have finally been achieved. There is no limit to the number of credits and prerequisites that may be re-submitted, and the applicant is encouraged to re-submit all queried credits and prerequisites so long as they can provide new submittal information.

Results of the assessment will be provided to the Applicant Representative within 8 weeks of the submission date.

Appeal Procedure

After the assessment report from Round 2 is received, in the case that the Applicant is still not satisfied with the results, a procedure is available to appeal the outcome of a maximum of 5 prerequisites/credits (additional appeals levy extra costs). Further evidence should be provided to demonstrate how appealed prerequisites/credits have finally been achieved.

The following rules and conditions apply:

- The Appeal should be submitted in writing to the Assessment Organization within 30 calendar days after receiving the assessment report from Round 2.
- Final Appeal Application will be reviewed by the PAC. Feedback will be issued within 8 weeks after the reception of the application.

Provisional Certificate

At the end of Round 1, Round 2 or after the appeal procedure, if the project can demonstrate compliance with all the prerequisites and enough credit criteria to reach a total of 35 points, LOTUS Provisional Certification can be awarded.

Provisional Certification represents the intention of a project to be certified at Full Certification stage and allows for marketing opportunities prior to construction completion.

No certification level is awarded to projects at Provisional Certification stage, only an indication that the project is on-track to achieve an anticipated level of certification at Full Certification stage is given.

A Provisional Certificate can be issued by the VGBC on demand by the Applicant.

LOTUS Provisional Certification is valid for a maximum period of 18 months after the completion of construction at which point Full Certification must be completed to maintain a LOTUS Certification for the project.

LOTUS Full Certification Stage

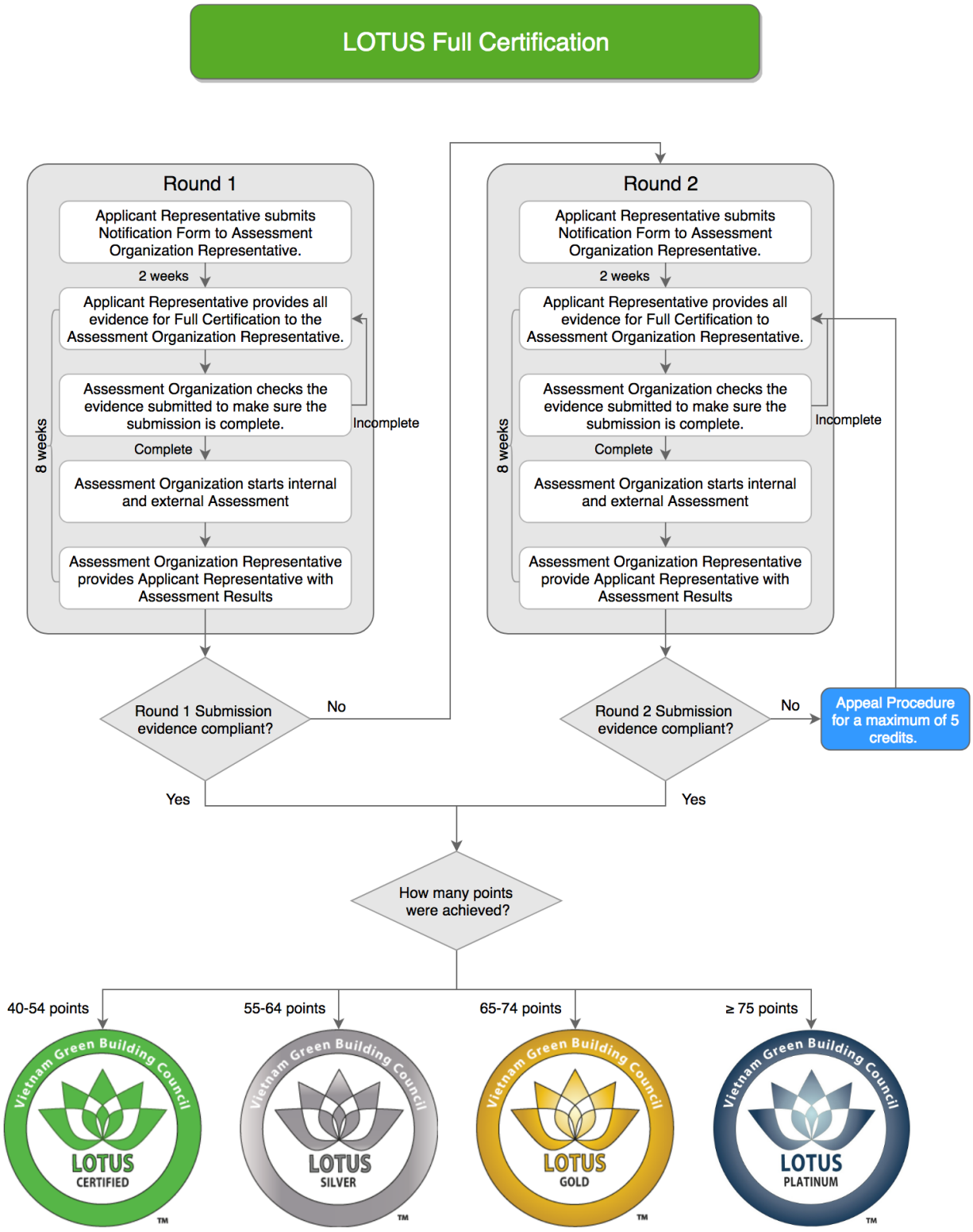

Figure 4: LOTUS NC Full Certification Process

The assessment process for LOTUS Full Certificate is the same as the LOTUS Provisional Certificate and consists also of two rounds of assessment and one potential appeal procedure. The difference is that instead of verifying design and tender documentation, the LOTUS Full Certificate assessment verifies as-built and as-installed evidence.

At the Full Certificate assessment, in case of deviation or addition from the Provisional stage, it is possible for a project to lose credits that were gained in the Provisional Certificate stage but also to gain extra credits for which evidence can be provided.

The assessment for LOTUS Full Certification is to be undertaken within 18 months of the completion of construction.

Site Inspections

At Full Certification stage, in complement of the Full Certification submissions, some site inspections may be conducted by members of the PAC. The aim of the site inspections is to provide a more complete and precise assessment and make observations of the green features.

Site inspections will be conducted within 8 weeks following the submissions for Round 1 of Full Certification. There will be site inspections on all the projects targeting LOTUS Gold and LOTUS Platinum Certification and some random site inspections on other projects.

Site inspections do not replace Full Certification stage submissions and the projects that will be inspected still need to provide all the submittals required in the prerequisites and targeted credits. However, site inspections may be used to validate or invalidate some of the evidence provided by the project.

Full Certificate

The LOTUS Full Certificate will be issued by the VGBC upon successful completion of this final assessment. Building projects will be issued with LOTUS Certified, LOTUS Silver, LOTUS Gold or LOTUS Platinum certificates depending on the number of points achieved.

The Full Certificate is valid for 5 years provided that energy and water consumption data is submitted on a yearly basis. After 5 years, the certificate is expired and cannot be extended. Projects are then encouraged to pursue LOTUS Buildings in Operation (LOTUS BIO).

LOTUS NC Submissions

Types of Submissions

There are two different types of submissions:

- Provisional Certification stage submissions, happening at the design/tender stage and which are required for LOTUS Provisional Certification
- Full Certification stage submissions, happening at the as-built stage and which are required for LOTUS Full Certification

Provisional Certification submissions

The list of all submittals to be provided for Provisional Certification stage is given at the end of each prerequisite and credit. Submittals mostly include tender and design documents showing the project is on-line to meet LOTUS requirements at the end of construction.

The structure of the submissions should follow the description provided in the section Submission Process below.

Full Certification submissions

The list of all submittals to be provided for Full Certification stage is given at the end of each prerequisite and credit. Submittals mostly include as-built documents and evidence showing that LOTUS requirements have been met.
The structure of the submissions should follow the description provided in the section Submission Process below.

Where the sentence “If not already approved at Provisional Certification or if there is any change” is written, all the submittals listed below this sentence do not need to be submitted for Full Certification if all of the following is true:

- The submittals have been provided for Provisional Certification
- The assessment report at Provisional Certification shows that the submittals have been approved by the Assessment Organization
- No change (deviation or addition) impacting the credit has occurred since the submittals have been provided to the Assessment Organization

This means that, for some credits that have been awarded by the Assessment Organization at Provisional Certification, no submission may be required for Full Certification.

Submission Process

At each round of both types of submissions, a complete portfolio of evidence should be submitted at one time, demonstrating that a project meets the requirements of all the prerequisites and all the credits targeted.

Once payment for Registration Fee has been received and the Certification Agreement has been duly signed, the Assessment Organization Representative provides the Applicant Representative with a complete package of documentation that includes a pre-arranged Project Submission Folder and a Resources Folder.

Project Submission Folder

The Project Submission Folder is the main folder provided that, upon completion, will be returned to the Assessment Organization Representative for assessment. The Project Submission Folder contains 8 sub-folders for the 7 LOTUS NC Categories and one General Information Folder.

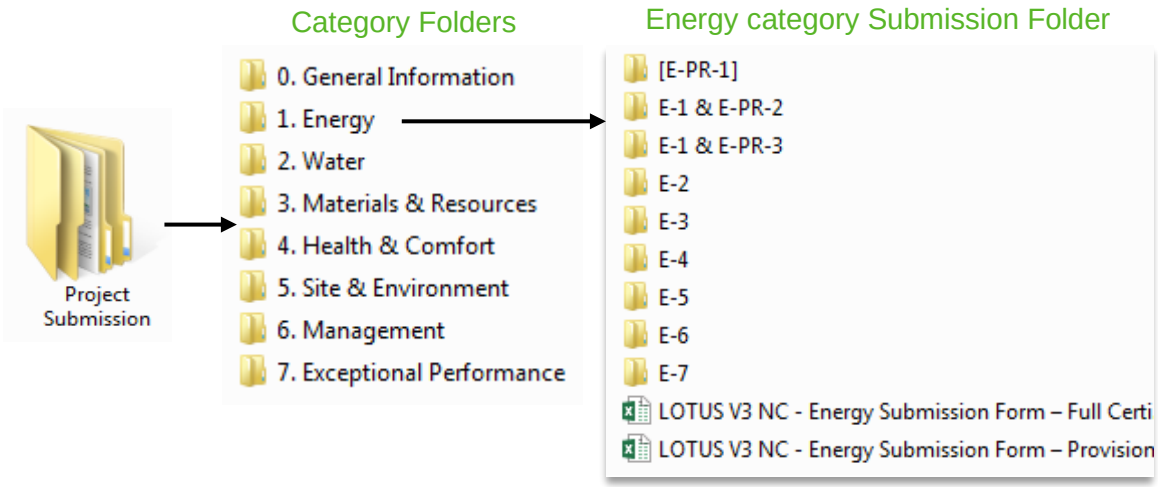

Figure 5: Project Submission Folder

For each submission, the Applicant Representative must use the Project Submission Folder as shown in Figure 5. More information about the different sub-folders is given in the following.

General Information Folder

All general project information should be provided in the General Information Folder. If information is not provided, this could cause problems validating evidence when assessing individual credits.

This folder should include:

- The completed LOTUS NC V3 Project General Information spreadsheet.
  This file provides the Assessment Organization with important information about the project, including:
  - Project location
  - Construction/completion dates
  - List of consultants involved in the building construction and/or certification
  - General information on building and site including a breakdown of spaces
  - Summary of all the credits targeted by the project and the status of the submittals
- Any critical correspondence between the Applicant Representative and the Assessment Organization Representative that may impact the project assessment.
- A full set of project documentation including design drawings and specifications (where available) for all architectural, civil, structural, mechanical, electrical, hydraulic and building controls (VGBC recommends files are provided in .PDF format).

The General Information Folder should be updated with latest information and included in each submission from the Applicant Representative.

Category Folder

Within each of the 7 category folders are included two Category Submission Forms (one for Provisional Certification and one for Full Certification) and a credit folder for each individual credit or prerequisite in that category.

Credit Folder

Credit folders should be submitted for each of the credits targeted. Each credit folder should contain all supporting evidence for the credit.

Category Submission Forms

The Category Submission Forms aim to provide a template for the Applicant to describe the strategies implemented and to submit all the evidence required.

In order to make the submission and assessment work easier and quicker, Category Submission Forms have been formatted to refer to the submissions section of each credit.

For each prerequisite and targeted credit, the following sections must be completed:

- Points: Select the number of points claimed for the credit
- Approach and Implementation: Insert a summary to explain how the credit requirements have been met: solutions implemented, methodology used, main features and results. If appropriate, the Applicant may provide further information such a description of the challenges of realizing the credit.

In the case there is any change from previous round of submissions (e.g. different solutions implemented, different equipment/products/systems/materials selected, modified floor layout, etc.), a description of all the changes should be included.

- Documents submitted: Complete the table by:
  - Adding the exact name of the electronic file(s) submitted in “File(s) Name”
  - Adding a “Reference” which will be used to guide the reviewer when assessing long or complicated documents which only partly address credit requirements (e.g. page 10, section 3.4, table 4.3)

Resources Folder

This folder contains a few documents that are provided to the Applicant Representative:

- LOTUS NC V3 Management Tool: a tool that can be helpful to manage the project, select appropriate pathways, track progression, set targets, etc. The Applicant Representative can use this tool at their own discretion.
- Calculators, which are excel files performing calculations, such as:
  - LOTUS Calculator - Water Calculations: a tool that can perform all the calculations necessary for the Water credits. VGBC strongly encourages the use of this tool as a submission document for the calculations of the Water Credits.
  - LOTUS Calculator - OTTV Calculation. VGBC strongly encourages the use of this tool to perform the OTTV calculations necessary for E-3 Building Envelope Option A.
  - additional calculators that can be used for different credits requiring calculations
- Guidelines providing additional information and guidance, such as:
  - LOTUS NC V3 Guidelines - Energy Performance Calculation Method. This document provides all the guidelines that have to be followed to realize the simulations required in the scope of E-PR-3 and E-2 Total Building Energy Use.
  - LOTUS Guidelines - CFD Simulation. This document provides requirements to follow for projects performing CFD simulation for credit E-4 Building Cooling.
- Templates, which are excel files to fill in, such as:
  - LOTUS Template - Energy modelling Input tables. This file must be completed and submitted for compliance with E-PR-3 and E-2 Total Building Energy Use.

Special project situations

Core & Shell projects

Core and Shell projects (C&S projects) are building developments where some internal finishes and services are left out, for provision by the tenants or residents.

As specified in eligibility criteria 1, LOTUS NC applies to whole buildings. To obtain certification, as for other projects, the entire gross floor area of a C&S project must be assessed against LOTUS NC. Compliance to all prerequisites and targeted credits will have to be demonstrated for the entire gross floor area with few exceptions depending on the credits and the scope of work of the developer.

All the exceptions are listed in Table A.1 in Annex in which the scope of applicability and the procedure to follow for each credit and prerequisite is outlined.

In general, in the limited scope of applicability, the same requirements as given in the prerequisites and credits should be followed. As for the parts of the project outside of the scope of applicability, they are not required to meet LOTUS NC requirements, but, in most cases, the project team is required to prepare green fit-out guidelines that explain how tenants/residents should design their interior spaces. These guidelines should be based on the LOTUS NC V3 Technical Manual and different guidelines should be provided for the residents and for the different types of tenants.

Mixed-Use Residential/NR buildings

For mixed-use buildings combining some NR Commercial and Residential components:

- projects should be considered as NR and should follow requirements for NR projects if they have less than 40% of residential components
- projects should be considered as Residential and should follow requirements for Residential projects if they have more than 60% of residential components
- other projects with 40% to 60% of residential components can be considered as NR or Residential (and follow requirements for NR or Residential projects) depending on project's team choice

< 40% Residential Components	40%-60% Residential Components	> 60% Residential Components
Non-Residential project	**Project's team choice**	**Residential project**

Since the entire gross floor area of a LOTUS Project must be certified, mixed-use projects considered as NR are subject to the requirements set for NR projects for all prerequisites and targeted credits and mixed-use projects considered as Residential are subject to the requirements set for Residential projects for all prerequisites and targeted credits.
Additionally, in some prerequisites and credits, a section 'Mixed-use Residential/NR projects' is included to add requirements and introduce further details specific to mixed-use projects combining some NR and Residential components.

Design-Build projects

Design-Build is a method to deliver a project in which the design and construction services are contracted by a single entity known as the design–builder or design–build contractor.

As projects following a Design-Build approach do not need to prepare tender documentation, 2 options are proposed for these projects.

Option 1:
To demonstrate compliance with the prerequisites and the targeted credits, wherever tender documents (specifications, drawings, etc.) are required, the Applicant should provide alternative pieces of evidence, such as: design drawings, manufacturer's data, letter of commitment signed by the owner, etc.

If the project cannot provide sufficient evidence to demonstrate compliance with all the prerequisites and achieve enough points to obtain Provisional Certification, Option 2 should be followed.

Option 2:

LOTUS Provisional Certification Stage is modified as follows:

- The typical Provisional Certification Stage, as described above in the Technical Manual, is replaced by a Pre-assessment Stage.
- The Pre-assessment Stage only aims to provide projects with indicative results of their performance. The Assessment Organization will check that projects are on a right path to LOTUS Certification and provide some advice on how performance could be improved.
- The Pre-assessment Stage includes 2 rounds of submissions as the Provisional Certification stage but, at the end of the Pre-assessment Stage, no Certificate will be awarded to projects.
- In the credits where tender stage specifications are required for submission, projects do not need to provide tender stage specifications but instead can provide necessary information under any form (narrative, letter of commitment, project brief, etc.)

- After review of these credits, the Assessment Organization will provide assessment results as follows:
  - Credits and prerequisites are “on-track” if the information submitted shows a clear indication that the project will achieve the credit at Full Certification stage.
  - Credits and prerequisites are pending if the information submitted fails to show a clear indication that the project will achieve the credit at Full Certification stage: it could be due to either a lack of information or mistakes in the information.

Projects with incomplete spaces

Incomplete spaces are spaces that are not ready for occupancy at the time of submissions for Full Certification.
For the incomplete spaces that are intended to be finished by the resident or tenants, the project should follow requirements for Core & Shell projects.

For the incomplete spaces that are intended to be finished by the owner:

- they shouldn’t represent more than 10% of the project’s GFA. Else, Full Certification cannot be awarded.
- the project should submit a letter of commitment signed and stamped by the owner declaring that the incomplete spaces will meet the requirements of all the prerequisites and credits achieved by the project when completed.
- for prerequisites and credits using baselines to calculate performance (E-PR-3 & E-2 Total Building Energy Use and W-PR-1 & W-1 Water Efficient Fixtures), the design model should be set equal to the baseline model for all the systems, equipment, appliances that have not been installed in the incomplete spaces. All the systems, equipment, appliances serving the incomplete spaces that have been installed should be modelled as-installed.
- for the other prerequisites and credits, the works that have not been completed in the incomplete spaces, and the systems, equipment, appliances that have not been installed in the incomplete spaces don’t need to be considered.

Project sites with multiple buildings

For a site with multiple buildings, it is possible to certify some buildings individually (individual project certification), certify a group of buildings as one project (group project certification) and have some buildings left uncertified.
All the requirements for sites with multiple buildings are outlined in the separate document LOTUS NC V3 Guidelines - Sites with multiple buildings.

LOTUS NC Credit List

Credit	Title	Non-Residential (NR)	Residential (R)
ENERGY		32 points	32 points
E-PR-1	Minimum Energy Efficiency Performance	Prerequisite	Prerequisite
E-PR-2	Passive Design	Prerequisite	Prerequisite
E-1	Passive Design	1	1
E-PR-3	Total Building Energy Use	Prerequisite	Prerequisite
E-2	Total Building Energy Use	14	14
E-3	Building Envelope	3	3
E-4	Building Cooling	6	6
E-5	Artificial Lighting	3	3
E-6	Energy Monitoring and Management	2	1
E-7	Lifts	N/A	1
E-8	Renewable Energy	3	3
WATER		13 points	13 points
W-PR-1	Water Efficient Fixtures	Prerequisite	Prerequisite
W-1	Water Efficient Fixtures	5	5
W-2	Water Efficient Landscaping	2	2
W-3	Water Metering	1	1
W-4	Sustainable Water Solutions	5	5
MATERIALS & RESOURCES		12 points	13 points
MR-1	Reduced Concrete Use	2	2
MR-2	Sustainable Materials	5	5
MR-3	Non-baked Materials	2	2
MR-PR-1	Demolition and Construction Waste	Prerequisite	Prerequisite
MR-4	Demolition and Construction Waste	2	2
MR-5	Operation Waste Management	1	2

HEALTH & COMFORT		14 points	14 points
H-PR-1	Indoor Smoking	Prerequisite	Prerequisite
H-1	Ventilation for indoor air quality	3	3
H-PR-2	Low-Emission Products	Prerequisite	Prerequisite
H-2	Low-Emission Products	2	3
H-3	Biophilic Design	1	1
H-4	Daylighting	3	3
H-5	External Views	2	N/A
H-6	Thermal Comfort	2	2
H-7	Acoustic Comfort	1	2
SITE & ENVIRONMENT		21 points	20 points
SE-1	Flood Resistance	1	1
SE-2	Development Footprint	2	2
SE-3	Vegetation	4	4
SE-4	Stormwater Management	2	2
SE-5	Heat Island Effect	2	2
SE-6	Refrigerants	2	1
SE-7	Construction Activity Pollution Control	1	1
SE-8	Light Pollution Minimization	1	1
SE-9	Green Transportation	3	3
SE-10	Community Connectivity	1	1
SE-11	Outdoor Communal Space and Facilities	2	2
MANAGEMENT		8 points	8 points
Man-1	Effective Design Process	1	1
Man-2	Construction Stage	1	1
Man-3	Commissioning	4	4
Man-PR-1	Maintenance	Prerequisite	Prerequisite
Man-4	Maintenance	1	1
Man-PR-2	Green Awareness	Prerequisite	Prerequisite
Man-5	Green Awareness	1	1
EXCEPTIONAL PERFORMANCE		8 points	8 points
EP-1	Enhanced Performance	8	8
EP-2	Innovative Solutions		

Energy

As urbanization is speeding all over the world, buildings and construction have been described as a hidden culprit, responsible for more than 35% of global final energy use and nearly 40% of energy-related CO_2 emissions (c.f. Global status report 2017 coordinated by United Nations Environment Programme).

While fast economic growth and urbanization rates are improving living conditions in Vietnam, they are also leading to an increasing energy demand and worsening of climate change. According to the Vietnam Energy Outlook Report 2017 developed by Ministry of Industry and Trade (MOIT) in collaboration with the Danish Energy Agency (DEA), it is expected that electricity demand will grow by 8% annually on average until 2035 and that almost half of the new power generation capacity needed will be coal fired.

However, since buildings, especially in urban areas, consume most of the energy produced annually in Vietnam, there is potential for mitigating climate change and energy insecurity through integrating energy efficiency measures into buildings which can potentially reduce their energy consumption up to 50% and more.

With this target in mind, the LOTUS rating systems rewards efforts taken to reduce the building energy consumption through optimized thermal performance, incorporating natural ventilation and energy efficient technologies, as well as utilizing renewable energy sources.

Credit	Title	NR	Residential
E-PR-1	Minimum Energy Efficiency Performance	Prerequisite	Prerequisite
E-PR-2	Passive Design	Prerequisite	Prerequisite
E-1	Passive Design	1 point	1 point
E-PR-3	Total Building Energy Use	Prerequisite	Prerequisite
E-2	Total Building Energy Use	14 points	14 points
E-3	Building Envelope	3 points	3 points
E-4	Building Cooling	6 points	6 points
E-5	Artificial Lighting	3 points	3 points
E-6	Energy Monitoring and Management	2 points	1 point
E-7	Lifts	N/A	1 point
E-8	Renewable Energy	3 points	3 points
	Total of points available	32 points	32 points

E-PR-1 Minimum Energy Efficiency Performance

Scope

E-PR-1 prerequisite applies to NR and Residential projects.

Intent

To ensure a minimum energy efficiency performance by complying with mandatory requirements from Vietnamese regulations.

Requirements

NR & Residential (Prerequisite)

Criteria	PR
Project complies with all mandatory requirements of QCVN 09:2017/BXD	Energy Prerequisite 1

Overview

Energy consumption within buildings is a major source of energy demand in Vietnam. Unabated, Vietnam's energy consumption stands to outweigh production and may result in more frequent energy shortages. Additionally, this escalating consumption will have an increasing contribution to climate change as a large portion of energy produced in Vietnam is derived from coal and gas.

QCVN 09:2017/BXD is the Vietnamese National Technical Code providing mandatory technical standards to achieve energy efficiency in the design and construction or retrofit of civil engineering buildings (offices, hotels, hospitals, schools, retails, services, residential, etc.) with a gross floor area of 2,500 m^2 or larger.

Approach & Implementation

Projects must comply with all mandatory requirements included in QCVN 09:2017/BXD on:

- Building envelope
- Ventilation and air conditioning
- Interior lighting
- Water heating and other electric equipment

Projects that have already demonstrated compliance with QCVN 09:2017/BXD to the Department of Construction (DOC) are automatically compliant with the prerequisite.

For other projects, evidence showing compliance with QCVN 09:2017/BXD on the following requirements will have to be submitted:

- R-values
  - Only external wall and roof areas adjacent to conditioned spaces should be considered.
  - Average wall R-value of the building should be higher than 0.56 m^2.K/W
  - Average roof R-value of the building should be higher than 1 m^2.K/W (Some exceptions are included for reflective, steep-slope and shaded roofs)

- SHGC values for glazing
  - For vertical glazing, area-weighted average SHGC value of installed glazing should be lower than the area-weighted average maximum SHGC value required by QCVN 09:2017/BXD
  - For skylights, SHGC should be lower than 0.3. (Exception: SHGC should be lower than 0.6 for attics using daylighting)
  - SHGC values of glazing should be provided by glass manufacturers and should be determined by a third-party laboratory following procedure NFRC 200-2017.
  - Spandrel glass covering structural elements or other layers of materials should not be considered as glazing.

- Efficiency of HVAC systems (CSPF/COP values)
  - Every HVAC system installed in the project should have an efficiency higher than the values listed in Tables 2.3 and 2.4 of QCVN 09:2017/BXD

- Lighting power density (LPD) values
  - Installed LPD value should be lower than the maximum LPD value allowed in Table 2.5 of QCVN 09:2017/BXD. Only building types and space types included in that table should be considered for compliance with this prerequisite.

For project types not included in the scope of QCVN 09:2017/BXD (such as: factories, cultural buildings, sports centers, etc.), compliance with the above requirements should also be demonstrated at the exception of the requirements on LPD values.

Calculations

R-values:

R-value calculations should be performed in accordance with Annex 1 of QCVN 09:2017/BXD and using thermal conductivity values from materials manufacturer or, if not available, using thermal conductivity values from Annex 2 of QCVN 09:2017/BXD.

In buildings with different types of wall and roof assemblies, area-weighted average wall R-value and area-weighted average roof R-value should be calculated.

SHGC values:

Use the following method to calculate the area-weighted average SHGC value of installed vertical glazing:

- if any sunshades are installed, determine the value of A coefficient based on Tables 2.2a and 2.2b of QCVN 09:2017/BXD
- use the following formula:

$$\text{Area} - \text{Weighted Average SHGC of installed glazing} = \frac{\sum_g (\text{S}_\text{g} \times \text{SHGC}_g \times 1/A_g)}{S_T}$$

S_g = Area of glazing type g [m^2]

$SHGC_g$ = SHGC value of glazing type g [-]

A_g = A coefficient for glazing type g (if no sunshade, A_g =1) [-]

S_T = Total glazing area on all the facades of the project [m^2]

Use the following method to calculate the area-weighted average maximum SHGC value required by QCVN 09:2017/BXD:

- calculate the WWR values of each façade of the project
- based on the WWR values of each façade and using linear interpolation, determine the maximum SHGC values for each façade based on Table 2.1 of QCVN 09:2017/BXD.
- use the following formula:

$$\text{Area} - \text{Weighted Average maximum SHGC} = \frac{\sum_f (\text{S}_\text{f} \times \text{SHGC}_f)}{S_T}$$

S_f = Area of glazing on façade f [m^2]

$SHGC_f$ = Maximum SHGC value required by QCVN 09:2017/BXD for façade f [-]

S_T = Total glazing area on all the facades of the project [m^2]

Example of calculation:

A project has the following characteristics:

- Façade areas and glazing areas are as presented in Table E.1.
- One single type of glazing with a SHGC of 0.44 is installed for the whole project
- On west and east orientations, a horizontal sunshade equivalent to an A coefficient of 1.3 (based on Table 2.2a of QCVN 09:2017/BXD) is installed.

Before starting calculations, “Glazing type 1” is named to represent the glazing with the horizontal sunshade and “Glazing type 2” is named to represent the glazing with no sunshade.

Table E.1: Example of calculation – Area-Weighted Average SHGC

Orientation	West	East	North	South	Total
Data on façade and glazing areas					
Façade areas	340 m^2	340 m^2	700 m^2	700 m^2	2080 m^2
Glazing type 1 area	120 m^2	150 m^2	0 m^2	0 m^2	270 m^2
Glazing type 2 area	0 m^2	0 m^2	300 m^2	400 m^2	700 m^2
Total glazing area	120 m^2	150 m^2	300 m^2	400 m^2	970 m^2
Results of calculations (details shown below the table)					
WWR (%)	35.3%	44.1%	42.9%	57.1%	46.6%
Maximum SHGC required	0.516 [1]	0.427	0.471	0.35	0.42 [2]
SHGC of installed glazing	0.44	0.44	0.44	0.44	0.41 [3]

[1] Calculation of maximum SHGC required for the west façade which has a WWR of 35.3%:

For a WWR of 30%, the maximum SHGC value requirement in QCVN 09:2017/BXD is 0.58

For a WWR of 40%, the maximum SHGC value requirement in QCVN 09:2017/BXD is 0.46

$$\text{Maximum SHGC for west facade} = 0.58 - (0.58 - 0.46) \times \frac{35.3 - 30}{40 - 30} = 0.516$$

[2] Calculation of the maximum SHGC value required for the project:

$$\text{Maximum SHGC for project} = \frac{0.516 \times 120 + 0.427 \times 150 + 0.471 \times 300 + 0.35 \times 400}{970} = 0.42$$

[3] Calculation of the area-weighted average SHGC value of installed glazing:

$$\text{Area} - \text{weighted average SHGC} = \frac{0.44 \times 270 \times 1/1.3 + 0.44 \times 700 \times 1}{970} = 0.41$$

The project is compliant with an area-weighted average SHGC of installed glazing of 0.41 that is lower than the maximum SHGC required for the project of 0.42.

Efficiency of HVAC systems:

CSPF/COP values of HVAC systems should be calculated at standard rating conditions in accordance with the test procedures listed in Tables 2.3 and 2.4 of QCVN 09:2017/BXD.

LPD values:

Installed LPD value and baseline LPD value (maximum LPD value allowed by QCVN 09:2017/BXD) of the building should be calculated in accordance with the Calculation section of the Credit E-5 Artificial Lighting - Strategy A.

Submissions

Provisional Certification Stage
For projects that have demonstrated compliance with QCVN 09:2017/BXD to the DOC:
• Complete file that has been submitted to the DOC and letter of approval from DOC
For all the other projects:
R-values:
• Tender specifications -OR- Manufacturer's data indicating the thermal conductivity of the materials used for external walls and roof • Details of R-values calculations
SHGC values of glazing:
• Tender specifications -OR- Manufacturer's data indicating SHGC values of glazing to be installed
Efficiency of HVAC systems:
• HVAC tender drawings showing schedule of all HVAC equipment • Tender specifications -OR- Manufacturer's published data on all HVAC equipment, indicating cooling capacity and CSPF/COP at the appropriate rating conditions
Lighting power density:
• Tender stage schedule of all devices proposed for artificial lighting • Lighting tender drawings • Tender specifications -OR- Manufacturer's published data for all lamps and ballasts used in the interior of the building and in roofed exterior spaces • Calculations of the LPD value of the building and the baseline LPD value

Full Certification Stage
For projects that have demonstrated compliance with QCVN 09:2017/BXD to the DOC:
If not already approved at Provisional Certification or if there is any change: • Complete file that has been submitted to the DOC and letter of approval from DOC

For all the other projects:
R-values:
• Evidence showing the materials used for all the external walls and roof, such as photographs, invoices, receipts, etc.
If not already approved at Provisional Certification or if there is any change: • For all materials, where available, manufacturer's data indicating the thermal conductivity of the materials used for external walls and roof • Details of R-values calculations
SHGC values of glazing:
• Evidence showing the glazing installed, such as invoices, receipts, etc. If not already approved at Provisional Certification or if there is any change: • Manufacturer's data indicating SHGC values of the glazing installed
Efficiency of HVAC systems:
• As-built stage HVAC drawings showing final schedule of all HVAC equipment • Evidence showing all the HVAC equipment installed such as invoices, receipts, commissioning reports, etc. If not already approved at Provisional Certification or if there is any change: • Manufacturer's published data on all HVAC equipment, indicating cooling capacity and CSPF/COP at the appropriate rating conditions
Lighting power density:
• As-built lighting drawings • Evidence showing all the devices installed for artificial lighting such as invoices, receipts, commissioning report, etc. If not already approved at Provisional Certification or if there is any change: • Final schedule of all devices installed for artificial lighting • Manufacturer's published data for all lamps and ballasts used in the interior of the building and in roofed exterior spaces • Final calculations of the LPD value of the building and the baseline LPD value

E-PR-2 & E-1 Passive Design

Scope

E-PR-2 prerequisite and E-1 credit apply to NR and Residential projects.

Intent

To identify, analyze and incorporate design techniques that take advantage of the natural climate and site to minimize mechanical cooling and heating in the building, while ensuring comfort for all occupants.

Requirements

NR & Residential (Prerequisite)

Criteria	PR
Conduct a Passive Design Analysis	Energy Prerequisite 2

NR & Residential (1 point)

Criteria	Points
Conduct a Passive Design Analysis including thermal and daylight simulations at early design stage	1

Overview

Passive design analysis evaluates the site location, surroundings and topography, as well as the orientation of the proposed building. The study allows for analysis of solar paths, wind modelling, thermal performance modelling and shadowing assessment. The main purpose of passive design analysis is to demonstrate natural energy flows to optimize building performance and reduce reliance on energy intensive systems. As such, careful attention must be paid to adapting the design to the local climate while designers must demonstrate how the proposed building integrates/considers passive design measures.

Approach & Implementation

Energy Prerequisite 2

The following factors should be considered in a passive design strategy:

Climatic Data

- Providing monthly data of the site for the following climatic parameters: temperature, humidity, irradiation, rainfall, wind speed and direction

Orientation

- A well-positioned building delivers significant life-style and environmental benefits
- Appropriate orientation assists passive cooling by minimizing its exposure to the sun and maximizing the effect of trade winds, resulting in improved comfort and decreased energy consumption (Figure E.1)

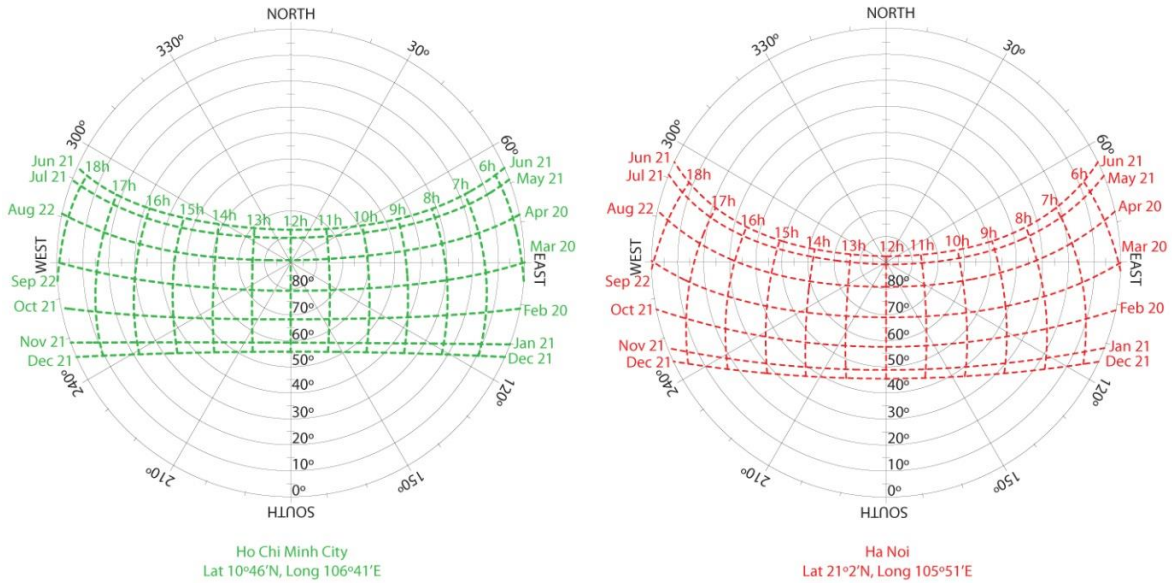

Figure E.1: Sun-paths for Hanoi and Ho Chi Minh City

Glazing

- Sizing, positioning and detailing of windows avoids overheating in summer and heat loss in winter
- The positioning and design of the windows can facilitate air movement and cooling in the summer and protect from cold winter winds
- Specifying glazing which has proper insulation levels and light transmittance to reduce unwanted heat losses and gains

Material and Construction

- Specifying proper levels of insulation to reduce unwanted heat loss or heat gains through the roof, walls, doors, windows and floors
- Applying construction methods which result in an air-tight envelope reducing infiltration and loss of energy and moisture

Natural Ventilation

- Designing robustly controlled air flows through buildings for daytime and night time cooling

Zoning

- Providing thoughtful zoning to allow different thermal requirements to be compartmentalized to reduce wasted energy

Shading

- Reducing solar gains at openings, outdoor spaces and building elevations can dramatically improve comfort and save energy
- Utilizing of overhangs, louvers and planting which are effective means for shading a building from excessive solar gains (Figure E.1)

Landscaping

- Using the landscape for shading, wind channeling and passive cooling of the surroundings

Energy Credit 1

In addition to the above requirements for passive design analysis, the project should perform some thermal and daylight simulations. The aim of these simulations is to assess and further optimize the effectiveness of the passive design strategies.

The thermal simulation should be used to determine at a minimum the heat gains through the building envelope, while the daylight simulation should be used to determine the daylight performance in terms of illuminance and glare considered on an annual basis.

Also, the following requirements should be met for compliance with the credit:

- The simulations should be performed at early design stage when design changes based on the simulation results can still be made easily.
- The simulations should compare the effectiveness of different pre-selected design options or an optimization tool identifying the best design options should be used
- Quantifiable improvements in energy efficiency and daylight provision thanks to the passive design analysis and simulations should be demonstrated.

Submissions

Provisional Certification Stage
Energy Prerequisite 2
• Passive design analysis report considering all the factors described in Approach & Implementation and indicating the steps taken by the design team to address these factors.
Energy Credit 1
• Simulation reports included in the passive design analysis report and showing the inputs entered in the simulation, the different options compared, and the results obtained.

Full Certification Stage
Energy Prerequisite 2
If not already approved at Provisional Certification or if there is any change: • Passive design analysis report considering all the factors described in Approach & Implementation and indicating the steps taken by the design team to address these factors.
Energy Credit 1
If not already approved at Provisional Certification or if there is any change: • Simulation reports included in the passive design analysis report and showing the inputs entered in the simulation, the different options compared, and the results obtained.

E-PR-3 & E-2 Total Building Energy Use

Scope

E-PR-3 prerequisite and E-2 credit apply to NR and Residential projects.

Intent

To reduce the total building energy use through energy modelling, allowing the identification of strategies to reduce energy consumption and the evaluation of their effectiveness.

Requirements

NR & Residential (Prerequisite)

Criteria	PR
Demonstrate a 10% reduction of the total building energy use compared to the baseline	Energy Prerequisite 3

NR & Residential (1-14 points)

Criteria	Points
1 point for every additional 2.5 % reduction of energy use from the baseline (Up to 45%)	14

Overview

Energy modelling is a design strategy which encompasses building geometry, spatial relationships, geographic information, quantities and properties of building components and systems. A building model helps designers make informed decisions regarding the potential benefits of specific measures, materials, systems and techniques employed in the final construction.

Approach & Implementation

Energy simulations using high resolution modelling need to be performed in order to estimate the energy use of the design and baseline buildings. These simulations have to be conducted in accordance with the LOTUS NC V3 Guidelines - Energy performance calculation method set by the VGBC which will be provided to registered projects. In these guidelines is described all the necessary information to realize the modelling for the design and baseline buildings.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates a reduction of the total building energy use compared to the baseline of more than 47.5%.

Submissions

Provisional Certification Stage
Energy Prerequisite 3 and Credit 1
• Energy simulations to be documented in accordance with section 1.3 of the LOTUS NC V3 Guidelines - Energy Performance Calculation Method.

Full Certification Stage
Energy Prerequisite 3 and Credit 1
If not already approved at Provisional Certification or if there is any change: • Final energy simulations to be documented in accordance with section 1.3 of the LOTUS NC V3 Guidelines - Energy Performance Calculation Method.
If building construction has been completed for more than 6 months at the time of submission: • Documents indicating monthly building energy consumption since the beginning of operations.

E-3 Building Envelope

Scope

E-3 credit applies to NR and Residential projects.

Intent

To ensure the thermal performance of the building envelope is optimized.

Requirements

NR & Residential (1-3 points)

Only one of the 2 following options can be pursued:

Option A: Overall Thermal Transfer Value (Available to all projects)

Criteria	Points
Building's average OTTV surpasses QCVN 09:2017/BXD requirements by 15%	1
1 point for every additional 15% reduction of building's average OTTV compared to QCVN 09:2017/BXD requirements (Up to 45%)	3

Option B: Building Envelope Design

Option B is only available to:

- non-residential projects with more than 50% of occupied spaces without air-conditioning
- residential projects with more than 50% of dwelling units with a building layout design that meets requirements of Strategy A1 of credit E-4

Criteria	Points
Strategy B1: Solar radiation	
Implement strategies to reduce the solar radiation absorbed by opaque surfaces	1
Strategy B2: West facing façade*	
West facing façade area is lower than 20% of total facade area	1
West facing façade area is lower than 10% of total facade area	2
Strategy B3: Window-to-Wall Ratio on West and East facing facades	
Window-to-Wall Ratio of the West and East facing façades is lower than 30%	1
Window-to-Wall Ratio of the West and East facing façade is lower than 15%	2
Strategy B4: Effective external shading	
Install effective external shading devices on glazing areas	1

** The west facing façade is defined as the facades oriented within the range of 22.5 degrees North of West and 22.5 degrees South of West. East facing façade is defined similarly.*

Overview

A building envelope is the physical separation between the interior and the exterior environments of a building.

Option A: Overall Thermal Transfer Value

For air-conditioned buildings, where indoor climate is controlled by HVAC systems, it is essential to maintain a proper thermal separation between the interior and the exterior of the building. A good method to assess the overall performance of the building envelope involves the calculation of the Overall Thermal Transfer Value (OTTV) which determines the thermal transfer permissible into the building through its walls, roof and windows due to solar heat gain and outdoor-indoor temperature difference (Figure E.2). A building envelope with a low OTTV value will minimize external heat gain while reducing the load on air-conditioning systems.

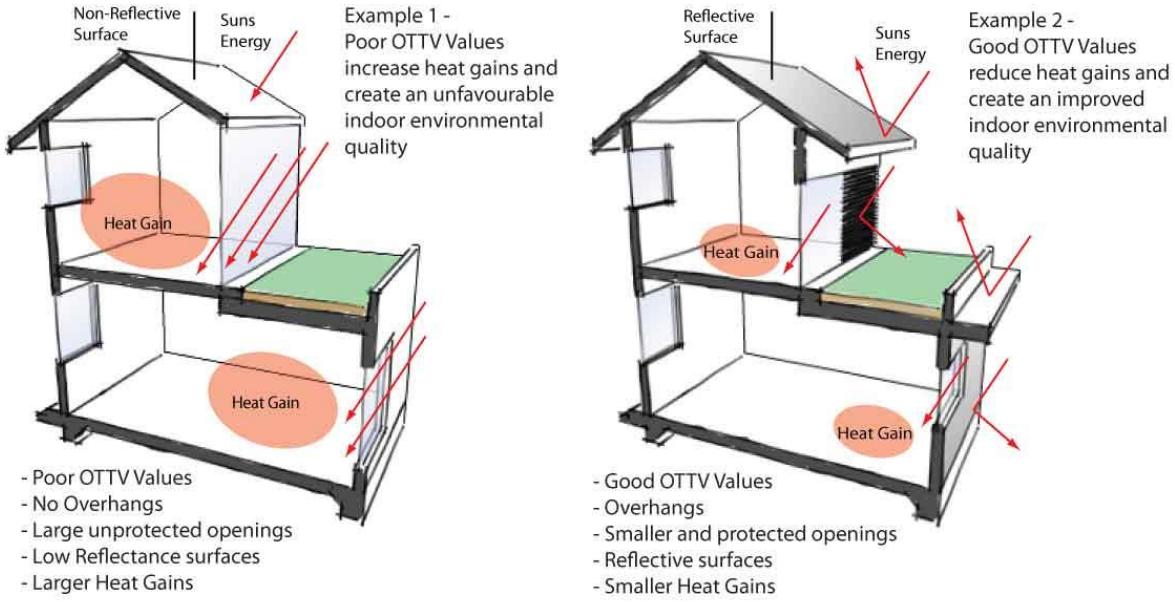

Figure E.2: OTTV to assess the overall performance of the building envelope

Option B: Building Envelope Design

For naturally ventilated buildings, the insulation (limiting the heat transfer due to the indoor-outdoor temperature difference) is of much less importance since the openings will let the warm air from outdoors penetrate the building. Such buildings should mainly focus on limiting the direct solar heat gains (from solar radiation) through optimized orientation, proper fenestration layout, the use of external shadings and the use of materials with high solar reflectance.

Approach & Implementation

Option A: Overall Thermal Transfer Value

Maximum OTTV values required by the QCVN 09:2017/BXD are 60 W/m^2 for walls and 25 W/m^2 for roofs.

To improve the performance of the building envelope and reduce the external heat gains, projects should consider the following strategies and technologies:

- Specification of materials with high thermal insulation for opaque walls and roofs
- Optimized positioning and orientation of the building to reduce loads
- Provision of external shading to reduce unnecessary heat gains from solar irradiation
- Specification of glazing with low SHGC value
- Specification of surface materials with a high solar reflectance

Option B: Building Envelope Design

External walls, roof and glazing areas adjacent to lifts, staircases, toilets or other unoccupied spaces are exempted from the strategies listed in Option B. Where calculations are made, these areas should be deducted.

In the case where a building has no west facing façade and no east facing façade:

- the building can be awarded 2 points under Strategy B2
- Strategy B3 is not applicable.
- in Strategy B4, shading devices only need to be provided on north and south facades.

4 strategies with the aim to limit the solar heat gains can be implemented:

Strategy B1: Solar radiation

To limit solar radiation on opaque roof AND walls of the building, LOTUS requires that 90% of the opaque roof and wall surface area meet any or any combination of the following:

- roof solar reflectivity is higher than 0.7
- a green roof is installed
- a fixed shading structure is installed and is ventilated by spacing out at least 0.3 meter from the roof surface.
- PV panels and solar collectors are installed over the roof surface
- wall solar reflectivity is higher than 0.4
- wall surface is a green wall (wall covered with greenery that includes a growing medium)
- external shading devices are installed

Strategy B2: West facing façade

Optimize the orientation of the building to limit the west-facing façade and optimize the zoning of the building by locating unoccupied spaces adjacent to the west facing façade.

Strategy B3: Window to Wall Ratio on West and East facing façades

Reduce the area of glazing on the west and east facing façades.

Strategy B4: Effective external shading

Provide effective external shading devices on glazing areas to reduce unnecessary heat gains from solar irradiation.
Compliance with this strategy is based on 2 criteria that will have to be demonstrated in accordance with the results of the passive design analysis realized in Prerequisite E-PR-2:

- proper selection of the glazing areas to be shaded, and
- effectiveness of the shading devices

The glazing areas that are the most prone to solar heat gains should be shaded in priority and the shading devices should be properly designed to reduce solar heat gains to a minimum.

Surrounding buildings, topography, landscaping can also be considered as providing shading, when their effectiveness is sufficiently supported by evidence such as building simulation showing shading at key points during the day.

Calculations

Option A: Overall Thermal Transfer Value

Projects should use the LOTUS Calculator - OTTV Calculation that calculates OTTV automatically based on the following method:

- Step 1: Calculations of the OTTV values for each façade and roof

Calculations must be undertaken for each wall and roof assembly according to the following formula:

$$\mathrm{OTTV}\,[\mathrm{W/m^2}] = (1-\mathrm{WWR})\times \mathrm{U_w}\times \alpha \times \left(\mathrm{TD_{eq}}-\Delta \mathrm{T}\right) + (1-\mathrm{WWR})\times \mathrm{U_w}\times \Delta \mathrm{T} + \mathrm{WWR}\times \mathrm{K_{cs}}\times \mathrm{I_o}\times \beta + \mathrm{WWR}\times \mathrm{U_f}\times \Delta \mathrm{T}$$

Where:

WWR = Window-to-wall area ratio of the façade or roof: the ratio of window area over the general area of the façade concerned or the ratio of skylight over the general area of roof (non-dimensional)

U_w = Thermal transmittance of the opaque wall/roof [W/m^2.K]

A = Coefficient of solar absorbance for the surface of the materials of opaque wall/roof

TD_{eq} = Equivalent indoor-outdoor temperature difference, in °C, which incorporates the effects of solar radiation onto the surface of opaque wall or roof

ΔT = Temperature difference, in ˚C, between indoor and outdoor temperatures

I_o = Average irradiation on wall and glazed area. Average hourly value of the solar energy incident on the windows for the i^{th} orientation, to account for the variation in the available solar, due to the orientation of the window [W/m^2]

β = External shading multiplier – non-dimensional. To consider the influence of external shading devices on solar heat gains through the fenestration

K_{cs} = Solar heat gain coefficient (SHGC), non-dimensional

U_f = Thermal transmittance of fenestration system [W/m^2.K]

K_{cs} and U_f values shall be calculated under NFRC (National Fenestration Rating Council) procedures

- Step 2: Calculation of the building's average OTTV (all facades and roofs included)

Building's average OTTV shall be calculated with the following formula:

$$\mathrm{OTTV_{average}} = \frac{\mathrm{OTTV_1} \times \mathrm{A_1} + \ldots + \mathrm{OTTV_n} \times \mathrm{A_n}}{\mathrm{A_1} + \ \ldots + \ \mathrm{A_n}}$$

Where n is the number of facades and roofs, $OTTV_n$ is the OTTV value of the nth facade/roof and A_n is the area of the nth facade/roof.

- Step 3: Calculations of the maximum average building OTTV compliant with QCVN 09:2017/BXD requirements

$$\mathrm{OTTV_{required}} = \frac{60 \times \mathrm{A_W} + \ 25 \times \mathrm{A_R}}{\mathrm{A_W} + \ \mathrm{A_R}}$$

- Step 4: Calculation of the OTTV reduction compared to requirements

$$\mathrm{Improvement\ [\%]} = \frac{\mathrm{OTTV_{required}} - \mathrm{OTTV_{average}}}{\mathrm{OTTV_{required}}}$$

<u>Option B: Building Envelope Design</u>

Calculations are relatively simple and will be illustrated under the form of an example.

Example of calculation:

A building has façades areas as specified in Table E.2. Effective external shadings are installed on all glazing on the west and east orientations. Also, the building has a roof solar reflectivity of 0.75 and a wall solar reflectivity of 0.35. The passive design analysis has shown via simulation that external shadings are needed on the southern facade as well as on east and west façade to cut solar heat gains.

Table E.2: Example of calculation – Building façades areas

Orientation	Total	West	East	North	South
Façade areas	2070 m^2	330 m^2	340 m^2	700 m^2	700 m^2
Façade areas adjacent to unoccupied spaces	80 m^2	30 m^2	40 m^2	10 m^2	0 m^2
Glazing areas	442 m^2	70 m^2	87 m^2	120 m^2	165 m^2
Glazing areas adjacent to unoccupied spaces	25 m^2	10 m^2	15 m^2	0 m^2	0 m^2

- Strategy B1:

The roof solar reflectivity is higher than 0.7 but the wall solar reflectivity is lower than 0.4 as required in the credit. No shadings, green roofs or green walls are installed. As less than 90% of the opaque roof and wall surface is limiting solar radiation, no points can be achieved under Strategy B1.

- Strategy B2: Calculate the percentage of west-facing façade area

$$\%\ \text{of west facing façade area} = \frac{330 - 30\ \text{m}^2}{2070 - 80\ \text{m}^2} = 15\ \%$$

The percentage of west-facing façade area is under 20% of the total building façade area, so 1 point can be granted.

- Strategy B3: Calculate the WWR of the west and east-facing façades

$$\text{WWR of west facing façade} = \frac{70 - 10\ \text{m}^2}{330 - 30\ \text{m}^2} = 20\ \%$$

$$\text{WWR of east facing façade} = \frac{87 - 15\ \text{m}^2}{340 - 40\ \text{m}^2} = 24\ \%$$

The WWR of the west and east-facing façades are both under 30%, so 1 point can be granted.

- Strategy B4:

Effective external shadings have been implemented only on West and East orientations. According to the passive design analysis, the southern facade requires horizontal shading devices but none is provided; therefore it is considered not suitable and the project is not awarded with 1 point for external shadings.

- Conclusion: This project can be awarded 2 points under Option B.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates through Option A that building's average OTTV surpasses QCVN 09:2017/BXD requirements by 60%.

-OR-

One point in Credit EP-1 can be awarded if the project demonstrates through Option B that at least 4 points can be achieved through Strategies B1, B2, B3 and B4.

Submissions

Provisional Certification Stage	Option A	Option B
• Tender stage elevations, sections and annotated indicating materials drawings of all external walls and roof	✓	✓
• Glazing: Tender specification extracts -OR- Manufacturer's data indicating U-values and SHGC values	✓	
• Opaque walls and roofs: Tender specification extracts -OR- Manufacturer's data indicating the solar reflectivity coefficients of the materials used for external walls and roof -OR- Justification for any values used solar reflectivity coefficients (when tender specifications or manufacturer's data is not available)	✓	
• Calculations of the OTTV values of the building and of the percentage of improvement compared to QCVN 09:2017/BXD requirements.	✓	
Strategy B1: Solar radiation		
• Tender specification extracts -OR- Manufacturer's data indicating the solar reflectivity coefficients of opaque walls and roof surfaces -OR- Justification for any values used for solar reflectivity coefficients (when manufacturer's data is not available)		✓
Strategy B2: West facing façade		
• Calculations of the percentage of west-facing facade area		✓
Strategy B3: Window to Wall Ratio on West and East facing facades		
• Calculations of the WWR of the west and east-facing facades		✓
Strategy B4: Effective external shadings		
• Report demonstrating the effectiveness of the external shadings to be installed		✓

Full Certification Stage	Option A	Option B
• As-built elevations, sections and annotated indicating materials drawings of all external walls and roof	✓	✓
• Evidence showing how all the external walls and roofs are built and shaded, such as photographs, commissioning report, etc.	✓	✓
If not already approved at Provisional Certification or if there is any change:		
• Glazing: Manufacturer's data indicating U-values and solar heat gain coefficients (SHGC)	✓	

• Opaque walls and roofs: Manufacturer's data indicating the solar reflectivity coefficients of the materials used for external walls and roof -OR- Justification for any values used for solar reflectivity coefficients (when manufacturer's data is not available)	✓	
• Final calculations of the OTTV values of the building and of the percentage of improvement compared to QCVN 09:2017/BXD requirements.	✓	
Strategy B1: Solar radiation		
• Manufacturer's data indicating the solar reflectivity coefficients of opaque walls and roof surfaces -OR- Justification for any values used for solar reflectivity coefficients (when manufacturer's data is not available)		✓
Strategy B2: West facing façade		
• Final calculations of the percentage of west-facing facade area		✓
Strategy B3: Window to Wall Ratio on West and East facing facades		
• Final calculations of the WWR of the west and east-facing facades		✓
Strategy B4: Effective external shadings		
• Final report demonstrating the effectiveness of the external shadings installed		✓

E-4 Building Cooling

Scope

E-4 credit applies to NR and Residential projects.

Intent

To reduce the energy consumption for space cooling.

Requirements

Both Strategy A and Strategy B can be pursued with a maximum of 6 points available.

Strategy A: Natural Ventilation

NR (1-6 points)

Criteria	Points
10 % of occupied areas are naturally ventilated	1
1 point for every additional 15% of occupied areas that are naturally ventilated	6

Residential (1-6 points)

Criteria	Points
Strategy A1: Building layout design	
1 point is awarded for every 20% of dwelling-units that have window openings facing prevailing wind directions (up to 80%)	4
Strategy A2: Dwelling unit design	
1 point is awarded for every 20% of living rooms and bedrooms that have effective cross ventilation (up to 80%)	4
Strategy A3: Common areas	
80% of the lobby, corridor and staircase areas is naturally ventilated	1

Strategy B: Air-conditioning

NR & Residential (1-6 points)

Criteria	Points
Strategy B1: Efficiency improvement	
1 point is awarded for every: 20% improvement of CSPF for non-ducted air-conditioners -AND- 10% improvement of COP for other types of direct electric air-conditioners -AND- 5% improvement of COP for chillers with cooling capacity under 1055 kW -AND- 3% improvement of COP for chillers with cooling capacity above 1055 kW	6

Strategy B2: Variable Controls	
Install variable controls on all suitable HVAC systems	1
Strategy B3: Alternative HVAC system types	
Install a Dedicated Outdoor Air System (DOAS) and/or a Radiant Cooling system	1

Overview

Space cooling usually accounts for the largest portion of a building's energy consumption in Vietnam. By improving the building envelope, it is possible to reduce the cooling load to a certain extent but solutions like natural ventilation or air-conditioning need to be implemented to provide comfortable spaces.

Naturally ventilated buildings take advantage of local wind patterns and stack effect to provide a fresh air flow. This practice reduces the need for HVAC systems, while increasing Indoor Air Quality (IAQ) and thermal comfort.

There are two distinct ways of providing natural ventilation within buildings:

- The first method, wind driven ventilation, involves the use of natural air flows as the primary means of ventilating spaces. This method involves proper building orientation, as well as the correct design of size, number and placement of wall and roof openings.
- The second method, stack ventilation, depends on the density differences between air of different temperatures. As air is warmed, either by internal heat loads or within a thermal chimney, it begins to rise due to its lower relative density. In a structure designed to take advantage of the stack effect, the warm air rises and leaves the building via openings at high elevations. This creates a pressure difference between the interior of the building and the exterior, which causes cooler, denser air to enter at lower elevations.

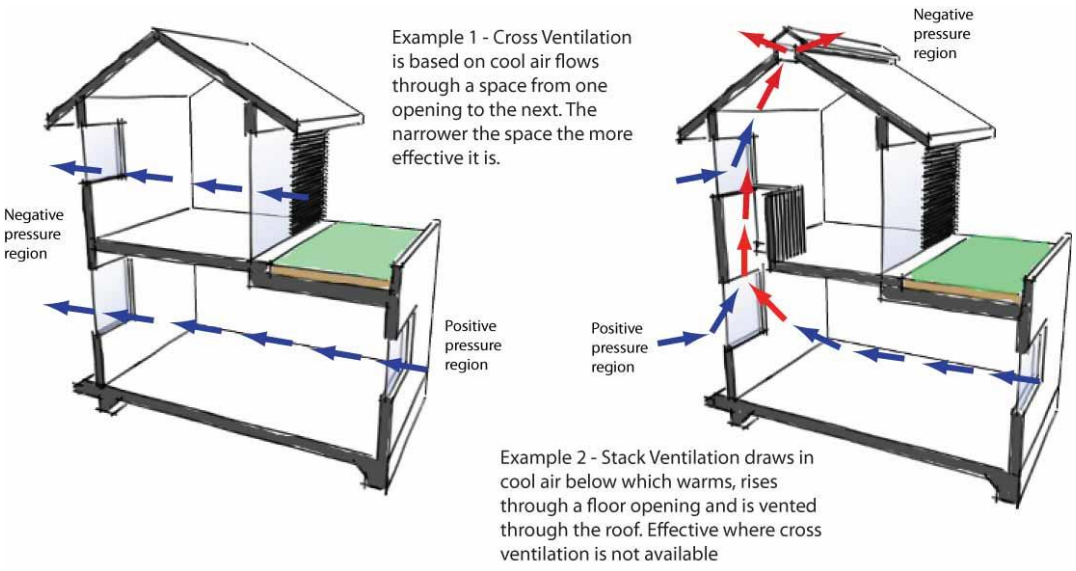

Figure E.3: Two methods of natural ventilation: wind driven ventilation and stack ventilation

As for air-conditioning systems, relying on a refrigeration cycle, they are designed to change the air temperature and humidity within a space to bring more comfortable conditions.

A properly installed and well-designed cooling system along with reduction in HVAC loads can result in high energy and financial savings over the life of a building. Selecting energy efficient equipment that is properly commissioned will improve system efficiency and will lengthen the life of the equipment.

Approach & Implementation

Strategy A: Natural Ventilation

The inclusion of natural ventilation as a major source of ventilation and cooling must be investigated early in the design stage.

Technologies and strategies which promote natural ventilation include:

- Proper building layout and orientation which utilizes prevailing wind conditions to achieve adequate flow of outside air
- Computational Fluid Dynamic (CFD) modelling to identify airflows and to increase the efficiency of the layout to promote natural ventilation
- Properly located windows and ventilation openings to ensure natural airflows do not produce uncomfortable drafts or stagnant areas

To avoid compromising aesthetic intent or liability issues associated with operable windows in high rise buildings this requirement may be met by other means of induced natural airflow. Alternatives may include trickle vents, wing walls, or a thermal chimney.

In Strategy A, the following definitions apply:

- The prevailing wind is the wind that blows the most frequently during the hottest period of the year (the 3 hottest months based on maximum monthly average high temperatures). Information on the frequency of wind direction of the project location can be found in Table 2.16 of QCVN 02:2009/BXD - Vietnam Building Code Natural Physical & Climatic Data for Construction or can come from meteorological data.
- The windward side of the building is the side from which the prevailing wind is blowing. It should not necessarily be located perpendicularly to the prevailing wind direction, oblique angles are acceptable. It is also possible to use architectural features to steer the wind such as casement windows, wing walls, fences, or even strategically-planted vegetation.

NR projects

For locations where the average maximum temperature during the hottest month is below 30°C (Sapa, Đà Lạt, Tam Đảo), a space shall be considered naturally ventilated where the total operable opening area is no less than 5% of the floor area.

For locations where the hottest month average maximum temperature is above 30°C, a space shall be considered as naturally ventilated if it meets requirements of at least one of the two methods described below: Prescriptive method or Performance method.

Mixed-mode ventilated spaces also have to follow at least one of the two methods but in order to be considered as naturally ventilated spaces, projects should also provide information on the type of mixed-mode system used and how it is implemented in order to reduce energy consumption for HVAC.

In the case that a project implements an engineered natural ventilation system, the project must provide all necessary information to demonstrate that the performance achieved in terms of energy savings and thermal comfort is equivalent to the Prescriptive method and/or Performance method. Compliance will be subject to VGBC approval.

Method 1: Prescriptive method

The space should meet all of the following specifications (based on QCVN 09:2013/BXD requirements):

- Ventilation inlet: Inlet openings shall be placed on the windward side of the building. The total effective area of operable openings to the outside (inlet area) shall be no less than 5% of the floor area. These openings shall be readily accessible to occupants. The effective area of a window is defined as the physical area of the window open to the outdoors (this can be calculated using simple geometry).
- Ventilation outlet: Outlet openings shall be placed on the leeward side of the building. The total effective area of operable openings through the ceiling or the opposite wall from the ventilation inlet (outlet area) shall be no less than the inlet area.
- The openings shall be evenly distributed across the area to enhance cross-ventilation
- There should a direct and unobstructed route between the windward inlet and leeward outlet openings (direct path to the outside).
- All area within any naturally-ventilated space shall be within 8 meters of (and permanently open to) an operable wall or roof opening.
- Plan depth of the occupied space shall not be greater than 15 meters
- Outlet openings shall be located not lower than inlet openings

Method 2: Performance method

Using CFD simulation or wind tunnel testing, it should be justified that the weighted average air speed within the space is greater than the values in Table E.3.
To be accepted, the CFD simulation should be conducted in accordance with the LOTUS Guidelines for CFD simulation set by the VGBC.

Table E.3: Minimum air speed requirements for naturally ventilated spaces

Hottest month average daily maximum temperature	Minimum air speed (m/s)
30°C < T°C < 31°C	0.2
31°C < T°C < 32°C	0.5
32°C < T°C <33°C	0.8
33°C < T°C	1

Residential projects

Residential projects should follow the strategies A1, A2 and A3 detailed below:

Strategy A1: Building layout design

Building layout should be designed to utilize prevailing wind conditions and achieve cross ventilation. To comply with strategy A1, a dwelling-unit must have:

- Some window openings on the windward side, facing prevailing wind direction, and
- Some window openings located on the opposite direction of the prevailing wind

In this strategy, window openings should be opened to the outside. For buildings with 6 or less stories located in a dense urban area, it is not necessary to be oriented in such a way to face prevailing wind direction.

Strategy A2: Dwelling unit design

Dwelling units should be designed to achieve effective cross ventilation in the living rooms and bedrooms. Cross ventilation in a room is considered as effective when:

- There is a continuous (unobstructed) air flow path between 2 window openings either within the room or from the room to another. One opening can be used as supply for up to two air flow paths.
- Window openings are located either in opposite or adjacent external walls. If they are located on adjacent walls, they must be at least 3 meters apart at their closest point.
- Distance between the supply and exhaust openings is not more than 15 meters
- There is no more than one doorway or opening smaller than 2 m^2 between the openings
- The total area of openings shall be at least 5% of the room's floor area

In this strategy, the main entrance of the dwelling unit is assumed to be closed and all the windows / internal doors are assumed to be opened. Exception: when a gate door (with an opened area of at least 1 m^2) is covering the main entry door of the dwelling unit, the door can be considered as an exhaust opening.

Strategy A3: Common areas

Lobby, corridor and staircase areas should be designed to be naturally ventilated:

- For each space, the openable area of windows must be 5% or more of the net floor area of the space.
- Spaces equipped with air-conditioning system are not considered as naturally ventilated.

Mixed-use Residential/NR projects

- For projects considered as NR projects: Requirements for NR projects should be followed and all occupied spaces, including habitable spaces, should be considered.
- For projects considered as Residential projects: Requirements of Strategy A1, A2 and A3 should be followed considering only the Residential components of the building.

Strategy B: Air-conditioning

Strategy B1: Efficiency improvement

Select and install air-conditioning equipment whose CPSF (Cooling Seasonal Performance Factor) or COP (Coefficient of performance) values meet and surpass the minimum requirement values of Tables E.4, E.5 and E.6 from QCVN 09:2017/BXD and ASHRAE 90.1-2013.

Note: VRV/VRF systems should be considered as air-cooled air-conditioners and their efficiency should be compared to values in Table E.5.

Table E.4: Minimum CSPF requirements for non-ducted air conditioners with capacity < 12 kW (*Adapted from QCVN 09:2017/BXD Table 2.3*)

Equipment Type	Capacity	Minimum CSPF	Test procedures
Unitary air-conditioner	< 12 kW	2.80	TCVN 6576:2013 TCVN 7830:2015 and TCVN 10273-1:2013
Split air-conditioner	< 4.5 kW	3.10	
	≥ 4.5 kW and < 7.0 kW	3.00	
	≥ 7.0 kW and < 12.0 kW	2.80	

Table E.5: Minimum COP requirements for other types of direct electric air conditioners
(*Adapted from QCVN 09:2017/BXD Table 2.3 and ASHRAE 90.1-2013 Table 6.8.1-1*)

Equipment Type	Capacity	Minimum COP	Test procedures
Air conditioners, air cooled	< 19 kW	3.81 $SCOP_C$	TCVN 6307:1997 or AHRI 210/240
	≥ 19 kW and < 40 kW	3.28	AHRI 340/360
	≥ 40 kW and < 70 kW	3.22	
	≥ 70 kW and < 223 kW	2.93	
	≥ 223 kW	2.84	
Air conditioners, water cooled	< 19 kW	3.54	AHRI 210/240
	≥ 19 kW and < 40 kW	3.54	AHRI 340/360
	≥ 40 kW and < 70 kW	3.66	
	≥ 70 kW and < 223 kW	3.63	
	≥ 223 kW	3.57	
Air conditioners, evaporatively cooled	< 19 kW	3.54	AHRI 210/240
	≥ 19 kW and < 40 kW	3.54	AHRI 340/360
	≥ 40 kW and < 70 kW	3.51	
	≥ 70 kW and < 223 kW	3.48	
	≥ 223 kW	3.43	
Condensing Units, Air-Cooled	≥ 40 kW	3.07	AHRI 365
Condensing Units, Water or evaporatively cooled	≥ 40 kW	3.95	

Table E.6: Minimum COP Requirements for chillers
(*Adapted from QCVN 09:2017/BXD Table 2.4 and ASHRAE 90.1-2013 Table 6.8.1-3)*

Equipment Type	Capacity	Minimum COP	Test procedures
Air-cooled, with condenser, electrically operated	All Capacities	2.80	AHRI 550/590
Air-cooled, without condenser, electrically operated	Air-cooled chillers without condenser must be rated with matching condensers and comply with air-cooled chiller COP requirements		
Water cooled, electrically operated, positive displacement (rotary screw, scroll and reciprocating)	< 264 kW	4.51	AHRI 550/590
	≥ 264 and < 528 kW	4.53	
	≥ 528 kW and < 1055 kW	5.17	
	≥ 1055 kW	5.67	
Water Cooled, Electrically Operated, Centrifugal	< 1055 kW	5.55	
	≥1055 kW and < 2110 kW	6.11	
	≥ 2110 kW	6.17	

Strategy B2: Variable Controls

All HVAC systems in the building should be designed to ensure better part-load systems efficiency. This can be achieved by using the following variable controls systems:

- VRV/VRF (Variable Refrigerant Volume / Variable Refrigerant Flow) systems
- VSD on chiller plant equipment like chilled-water pumps and/or cooling tower fans
- Variable speed compressors for chillers, rooftop-units and split-units (inverters)
- High-performance VAV (Variable air volume) systems. To qualify as a high-performance system, the VAV system controls should be optimized with:
  - Optimal start / stop
  - Fan-pressure optimization
  - Supply-air-temperature reset
  - Ventilation optimization

Exception: As variable controls (inverters) in non-ducted air-conditioners are considered in the CSPF values, projects that only install non-ducted air-conditioners cannot be awarded a point in Strategy B2 even though the air-conditioners are equipped with inverters.

Strategy B3: Alternative HVAC system types

The 2 following alternative HVAC system types can be installed on the project for an additional point in Strategy B3:

- Dedicated Outdoor Air System (DOAS).

  These types of system use separate equipment to condition all the fresh air brought into a building for ventilation and delivers it to each occupied space, either directly or in conjunction with local or central HVAC units serving those same spaces. The local or central HVAC units are used to maintain space temperature.

- Radiant cooling system

  For compliance, the radiant cooling system doesn't have to meet the total cooling demand of the project.

  A radiant cooling system cools surfaces (floor or ceiling) rather than air like typical HVAC systems do. With radiant cooling systems, most of the cooling comes from removing sensible heat through radiant exchange with people and objects. This way, occupant thermal comfort can be achieved with warmer interior air temperatures than with air-based cooling systems.

Calculations

Strategy A: Natural Ventilation

NR projects

The percentage of the net occupied area that is naturally ventilated is calculated using the following formula based on area:

$$\text{Naturally Ventilated Occupied Area } [\%] = \frac{\sum \text{Area of Naturally Ventilated Spaces}}{\text{Total Net Occupied Area}} \times 100$$

Residential projects

Strategy A1: Building layout design

The percentage of dwelling-units complying with strategy A1 is calculated using the following formula based on the number of compliant units:

$$\text{Compliant Units } [\%] = \frac{\sum \text{Units facing prevailing wind}}{\sum \text{Units}} \times 100$$

Strategy A2: Dwelling unit design

The percentage of living rooms and bedrooms complying with strategy A2 is calculated using the following formula based on the number of compliant living rooms and bedrooms:

$$\text{Compliant living rooms and bedrooms } [\%] = \frac{\sum \text{Living rooms and bedrooms with effetive cross ventilation}}{\sum \text{living rooms and bedrooms}} \times 100$$

Strategy A3: Common areas

The percentage of common areas complying with strategy A3 is calculated using the following formula based on area:

$$\text{Naturally ventilated common areas } [\%] = \frac{\sum \text{common areas with natural ventilation}}{\sum \text{common areas}} \times 100$$

Strategy B: Air-conditioning

Strategy B1: Efficiency improvement

All air conditioning units and water chilling packages in the project should be included in the calculation. Cooling capacity and CSPF/COP values should be calculated using the rating conditions in accordance with the test procedures listed in tables E.4, E.5 and E.6.

Exception: For VRV/VRF systems, if available from manufacturer's data, projects should use SCOP/COP values calculated at standard rating conditions under AHRI 1230. Else, projects should calculate COP by hand using the net cooling capacity of the systems and including the power of the fans in the indoor units to calculate the total power input. The net cooling capacity should be calculated by subtracting the heat from indoor fans to the rated cooling capacity of the outdoor unit (cooling capacity at standard rating conditions under AHRI 340/360 or, if not available, at the following conditions: indoor air at 27 °Cdb / 19 °Cwb and outdoor air at 35 °Cdb).

The calculation of HVAC efficiencies improvement should be calculated based on capacity-weighted average CSPF/COP values using the following formulas:

$$\text{CSPF Improvement } [\%] = \left(\frac{\sum_d (\text{P}_\text{d} \times \text{Y}_d)}{\sum_d (\text{P}_d \times \text{Y}_\text{Ed})} - 1\right) \times 100$$

P_d = Capacity of the non-ducted air-conditioning unit d

Y_d = CSPF of the non-ducted air-conditioning unit d

Y_{Ed} = minimum CSPF for a unit of the same type and capacity as the proposed unit d (c.f. Table E.4)

$$\text{Direct electric AC COP Improvement } [\%] = \left(\frac{\sum_\text{i} (\text{P}_\text{i} \times \text{Y}_\text{i})}{\sum_\text{i} (\text{P}_\text{i} \times \text{Y}_\text{Ei})} - 1\right) \times 100$$

P_i = Capacity of the direct electric air-conditioning unit i

Y_i = COP or SCOP of the direct electric air-conditioning unit i

Y_{Ei} = minimum COP or SCOP for a unit of the same type and capacity as the proposed unit i (c.f. Table E.5)

$$\text{Chiller COP Improvement } [\%] = \left(\frac{\sum_\text{c} (\text{P}_\text{c} \times \text{Y}_\text{c})}{\sum_\text{c} (\text{P}_\text{c} \times \text{Y}_\text{Ec})} - 1\right) \times 100$$

P_c = Capacity of the chiller unit c

Y_c = COP of the chiller unit c

Y_{Ec} = minimum COP for a unit of the same type and capacity as the proposed unit c (c.f. Table E.6)

Points in Strategy B1 are calculated according to Table E.7.

Table E.7: Efficiency improvement required for points in Strategy B1

Equipment Type	1 point	2 points	3 points	4 points	5 points	6 points
Non-ducted air conditioners with capacity < 12 kW	20%	40%	60%	80%	100%	120%
Other direct electric air conditioners	10%	20%	30%	40%	50%	60%
Chillers with cooling capacity < 1055 kW	5%	10%	15%	20%	25%	30%
Chillers with cooling capacity ≥ 1055 kW	3%	6%	9%	12%	15%	18%

As an example, for a project to be awarded 2 points in Strategy B1:

- the capacity-weighted average efficiency improvement of all the non-ducted air conditioners with capacity < 12 kW installed (if any) should reach at least 40%
- AND the capacity-weighted average efficiency improvement of all the other direct electric air conditioners installed (if any) should reach at least 20%
- AND the capacity-weighted average efficiency improvement of all the chillers installed with capacity < 1055 kW (if any) should reach at least 10%.
- AND the capacity-weighted average efficiency improvement of all the chillers installed with capacity ≥ 1055 kW (if any) should reach at least 6%.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that more than 6 points are achieved under the different Strategies of the credit.

Submissions

Provisional Certification Stage	NR	R
Strategy A: Natural Ventilation		
• Tender stage elevations and plans marking all wall and roof openings	✓	✓
• Tender stage window schedule indicating the number, location and size of all wall and roof openings - OR - Room data sheets that indicate floor area and window specifications (glazing type, size and whether the window is operable).	✓	✓
• Calculations demonstrating that naturally ventilated occupied spaces conform to the requirements	✓	
• Calculation demonstrating the percentage of the net occupied area which will be naturally ventilated	✓	
If CFD simulation was conducted to determine air speed within the building: • Report following requirements of the LOTUS Guidelines - CFD simulation	✓	
If the building includes some mixed-mode ventilated spaces: • Report explaining the operation of the mixed-mode ventilation system and how it can reduce HVAC energy consumption	✓	
Strategy A1: Building layout design • Calculations of the percentage of units with openings facing prevailing wind direction and achieving cross ventilation.		✓
Strategy A2: Dwelling unit design • Schedule showing the number of living rooms and bedrooms in the building and highlighting those designed with effective cross ventilation		✓
• Calculations of the percentage of the living rooms and bedrooms which are designed with effective cross ventilation		✓
Strategy A3: Common areas • Schedule showing the number of common spaces in the building and highlighting those designed with cross ventilation		✓
• Calculations of the percentage of naturally ventilated common areas		✓

Strategy B: Air-conditioning		
• Tender stage schematic drawings of the HVAC systems	✓	✓
• Tender schedule of all HVAC equipment	✓	✓
Strategy B1: Efficiency improvement		
• Calculations of the efficiency improvement of proposed HVAC systems	✓	✓
Strategy B2: Variable Controls		
• Tender schedule of all equipment ensuring better part-load efficiency	✓	✓
Strategy B3: Alternative HVAC system types		
• Tender stage schematic drawings of the HVAC system showing the dedicated outdoor air system and/or the radiant cooling system	✓	✓

Full Certification Stage	NR	R
Strategy A: Natural Ventilation		
• As-built plans, elevations and sections marking all wall and roof openings	✓	✓
• As-built window schedule indicating the number, location and size of all wall and roof openings	✓	✓
If not already approved at Provisional Certification or if there is any change:		
• Final as-built calculations showing that naturally ventilated occupied spaces conform to the requirements	✓	
• Final as-built calculations demonstrating the percentage of the net occupied area which is naturally ventilated	✓	
If CFD simulation was conducted to determine air speed within the building:		
• Final report following requirements of the LOTUS Guidelines - CFD simulation	✓	
If the building includes some mixed-mode ventilated spaces:		
• Final report explaining the operation of the mixed-mode ventilation system and how it can reduce HVAC energy consumption	✓	
Strategy A1: Building layout design		
• Final as-built calculations demonstrating the percentage of units with openings facing prevailing wind direction and achieving cross ventilation.		✓
Strategy A2: Dwelling unit design		
• Final schedule showing the number of living rooms and bedrooms in the building and highlighting those designed with effective cross ventilation		✓
• Final as-built calculations demonstrating the percentage of the living rooms and bedrooms which are designed with effective cross ventilation		✓
Strategy A3: Common areas		
• Final schedule showing the number of common spaces in the building and highlighting those designed with cross ventilation		✓
• Final as-built calculations demonstrating the percentage of naturally ventilated common areas		✓

Strategy B: Air-conditioning		
• As-built schematic drawings of the HVAC system	✓	✓
• As-built schedule of all the HVAC equipment installed	✓	✓
• Manufacturer's data indicating efficiency values of all the HVAC systems	✓	✓
If not already approved at Provisional Certification or if there is any change: Strategy B1: Efficiency improvement • Final as-built calculations of the efficiency improvement of HVAC systems Strategy B3: Alternative HVAC system types • As-built schematic drawings of the HVAC system showing the dedicated outdoor air system and/or the radiant cooling system	✓ ✓	✓ ✓

E-5 Artificial Lighting

Scope

E-5 credit applies to NR and Residential projects.

Intent

To reduce energy consumption associated with the use of artificial lighting systems.

Requirements

NR (1-3 points)

Both Strategy A and Strategy B can be pursued with a maximum of 3 points available.

Residential (1-3 points)

Only Strategy A can be pursued.

Strategy A: Lighting Power Density

Criteria	Points
NR Installed LPD surpasses QCVN 09:2017/BXD requirements by 20%	1
Residential Installed LPD surpasses QCVN 09:2017/BXD requirements by 15%	
NR 1 additional point for every 20% of reduction of the installed LPD compared to QCVN 09:2017/BXD requirements (up to 60%)	3
Residential 1 additional point for every 15% of reduction of the installed LPD compared to QCVN 09:2017/BXD requirements (up to 45%)	

Strategy B: Lighting Control System

Criteria	Points
Implement a lighting control system in more than 50% of the building GFA and in 100% of the outdoor car park area	1

Overview

Artificial lighting contributes significantly to a building overall energy consumption. The application of appropriate levels of lighting contributes to occupant well-being, worker performance and building aesthetics. Reducing the amount of energy used to meet the lighting requirements of a building is a strategy which can lower operating costs.

Natural lighting can be applied to reduce the need for artificial lighting and high efficiency lighting fixtures can be applied to reduce the power consumption of artificial lighting.

Lighting systems can be included in a building management system that may be present in the building or as a standalone lighting control system. This allows tight control of the lighting fixtures in order to deliver the right lighting levels at the right time. Depending on many factors such as occupancy, natural lighting levels, task undertaken, time of the day, the lighting will be adjusted appropriately.

Approach & Implementation

Strategy A: Lighting Power Density

Lighting power associated with artificial lighting can be reduced in the following way:

- Specifying high efficiency lighting fixtures (fluorescent T5, LED, etc.) and ballasts
- Designing the lighting so as to have the proper illuminance levels
- Selecting interior walls and ceilings with high reflective qualities
- Using reflector lamps or build reflectors into luminaires

Strategy B: Lighting Control System

NR projects

The project should meet the following requirements on lighting control:

- In at least 50% of the gross floor area, each individual space is equipped with lighting controls of 2 or more types among the following:
  - Occupancy sensors or vacancy sensors for automatic lighting shutoff
  - Timer switches for automatic lighting shutoff
  - Photo-sensors controls for light dimming and/or automatic lighting shutoff
  - Task tuning controls for setting light levels to suit the particular task or other use of a workspace
  - Variable Load Shedding (automatic reduction of electrical demand in a building by shedding lighting loads dynamically)
- Implement automatic lighting shutoff (with scheduling, photo-sensors and/or occupancy sensors) for 100% of the outdoor car park area (if any).

Calculations

Strategy A: Lighting Power Density

QCVN 09:2017/BXD stipulates maximum LPD values for different building types (Table E.8).

Table E.8: Maximum LPD Values for different types of buildings / spaces
(*Source: Adapted from QCVN 09:2017/BXD Table 2.5*)

Building types / space types	Maximum LPD (W/m²)
Building types	
Office	11
Hotel	11
Hospital	13
School	12
Retail	16
Residential	8
Building / Space types *	
Library	14
Convention center	15
Healthcare clinic	11
Storage	9
Enclosed, in-house, parking space	3

** Depending on the project, the "Building / Space types" may be considered as building types or space types within another building type (e.g. a library building or a library space within a school).*

Projects with building types not listed in Table E.8 (such as: manufacturing facilities, museums, gymnasiums, etc.), should either:

- use values listed in Table 9.5.1 of ASHRAE 90.1-2007, or
- follow a space-by-space method using LPD values listed in Table 3.5.1 of the LOTUS NC V3 Guidelines - Energy Performance Calculation Method.

The project must demonstrate that the installed LPD in the building surpasses the requirements of the QCVN 09:2017/BXD with the following method:

- Calculate the installed LPD of the building as the ratio of the power required to provide artificial lighting to the gross floor area of lighted spaces. The calculation must include the power used by lamps, ballasts, current regulators and control devices.

$$LPD_I\ [\mathrm{W/m^2}] = \frac{P_L}{GFA_L}$$

LPD_I = Installed Lighting Power Density of the building [W/m²]

P_L = Total power required to provide artificial lighting in the building (including indoor parking spaces and outdoor/open parking spaces with roof) [W]

GFA_L= total gross floor area of lighted spaces in the building [m²]

- Calculate the average baseline LPD for the building:

$$LPD_B\ [\mathrm{W/m^2}] = \frac{\sum_i (LPD_{M\,i} \times GFA_{L\,i})}{\sum_i GFA_L}$$

LPD_B = Average Baseline Lighting Power Density [W/m^2]

$LPD_{M\,i}$ = Maximum Lighting Power Density for the building/space type i (c.f. Table E.8) [W/m^2]

$GFA_{L\,i}$ = total gross floor area of lighted spaces corresponding to the building/space type i [m^2]

For building types, the functional use of each area shall be accounted for. For instance, in a building with 4 floors dedicated to office spaces, the entire gross floor area of the 4 floors (including corridors, bathrooms, lobbies, etc. but excluding all the space types listed in Table E.8) should be considered as office. For spaces types, the actual area of the space should be considered.

- Calculate the average reduction in LPD with the following formula:

$$LPD\ Reduction\ [\%] = \left(1 - \frac{LPD_I}{LPD_B}\right) \times 100$$

Example of calculation:

A non-residential building includes 4 floors for retail and 10 floors for office. Each floor has a GFA of 1,300 m^2. The building also includes a basement of 2 floors for parking. The retail space includes some storage areas for a total of 500 m^2. All the areas and values of lighting power installed are shown in Table E.9.

Table E.9: Example of LPD reduction calculation for a mixed-use project

Building types	GFA of lighted spaces [m^2]	Total artificial lighting power installed [W]	Maximum LPD for the building/space type [W/m2]
Retail	4*1,300 – 500 = 4,700	53,400	16
Office	10*1,300 = 13,000	88,300	11
Storage	500	3,100	9
Basement parking	2*1,300 = 2,600	5,200	3
Total	GFA_L = 20,800 m^2	P_L = 150,000 W	

Calculation of the installed LPD of the building:

$$LPD_I\ [W/m^2] = \frac{P_L}{GFA_L} = \frac{150{,}000}{20{,}800} = 7.2\ W/m^2$$

Calculation of the baseline LPD:

$$LPD_B\ [W/m^2] = \frac{4{,}700 * 16 + 13{,}000 * 11 + 500 * 9 + 2{,}600 * 3}{20{,}800} = 11.1\ W/m^2$$

Calculation of the percentage of LPD reduction:

$$LPD\ Reduction\ [\%] = \left(1 - \frac{7.2}{11.1}\right) \times 100 = 35\ \%$$

This building can be granted 1 point with more than 20% of LPD reduction achieved.

Mixed-use Residential/NR projects

To calculate the amount of points attributed for a mixed-use Residential/NR project:

- Calculate the installed LPD of the whole project
- Calculate the average baseline LPD of the NR components of the project
- Calculate and verify if the following equations are respected:
  - For 1 point:

$$LPD_I\ [\mathrm{W}/m^2] \leq \frac{0.8 \times LPD_{B\ NR} \times GFA_{L\ NR} + 0.85 \times 8 \times GFA_{L\ Res}}{GFA_L}$$

  - For 2 points:

$$LPD_I\ [\mathrm{W}/m^2] \leq \frac{0.6 \times LPD_{B\ NR} \times GFA_{L\ NR} + 0.70 \times 8 \times GFA_{L\ Res}}{GFA_L}$$

  - For 3 points:

$$LPD_I\ [\mathrm{W}/m^2] \leq \frac{0.4 \times LPD_{B\ NR} \times GFA_{L\ NR} + 0.55 \times 8 \times GFA_{L\ Res}}{GFA_L}$$

LPD_I = Installed Lighting Power Density of the whole project [W/m^2]

$LPD_{B\ NR}$ = Average Baseline Lighting Power Density of the NR components of the project [W/m^2]

$GFA_{L\ NR}$ = total gross floor area of lighted spaces in the NR components of the project [m^2]

$GFA_{L\ Res}$ = total gross floor area of lighted spaces in the Residential components of the project [m^2]

GFA_L= total gross floor area of lighted spaces in the project [m^2]

Strategy B: Lighting Control System

NR projects

To show that lighting controls of 2 or more types are installed in 50% of the gross floor area:

- List out all building spaces and indicate their respective floor area and the types of lighting controls/sensors installed.
- Calculate the compliant area as the total floor area of the spaces that are equipped with 2 different types of lighting controls/sensors
- Show that the percentage of the building total gross floor area that is compliant is higher than 50%.

Exceptional Performance

NR projects

One point in Credit EP-1 can be awarded if the project demonstrates through Strategy A that installed LPD surpasses QCVN 09:2017/BXD requirements by 80%.

- AND/OR -

One point in EP-1 can be awarded if the project demonstrates that 3 points can be achieved under Strategy A and 1 point can be achieved under Strategy B.

Residential projects

One point in Credit EP-1 can be awarded if the project demonstrates through Strategy A that installed LPD surpasses QCVN 09:2017/BXD requirements by 60%.

Submissions

Provisional Certification Stage
Strategy A: Lighting Power Density
• Calculations demonstrating the percentage of LPD reduction achieved
Strategy B: Lighting Control System
• Tender specifications of the lighting control system indicating the sensors and controls to be installed and explaining the system architecture (including communication technologies) • Electrical tender drawings showing the location of all sensors and controls • Tender schedule showing all the sensors/controls to be installed in each space • Calculations demonstrating compliance with the requirements

Full Certification Stage
Strategy A: Lighting Power Density
If not already approved at Provisional Certification or if there is any change: • Final as-built calculations demonstrating the percentage of LPD reduction achieved
Strategy B: Lighting Control System
• Electrical as-built drawings showing the location of all sensors and controls • As-built schedule showing all the sensors/controls installed in each space • Evidence showing that the lighting control system has been correctly calibrated, adjusted and programmed such as commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: • Final as-built calculations demonstrating compliance with the requirements

E-6 Energy Monitoring and Management

Scope

E-6 credit applies to NR and Residential projects.

Intent

To ensure continuous monitoring and control of building's energy consuming systems.

Requirements

NR (1-2 points)

Criteria	Points
A Power Monitoring System (PMS) monitors major energy uses	1
A Building Management System (BMS) monitors and controls the electrical and mechanical equipment of the building	2

Residential (1 point)

Criteria	Points
Provide each dwelling unit with a home energy monitor to record electricity consumption	1

Overview

NR projects

Power sub-metering involves the installation of measurement equipment to meter building energy use. It helps to track energy consumption of major building uses and other end-use applications (e.g. by building systems or individual floors).

A Power Monitoring System (PMS) is a system including sub-meters to record data, a software to gather, manage and display the data, and a communication interface between the software and the meters. The continuous logging of energy-related data provides information on the operational characteristics of the building systems and allows for an analysis of time trends.

Building Management Systems (BMS) are more advanced computer-based technologies which monitor and manage building systems. Correctly installed and operated, BMS can achieve significant energy savings through the efficient operation of, in particular, HVAC and lighting systems.

Residential projects

A home energy monitor is an electronic device that provides feedback on electricity consumption. Most monitors allow to view real-time electricity usage in units of energy used (kWh), cost or carbon emissions. As shown in various studies, real-time data helps homeowners to change their behavior and leads to a reduction of the household energy use.

Approach & Implementation

NR projects

Power Monitoring System:

To meet the requirements for Power Monitoring System, the following energy uses must be monitored individually with permanent meters recording both consumption and demand at intervals of one hour or less:

- HVAC equipment such as chillers, air-conditioners, air handling units and pumps
- Interior artificial lighting
- Any system/load above 100 kVA

The power monitoring system should centralize the data from all meters through communication infrastructure and use the information to analyze the consumption of the different energy-using areas and to create monthly and annual summaries.

Where applicable, it is possible for projects to use virtual meters instead of actual energy meters. A virtual meter can be a function of the measured energy from a number of other meters. A simple scenario is the difference between the main meter and a number of sub-meters. But, also, a virtual meter can be a meter created within an analytics package using sensor information, known information about the device to be metered and/or control information.

Building Management System:

To meet the requirements of BMS implementation, the BMS must meet the requirements for Power Monitoring System and control at least the following systems:

- HVAC equipment such as chillers, condensers, air handling units and pumps
- Artificial lighting

The BMS should be used to optimize the performance of the systems and determine changes to the parameters of operation in order to achieve energy savings. Access to the BMS should be restricted to trained staffs that have the ability to analyze the data and make relevant adjustments to the systems in order to improve energy performance.

Residential projects

A permanent home energy monitor should be installed in each dwelling-unit and should:

- Have an in-house visual display located conveniently for unit owners - OR - have the ability to communicate the information to a personal computer
- Provide real-time feedback on energy consumption
- Provide a function to analyze data at regular intervals (daily, weekly, monthly or yearly)

If a centralized air-conditioning system is used to provide cooling to the dwelling units, energy meters should be installed to monitor the energy consumption for cooling.

Mixed-use Residential/NR projects

- For projects considered as NR projects: To be able to score points in the credit, the dwelling-units in the building should be metered individually but these meters do not need to be connected to the power monitoring system.
- For projects considered as Residential projects: For 1 point to be awarded, only requirements for Residential projects should be met.

Submissions

Provisional Certification Stage	NR	R
Power Monitoring System: • Short description of the main features of the PMS system • Tender single-line diagram showing power meters • Schematics of the communication interface between the software and the meters	✓ ✓ ✓	
Building Management System: • Short description of the main features of the BMS system with details on proposed user interface, central monitoring and control equipment • BMS control schematic drawings showing systems controlled by the BMS • BMS point schedule with I/O (input/output) summary • Plans showing location, type of all meters, sensors and controls to be installed	✓ ✓ ✓ ✓	
Home Energy Monitor: • Description of the type of home energy monitors to be used (accessibility to unit owners, ability to display real-time information and to analyze data at regular intervals) • Tender plans showing the location of the visual displays in the different units - OR - description of the monitor's ability to communicate the information to a remote location (e.g., computer).		✓ ✓

Full Certification Stage	NR	R
Power Monitoring System: • As-built single-line diagram showing power meters • As-built schematics of the communication interface between the software and the meters • Report indicating how the monitoring system is employed, including responsible staff and training provided, and outputs generated such as daily/monthly electricity consumption report	✓ ✓ ✓	
Building Management System: • BMS control as-built schematic drawings showing systems controlled by the BMS and wiring connections • As-built BMS point schedule with I/O (input/output) summary • As-built plans showing location and type of all meters, sensors and controls installed • Report indicating how the monitoring system is employed, including responsible staff and training provided, outputs generated such as daily/monthly electricity consumption report, and narrative explaining how the BMS is used to improve energy efficiency If not already approved at Provisional Certification or if there is any change: • Short description of the main features of the BMS system with details on user interface, central monitoring and control equipment used	✓ ✓ ✓ ✓ ✓	
Home Energy Monitor: • Evidence of the equipment installed such as photographs, invoices, receipts, etc. • As-built plans showing the location of the visual displays in the different units -OR- description of the monitor's ability to communicate the information to a remote location (e.g., computer). If not already approved at Provisional Certification or if there is any change: • Description of the type of home energy monitors used (accessibility to unit owners, ability to display real-time information and to analyze data at regular intervals)		✓ ✓ ✓

E-7 Lifts

Scope

E-7 credit only applies to Residential projects.

Intent

To reduce energy consumption associated with the use of lifts.

Requirement

Residential (1 point)

Criteria	Points
All lifts installed in the building shall either: • Reach energy efficiency class A following the certification guideline VDI 4707 Part 1 – Lifts Energy Efficiency -OR- • Follow at least 4 ways to reduce energy consumption among the following: - efficient hoisting - efficient lighting system - standby mode - energy regeneration - efficient controls	1

Overview

Energy consumption of lifts may be relatively low compared to cooling, home appliances and even lighting but it is far from being negligible and lift installations possess a high potential for saving energy. LOTUS encourages the use of lifts incorporating energy efficiency solutions such as VVVF (Variable Voltage, Variable Frequency), LED lighting, controls, etc.

VDI 4707 standard is an elevator energy efficiency classification guideline established by the Association of German Engineers. It provides a method to assess elevator energy performance taking into account factors such as load, speed, frequency of use and travel height – both during travel and standby modes.

Approach & Implementation

All the lifts installed in the project shall be compliant with one of the 2 following options.

- Reach energy efficiency class A following the certification guideline VDI 4707 Part 1 – Lifts Energy Efficiency.

  As described in the guideline, the ratings are influenced by travel height, speed, load and usage frequency (Table E.10). Depending on these factors, measurements of both standby and travel energy are considered separately to form the Energy Efficiency Class of the lift (ranging from 'A' to 'G' with 'A' being the best-in-class system.)

Table E.10: Usage categories according to VDI 4707 Part 1

Usage category	1	2	3	4	5
Usage intensity/frequency	Very low / very seldom	Low / seldom	Medium / occasionally	High / frequently	Very high / very frequently
Average travel time in hours/day	0.2 (≤0.3)	0.5 (>0.3 – 1)	1.5 (>1 – 2)	3 (>2 – 4.5)	6 (>4.5)
Average standby time in hours/day	23.8	23.5	22.5	21	18
Typical types of residential buildings	Residential building with up to 6 units	Residential building with up to 20 units	Residential building with up to 50 units	Residential building with more than 50 units	/

- Follow at least 4 ways to reduce energy consumption among the following:

  1) Efficient hoisting

     Use AC Variable-Voltage Variable-Frequency (VVVF) drives.

  2) Efficient lighting system

     Use LED lamps for car lighting and display lighting

  3) Standby mode

     When the lift is not in use, the power stage of the drive should be set to sleep mode, and car lighting and ventilation fans should be switched off.

  4) Energy regeneration

     Use regenerative drive to recover potential energy contained in the car when it is descending with a heavy load or ascending with a light load.

  5) Controls

     Use control systems such as:

     - Intelligent controller to ensure that the entire elevator goes in standby mode when not in use
     - Destination selection control (when users select their destination before they enter the car, and the system directs them to the elevator that will get them to their destination soonest).

Submissions

Provisional Certification Stage
• Tender schedule of the lift systems to be used in the building • Tender specifications and/or manufacturer's data indicating the types of lifts and the energy efficient features to be incorporated - OR - • Tender specifications and/or manufacturer's data indicating the VDI 4707 Energy Efficiency class to be reached.

Full Certification Stage
• Evidence showing the lift systems installed such as photographs, invoices, receipts, etc.
If not already approved at Provisional Certification or if there is any change: • As-built schedule of the lift systems used in the building • Manufacturer's data indicating the types of lifts and the energy efficient features incorporated - OR - • Manufacturer's data or energy efficiency certificate indicating the VDI 4707 Energy Efficiency class reached.

E-8 Renewable Energy

Scope

E-8 credit applies to NR and Residential projects.

Intent

To promote the use of renewable sources of energy and encourage their use in the built environment.

Requirements

NR & Residential (1-3 points)

Criteria	Points
1% of the total energy used in the building is produced from renewable sources	1
1 point for every additional 1% of the total energy used in the building produced from renewable sources (up to 3%)	3

Overview

The term renewable energy generally refers to electricity supplied from renewable energy sources, such as wind and solar power, geothermal, hydropower and various forms of biomass. These energy sources are considered renewable sources because their fuel sources are continuously replenished.

Using renewable energy sources can help to reduce the overall energy consumption, environmental impacts and CO_2 emissions of a building. The application of renewable energy strategies in buildings are presently uncommon in Vietnam and should be promoted in the interest of sustainable development.

Approach & Implementation

Specifying sources of power which produce energy on-site from a renewable source can achieve points within this credit.

Valid forms of renewable energy include:

- Photovoltaic (PV) & Solar Thermal (including solar water heating)
- Geothermal
- Wind
- Micro-hydro
- Biomass, subject to VGBC approval

Calculation

Energy modelling shall be undertaken according to the procedure outlined in Credit E-2 Total Building Energy Use and in the LOTUS NC V3 Guidelines - Energy performance calculation method.

Then, the following calculation shall be performed to indicate the total contribution to the building's energy use from renewable sources during the period of one year.

$$\text{Renewable Energy Contribution } [\%] = \frac{\text{Renewable Energy Produced}}{\text{Energy Consumption (Proposed Design)}} \times 100$$

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that more than 4% of the total energy used in the building is produced from renewable sources.

Submissions

Provisional Certification Stage
• Tender stage schedule of all the energy production equipment • Tender stage electrical schematic drawings indicating location within the site and required area • Tender specifications -OR- Manufacturer´s published technical data of all the energy production equipment • Calculations showing estimated annual energy harvest along with a description of simulation methodology/software used • Calculations of the renewable energy contribution to total energy use

Full Certification Stage
• Final as-installed schedule of all the energy production equipment • As-built electrical schematic drawings indicating location within the site and required area • Manufacturer's published technical data of all energy production equipment installed • Evidence showing the renewable energy equipment installed such as photographs, invoices, receipts, commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: • Final calculations showing estimated annual energy harvest along with a description of simulation methodology/software used • Final calculations of the renewable energy contribution to total energy use

Water

Water scarcity - including poor availability and quality - is a growing risk threatening both food and energy security of many countries in Southeast Asia. Several river basins in the country are expected to face acute stress or shortage by 2025, and groundwater sources are rapidly declining.

Even though Vietnam used to be considered as a country with high water availability with intensive river systems, it is now recognized that Vietnam has poor clean water resource, with only enough clean water to provide 4000 m^3/year/person, compared to the global average of 7000 m^3/year/person. Moreover, seasonal shortages have already worsened, especially around major metropolitan areas such as the Red river delta or big rice-producing areas like the Mekong delta due to high demand, water pollution and climate change impacts. Since these two river deltas are the country's premier rice-growing regions, water shortage threatens the nation’s food security.

As clean water becomes less readily available within Vietnam, the cost of this service is bound to increase in near future. Therefore, a water-efficient building not only ensures consistency in operation and production but also saves building owners money in operational costs. Furthermore, such building improvements will also help reduce the load on many of the antiquated sewage systems in urban areas of Vietnam.

Understanding the circumstance, LOTUS prioritizes the reduction of water consumption in the Water Category with credits encouraging the installation of water-efficient equipment, the use of water recovery solutions such as wastewater reuse/recycle and rainwater collection, landscape designs with low-water demand, and water metering.

Credit	Title	NR	Residential
W-PR-1	Water Efficient Fixtures	Prerequisite	Prerequisite
W-1	Water Efficient Fixtures	5 points	5 points
W-2	Water Efficient Landscaping	2 points	2 points
W-3	Water Metering	1 point	1 point
W-4	Sustainable Water Solutions	5 points	5 points
	Total of points available	13 points	13 points

W-PR-1 & W-1 Water Efficient Fixtures

Scope

W-PR-1 prerequisite and W-1 credit apply to NR and Residential projects.

Intent

To reduce the consumption of water in buildings by means of water efficient fixtures.

Requirements

NR & Residential (Prerequisite)

Criteria	PR
Reduce building domestic water consumption through fixtures by 20% in comparison to a baseline model	Water Prerequisite 1

NR & Residential (1-5 points)

Criteria	Points
Reduce building domestic water consumption through fixtures by 25% in comparison to a baseline model	1
1 point for every additional 5% reduction of the building domestic water consumption through fixtures (Up to 45%)	5

Overview

The world's fresh water is a finite resource that is becoming ever more increasingly polluted. It is inevitable that the total amount of clean water accessible to populations will be further reduced as a consequence of climate change and as these water resources become scarcer, the cost of domestic water will increase. Incorporating water use reduction measures into building designs can reduce this dependency on the ever-diminishing water supplies while reduce the operational costs.

Approach & Implementation

The following water fixtures can be used to reduce the water consumption within a building:

- Dual flush low flow WCs
- Low flow or waterless urinals
- Low flow aerated shower heads, kitchen and bathroom taps
- Standard low flow (not aerated) shower heads, kitchen and bathroom taps

Calculations

The aim of this calculation is to compare the building's water consumption through fixtures to a baseline model. The baseline annual water use should be calculated using values in tables W.1 to W.5. The tool 'LOTUS Calculator - Water Calculations' contains all the calculations and assumptions described below embedded into the tool and should be used instead of manually performing the calculations.

Table W.1: Daily fixture uses for office, hospitals & factory buildings
(Source: Default Fixture Uses, LEED Reference Guide for Green Building and Construction, 2009)

Fixture	Daily Fixture Uses		Duration of Use (flow fixtures)
	Full Time Occupants	Visitors	
WC - Single Flush (female)	3	0.5	-
WC - Dual flush (female)	1 full-flush / 2 half-flushes	0.1 full-flush / 0.4 half-flush	
WC - Single Flush (male)	1	0.1	-
WC - Dual flush (male)	1 full-flush	0.1 full-flush	
Urinal (male)	2	0.4	-
Lavatory Faucet	3	0.5	15 sec
Shower	0.1	0	300 sec
Kitchen Sink	1	0	15 sec

Table W.2: Daily fixture uses for residential & hotel buildings
(*Source: Default Fixture Uses, LEED Reference Guide for Green Building and Construction, 2009*)

Fixture	Daily Fixture Uses Per Occupant			Duration of Use (flow fixtures)
	Residents / Hotel Guests	Full Time Occupants	Visitors	
WC - Single Flush (female)	4	3	0.5	-
WC - Dual flush (female)	1 full-flush / 3 half-flushes	1 full-flush / 2 half-flushes	0.1 full-flush / 0.4 half-flush	
WC - Single Flush (male)	4	1	0.1	-
WC - Dual flush (male)	1 full-flush / 3 half-flushes	1 full-flush	0.1 full-flush	
Urinal (male)	0	2	0.4	-
Lavatory Faucet	7	3	0.5	Residents: 60 sec. Others: 15 sec
Shower	1	0.1	0	Residents: 480 sec. Others: 300 sec
Kitchen Sink	4	1	0	Residents: 60 sec. Others: 15 sec
Clothes washer	1 / living unit	0	0	

Table W.3: Daily fixture uses for educational buildings
(Source: Default Fixture Uses, LEED Reference Guide for Green Building and Construction, 2009)

Fixture	Daily Fixture Uses Per Occupant				Duration of Use (flow fixtures)
	Students (kindergarten and primary)	Students (secondary & post/secondary)	Full Time Occupants	Visitors	
WC - Single Flush (female)	3	1.5	3	0.5	-
WC - Dual flush (female)	1 full-flush / 2 half-flushes	0.5 full-flush / 1 half-flush	1 full-flush / 2 half-flushes	0.1 full-flush / 0.4 half-flush	
WC - Single Flush (male)	1	0.5	1	0.1	-
WC - Dual flush (male)	1 full-flush	0.5 full-flush	1 full-flush	0.1 full-flush	
Urinal (male)	2	1	2	0.4	-
Lavatory Faucet	3	1.5	3	0.5	15 sec
Shower	0	0	0.1	0	300 sec
Kitchen Sink	0	0	1	0	15 sec

Table W.4: Daily fixture uses for retail buildings
(Source: Default Fixture Uses, LEED Reference Guide for Green Building and Construction, 2009)

Fixture	Daily Fixture Uses Per Occupant			Duration of Use (flow fixtures)
	Retail Customers	Full Time Occupants	Visitors	
WC - Single Flush (female)	0.2	3	0.5	-
WC - Dual flush (female)	0.1 full-flush / 0.1 half-flush	1 full-flush / 2 half-flushes	0.1 full-flush / 0.4 half-flush	
WC - Single Flush (male)	0.1	1	0.1	-
WC - Dual flush (male)	0.1 full-flush	1 full-flush	0.1 full-flush	
Urinal (male)	0.1	2	0.4	-
Lavatory Faucet	0.2	3	0.5	15 sec
Shower	0	0.1	0	300 sec
Kitchen Sink	0	1	0	15 sec

Table W.5: Baseline fixtures water use (*Source: UPC and IPC Standards*)

Fixture	Fixtures Water Use
WC (single/dual flush)	6.0 liters per flush (lpf)
Urinal (flush)	3.79 lpf
Faucet (conventional)	0.14 l/s
Showerheads	0.16 l/s
Kitchen faucet	0.14 l/s
Clothes washer	120 l/load of 8kg

The following assumptions should be made when making the calculations of both baseline and design water uses:

- The gender ratio should be representative of the building occupancy, if this is not available, a ratio of one to one should be used
- The number of daily fixture uses and flow fixture use durations (in baseline case) should follow values in tables W.1 to W.4 according to the building type
- In case no urinals are available in the building, daily uses values for WCs (female) shall be considered for the male occupants.
- Full-time occupants are employees/staff in the building and their number should be calculated based on a daily occupancy of 8 hours. Part-time occupants should be given an equivalent 'full-time occupants' value based on the number of hours they spend in the building per day divided by 8
- In buildings with multiple shifts, use the number of full-time occupants from all shifts.
- Outpatients in health care facilities and customers in cafes and restaurants should be considered as visitors.
- Any occupants using the building for sleeping overnight (hotel guests, hospital inpatients, etc.) should be considered as residents.
- In case faucets with auto control are installed in the building, the baseline water use should be calculated with a 15 seconds duration of use and the design water use should be calculated with a 12 seconds duration of use.
- Kitchen faucets used exclusively for filling operations should not be considered
- Water fixtures do not include water-cooled HVAC and irrigation systems. Therefore, water consumption of these systems is not considered in this calculation.

For each type of occupancy in the project, and for both baseline and design cases, calculate the annual water consumption through fixtures with the following formulae:

$$\text{Annual Water Consumption Through Fixtures [L/year]} = [\sum(F \times Q_{flush} \times n \times P) + \sum(F \times Q_{flow} \times t_{flow} \times n \times P)] \times O$$

F = Proportion of fixtures

$$F = \frac{\text{Number of Fixtures with a Specific Flush/Flow Rate}}{\text{Total Number of Fixture of This Type}}$$

n = Number of daily uses per person per fixture type

P = Number of building occupants

Q_{flush} = Water used per flush for each type of flush fixture [lpf]

Q_{flow} = Flow rate per type of flow fixture [l/s]. At design stage, the flow rate value of fixtures should be based on pressure of 3 bars. At as-built stage, if flow rate measurements are performed during commissioning activities, actual flow rates can be used in calculations.

t_{flow} = Duration of use per type of flow fixture [s]

O = Number of operation days per year

Then, the total annual water consumption through fixtures is calculated as the sum of the annual water consumption through fixtures of all the different types of occupancy.

Finally, the reduction of water consumption through fixtures should be calculated as follows:

$$\text{Water Consumption Through Fixtures Reduction [\%]} = \left(1 - \frac{\text{Annual Water Consumption Through Fixtures (Design Case)}}{\text{Annual Water Consumption Through Fixtures (Baseline Case)}}\right) \times 100$$

Example of Calculation:

A building with an occupancy of 500 full-time occupants (gender ratio: 1 to 1) is equipped with the water fixtures in Table W.6. The building is operating 290 days during the year.

Table W.6: Example calculation - Building fixtures quantities and flow/flush rates

Fixtures in the building	Quantities of Fixtures	Fixtures Water Use
Urinals (flush)	3	3 lpf
WC Dual flush (male)	15	3.0 - 4.5 lpf
WC Single flush (male)	5	5 lpf
WC Dual flush (female)	18	3.0 - 4.5 lpf
WC Single flush (female)	6	5 lpf
Faucets	20	0.12 l/s
Faucets with auto-control	5	0.12 l/s during 12 sec
Showerheads	1	0.15 l/s

Table W.7: Example of calculation - Daily water use through fixtures calculation for baseline case

Fixtures Present in the Building	F	Q Flush/Flow	Number of Daily Uses (n)	Number of Occupants (P)	Daily Water Use Through Fixtures (L)
Urinal (flush)	1	3.79 lpf	2	250	1895
WC (male)	1	6 lpf	1	250	1500
WC (female)	1	6 lpf	3	250	4500
Faucets	1	0.14 l/s (15 sec)	3	500	3150
Showerheads	1	0.16 l/s (300 sec)	0.1	500	2400
Total daily water use through fixtures (liters)					13,445
Baseline total annual water use through fixtures (liters)					3,899,050

Table W.8: Example of calculation - Daily water use through fixtures calculation for the design case

Fixtures Installed	F	$Q_{Flush/Flow}$	Number of Daily Uses (n)	Number of Occupants (P)	Daily Water use Through Fixtures (L)
Urinal (Flush)	1	2 lpf	2	250	1000
WC Dual flush (male)	15/20	4.5 lpf	1	250	844
WC Single flush (male)	5/20	5 lpf	1	250	312.5
WC Dual flush (female)	18/24	$\left(\frac{2}{3}\times 3+\frac{1}{3}\times 4.5\right)$ lpf	3	250	1969
WC Single flush (female)	6/24	5 lpf	3	250	937.5
Faucet	20/25	0.12 l/s (15 sec)	3	500	2160
Faucet with auto-control	5/25	0.12 l/s (12 sec)	3	500	432
Showerheads	1	0.15 l/s (300 sec)	0.1	500	2250
Total daily water use through fixtures (liters)					9,905
Design total annual water use through fixtures (liters)					2,872,450

$$\text{Water Consumption Through Fixtures Reduction } [\%] = \left(1-\frac{2{,}872{,}450}{3{,}899{,}050}\right)\times 100 = 26.3\%$$

The building finally achieves a 26.3% reduction of the domestic water consumption through fixtures in comparison to a baseline model and 1 point can be awarded.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that building domestic water consumption through fixtures has been reduced by 50% in comparison to a baseline model.

Submissions

Provisional Certification Stage
• Tender schedule of all water fixtures to be installed indicating their flush/flow rates • Tender stage hydraulic plans and schematics indicating types of water fixtures • Tender stage specification extracts -OR- Manufacturer's published data of all water fixtures to be installed indicating their flush/flow rates • LOTUS Calculator - Water Calculations fully completed with all water fixtures to be installed and all types of occupants

Full Certification Stage
• Final schedule of all water fixtures installed indicating their flush/flow rates • As-built hydraulic plans and schematics indicating types of water fixtures • Manufacturer's published data of all the water fixtures installed indicating their flush/flow rates - OR - • Test measurements results indicating the flush/flow rates of all the water fixtures installed • Evidence showing that the water-efficient fixtures have been installed such as invoices, receipts, commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: • LOTUS Calculator - Water Calculations fully completed with all water fixtures proposed and all types of occupants

W-2 Water Efficient Landscaping

Scope

W-2 credit applies to NR and Residential projects.

Intent

To promote landscape designs which incorporate native species and limit the use of domestic water for irrigation.

Requirements

NR & Residential (1-2 points)

Only sites with a landscaped area which is greater than 100m^2 are eligible for this credit.

Criteria	Points
Reduce the amount of domestic water used for landscaping by 50% compared to benchmark consumption	1
Reduce the amount of domestic water used for landscaping by 80% compared to benchmark consumption	2

Overview

Irrigation can be a significant consumer of water on building sites. By reducing the irrigation requirements of landscape areas, the total water consumption of a building can be significantly reduced. Irrigation demand can be reduced by installing a xeriscape landscape and planting native species that are adapted to the local climate. Where irrigation is necessary, efficient irrigation techniques and technologies can be used. Alternatively, non-domestic water sources such as recycled water and harvested rainwater can be used for irrigation.

Xeriscaping is the preferred approach and has the following advantages:

- Reduced consumption of domestic or ground water
- Less maintenance required (irrigation not necessary, lawns don’t need to be cut)
- Xeriscape plants take full advantage of rainfall and thus reduce quantity of stormwater leaving the site
- Stormwater leaving the site can be of a higher quality

Approach & Implementation

The amount of domestic water used for irrigation can be reduced through a number of different strategies.

In this credit, applicants can demonstrate their reduction through any combination of the methods outlined in this section.

Xeriscape Landscape and Planting Native Species

Practices in this area can include:

- Plant native and/or climate adapted plants to reduce irrigation requirements. Some examples of drought resistant plants are:
  - Succulent plants: Cactus, Aloe, Euphorbiaceae family, etc.
  - Plants of Acacia genus: Acacia auriculiformis and Acacia mangiumare the two most popular species of the Acacia genus in Vietnam.
- Reduce lawn areas since lawn is usually a high consumer of water
- Mulch regularly. Mulching is an important part of xeriscaping as it helps the soil to retain moisture. Cover the surface around plants with composted leaves, coarse compost, bark, wood chips or gravel. Mulch also helps to stabilize soil temperature to protect the roots of plants from excessive heat
- Fertilize wisely
- Use the least toxic method of insect and disease control

Water Efficient Irrigation

Water efficient irrigation systems should be installed where possible; these can make significant water savings. Examples include:

- Drip or bubbler irrigation systems that apply water directly to the roots of plants. This strategy uses 30% to 50% less water than common sprinkler irrigation systems
- Irrigation systems fitted with either:
  - A manual timer with a maximum range of two hours; or
  - An automated timer, used with a soil moisture sensor or rain sensor to prevent the system operating during rain or where the soil already holds adequate moisture to sustain plant growth

Also, the following irrigation management principles can be followed:

- Conduct a vegetation survey for the building site. Based on the outcomes of the survey and knowledge of all plants' properties, a watering plan can be developed in order to reduce the amount of water used in irrigation. A precise watering schedule will help to reduce total water consumption
- Water at a rate so that it does not pond, pool or run off

- Do not water when the soil is already adequately moist to sustain plant growth, whether as a result of rain or other watering
- Water in such a manner so that it does not fall on buildings or hard surfaces
- Do not water in windy conditions where the distribution pattern of the irrigation systems will be affected
- Only water gardens that are sufficiently mulched to reduce evaporation

Irrigation with recycled, reused water and/or harvested rainwater

Recycled, reused water and/or rainwater collection systems can also be integrated in the building water system and can then be used for irrigation of the building landscape. However, before using recycled, reused water or rainwater to water plants, toxic contaminants should be filtered out. Soap and other cleaning substances should be carefully chosen; they should be environmentally friendly, biodegradable and cause no damage to plants.

The quality of the water used for irrigation should meet the requirements of QCVN 39:2011/BTNMT National technical regulation on Water Quality for irrigated agriculture.

Calculation

The irrigation demand of the landscape area can be demonstrated using irrigation demand calculations.

The total irrigation demand for the landscaped area can be calculated using the following equation. The demand should be calculated for each different type of vegetation within the landscape (e.g. lawn, shrubs, trees etc.) and then summed together. The tool 'LOTUS Calculator - Water Calculations' contains these calculations embedded into the tool and it is advised to use it instead of manually performing the calculations.

$$\text{Total annual Irrigation Demand}\left[\frac{\text{m}^3}{\text{year}}\right] = \sum_{\text{i=1}}^{\text{n}} \text{Irrigation Demand}_{\text{ i}}$$

$$\text{Annual Irrigation Demand}_{\text{ i}}{}^{*}\left[\frac{\text{m}^3}{\text{year}}\right] = \text{Area}_{\text{ i}} \times \sum_{\text{m=1}}^{12}\left(\frac{\text{ET}_{0\text{ m}} \times \text{Ks}_{\text{i}} \times \text{Kd}_{\text{i}} \times \text{Km}_{\text{i}}}{1000 \times \text{IE}_{\text{i}}} - \frac{\text{E}_{\text{rain m}}}{1000}\right)$$

* If the calculation of the irrigation demand of an area during a month gives a value lower than zero, the irrigation demand of that area during that month must be taken as zero in the total annual irrigation demand calculation.

Where:

Total landscaped area is split into *n* different sub-areas each with different landscape characteristics

Irrigation demand $_i$ = Irrigation demand for the soft landscape *i*

Area $_i$ = Area of the soft landscape *i* (m^2),

$ET_{0\,m}$ = Average monthly reference evapotranspiration value (mm/month) of the month m

Ks_i = Species factor specific for sub-area *i* (for the purposes of this calculation *Ks* for all native species can be considered as "low")

Kd_i = Density factor specific for sub-area *i*

Km_i = Microclimate factor specific for sub-area *i* (e.g. well shaded and sheltered area *Km* - "low", area exposed to full sun and wind - "high")

IE_i = Irrigation efficiency factor specific for sub-area *i* (e.g. drip irrigation IE = 0.9, sprinkler IE = 0.625, xeriscape garden with no irrigation IE = 1)

$E_{rain\,m}$ = Monthly effective rainfall of the month *m* (mm). The effective rainfall refers to the percentage of rainfall which becomes available to plants and can be calculated with the following formula:

$$\text{Monthly effective rainfall of the month } m \text{ (mm)} = \sum_d (Daily\ rainfall_d - 5) \times 0.75$$

Daily $rainfall_d$ is the rainfall of the day d.
Where daily rainfall data is unavailable, monthly rainfall data can be divided by the number of rainy days to give an average daily rainfall to be used in this equation.
If the landscape *i* is sheltered or partly sheltered from rainfall, apply a percentage to lower the amount of effective rainfall for the landscape *i*.

Typical values for these parameters are included in Table W.9.

Table W.9: Standard values for species, density and microclimate factors of vegetated areas (Source: LEED Reference Guide for Green Building and Construction, 2009)

Vegetation Type	Species Factor (Ks)			Density Factor (Kd)			Microclimate Factor (Km)		
	Low	Average	High	Low	Average	High	Low	Average	High
Trees	0.2	0.5	0.9	0.5	1.0	1.3	0.5	1.0	1.4
Shrubs	0.2	0.5	0.7	0.5	1.0	1.1	0.5	1.0	1.3
Groundcover	0.2	0.5	0.7	0.5	1.0	1.1	0.5	1.0	1.2
Lawn	0.55	0.7	0.8	0.6	1.0	1.0	0.8	1.0	1.2

The irrigation demand should then be converted to a demand per square meter of landscaped area using the following equation:

$$\text{Annual Irrigation Demand } /\text{m}^2 = \frac{\text{Irrigation Demand } (\text{m}^3/\text{year})}{\text{Soft Landscape Area } (\text{m}^2)}$$

The soft landscape (excluding hard areas) water demand benchmark for Vietnam is = 1.1 m^3/m^2/year.

Soft landscape water consumption can then be compared to this benchmark value by using the following steps:

1. Determine the soft landscape areas
2. For each soft landscape area, determine the annual irrigation demand by following the irrigation demand calculation method
3. Calculate the total annual irrigation demand of the site
4. Calculate the total annual irrigation demand of the site per square meter of landscaped area (Annual Irrigation Demand / m^2)
5. Calculate irrigation demand savings using the following equation:

$$\text{Irrigation Demand Reduction } [\%] = \left(1 - \frac{\text{Annual Irrigaton Demand/m}^2}{1.1\ \text{m}^3/\text{m}^2/\text{year}}\right) \times 100$$

Example of calculation:

A building's landscape in Ho Chi Minh City (ET_0 and E_{rain} values as per Table W.10) includes a 60 m^2 area of native trees, a 60 m^2 area of native shrubs, a 40 m^2 area of native groundcover and a 40 m^2 of a non-native lawn with an average species factor. All the vegetation areas are irrigated by a drip system. For Ho Chi Minh City, the annual effective rainfall is 854 mm.

Table W.10: Monthly ET_0 and E_{rain} values for Ho Chi Minh City

Ho Chi Minh City	Mth 1	Mth 2	Mth 3	Mth 4	Mth 5	Mth 6	Mth 7	Mth 8	Mth 9	Mth 10	Mth 11	Mth 12
ET_0 (mm)	120	135	145	147	136	120	118	114	112	107	106	104
E_{rain} (mm)	0.0	0.0	2.6	18.0	88.5	137.3	144.4	126.8	141.0	139.9	55.9	0.0

Table W.11: Example of calculation - standard values for species, density and microclimate factors of vegetated areas

Vegetation Type	Landscape Area (m^2)	Species Factor (Ks) *low except lawn (average)*	Density Factor (Kd) *average*	Microclimate Factor (Km) *average*	Irrigation Efficiency (IE) *drip on lawn*	Annual Irrigation Demand (m^3)
Trees	60	0.2	1.0	1.0	0.9	7.44
Shrubs	60	0.2	1.0	1.0	0.9	7.44
Groundcover	40	0.2	1.0	1.0	0.9	4.96
Lawn	40	0.7	1.0	1.0	0.9	21.18
Total	200					41.03

$$\text{Annual Irrigation Demand / m}^2 = \frac{41.03\ \text{m}^3/\text{year}}{200\ \text{m}^2} = 0.205\ \text{m}^3/\text{m}^2/\text{year}$$

$$\text{Irrigation Demand Reduction [\%]} = \left(1 - \frac{0.205\ \text{m}^3/\text{m}^2/\text{year}}{1.1\ \text{m}^3/\text{m}^2/\text{year}}\right) \times 100\% = 81.4\%$$

Based on this calculation, 2 points can be awarded for an 81.4% reduction in landscape irrigation consumption compared to the benchmark consumption.

Submissions

Provisional Certification Stage
• Landscape plan outlining the proposed landscape design and irrigated areas • List of all plants with Latin name, Vietnamese name, information about whether species is native, locally adapted or introduced and estimated number of individuals per species (trees) and/or coverage (grasses - m^2) • Calculations of the annual irrigation demand reduction compared to the benchmark • If using water efficient irrigation equipment, description of all proposed water saving irrigation fixtures and drawings showing location. • If using water recycling, reuse or water harvesting, schematic drawings of proposed reticulation network

Full Certification Stage
• As-built landscape plan outlining the landscape design and irrigated areas • If using water efficient irrigation equipment, evidence such as photographs, invoices, receipts, commissioning report, etc. showing installation and location of all installed water saving irrigation fixtures • If using water recycling, reuse or water harvesting, as-built drawings of the reticulation network
If not already approved at Provisional Certification or if there is any change: • List of all plants with picture/photo, Latin name, Vietnamese name, information about whether species is native, locally adapted or introduced and estimated number of individuals per species (trees) and/or coverage (grasses - m^2) • Final Calculations of the annual irrigation demand reduction compared to the benchmark

W-3 Water Metering

Scope

W-3 credit applies to NR and Residential projects.

Intent

To meter water uses and find opportunities to reduce water consumption in the building.

Requirements

NR & Residential (1 point)

Criteria	Points
Install water meters for all major water flows	1

Overview

Water metering is the installation of water meters for all major water flows (supply and use) in the project. It can help buildings to identify their water use patterns and to find opportunities to reduce their water consumption.

Approach & Implementation

The following major water flows must have their water consumptions monitored individually with permanent water meters, as applicable to the project:

- Total domestic water use (for the whole building and associated site)
- Indoor water fixtures
- Irrigation
- Cooling towers
- Recycled / reused wastewater
- Harvested rainwater / stormwater
- Other major process water uses

Where a water flow can be determined as the difference between a main meter (e.g. measuring the total domestic water use) and a number of other sub water meters, projects do not need to install a water meter for this water flow.

In the case that one of the major water flows listed above has a low water consumption, projects may not need to install water meters. This shall be subject to VGBC approval.

Residential projects

Residential projects need to meter water flows in common areas only. Water consumption in the dwelling-units doesn't have to be monitored.

The information collected with the meters should be used to keep track of water usage in the building, create monthly and annual summaries, and identify unusual water use.

Submissions

Provisional Certification Stage
• Report detailing the Water Monitoring strategy • Tender stage hydraulic plans and schematic drawings showing location of all water meters

Full Certification Stage
• As-built hydraulic plans and schematic drawings showing location of all water meters • Evidence of all meters installed such as photographs, invoices, commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: • Final report detailing the Water Monitoring strategy

W-4 Sustainable Water Solutions

Scope

W-4 credit applies to NR and Residential projects.

Intent

To encourage the implementation of sustainable solutions as a means to reduce domestic water consumption.

Requirements

NR & Residential (1-5 points)

Criteria	Points
Strategy A: Water recycling/reuse/harvest	
Recycled, reused or harvested water contributes to 10% of the project's total water consumption	1
1 point for every additional 10% contribution of recycled, reused or harvested water to the project's total water consumption (Up to 50%)	5
Strategy B: Swimming Pool Water Efficiency	
Implement strategies to reduce water use for swimming pools	1
Strategy C: Cooling Tower Water Efficiency	
The cooling tower system is designed to operate at 6 or more cycles of concentration at acceptable water quality	1
Strategy D: Drinking Water	
Provide a drinking water filtration system	1

Overview

Strategy A: Water recycling/reuse/harvest

Water recycling/reuse/harvest can save the amount of domestic water used for toilet flushing, irrigation and/or cooling tower makeup and reduce the amount of wastewater delivered to water treatment facilities.

Black water is the untreated wastewater coming from toilets, kitchen taps or industrial waste, while gray water corresponds to all the other forms of wastewater. Gray water includes used water discharged from bathtubs, showers, wash basins and laundries (Figure W.1). This water has the potential to be reused or recycled within a building and its site.

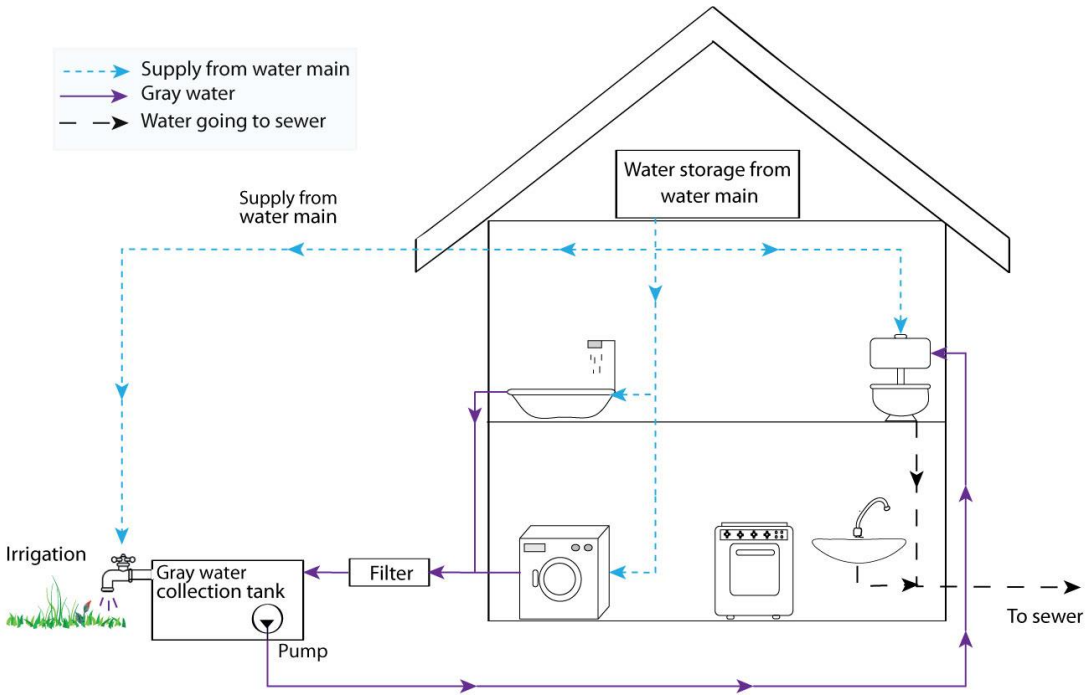

Figure W.1: Gray water harvesting system

Rainwater harvesting refers to the collection and storage of rain. Collection is usually from rooftops and channeled to storage tanks (Figure W.2). Stored water can be used for non-potable purposes such as irrigation, washing or toilet flushing. Rainwater harvesting systems can range from a simple barrel at the bottom of a down pipe to multiple tanks with pumps and controls.

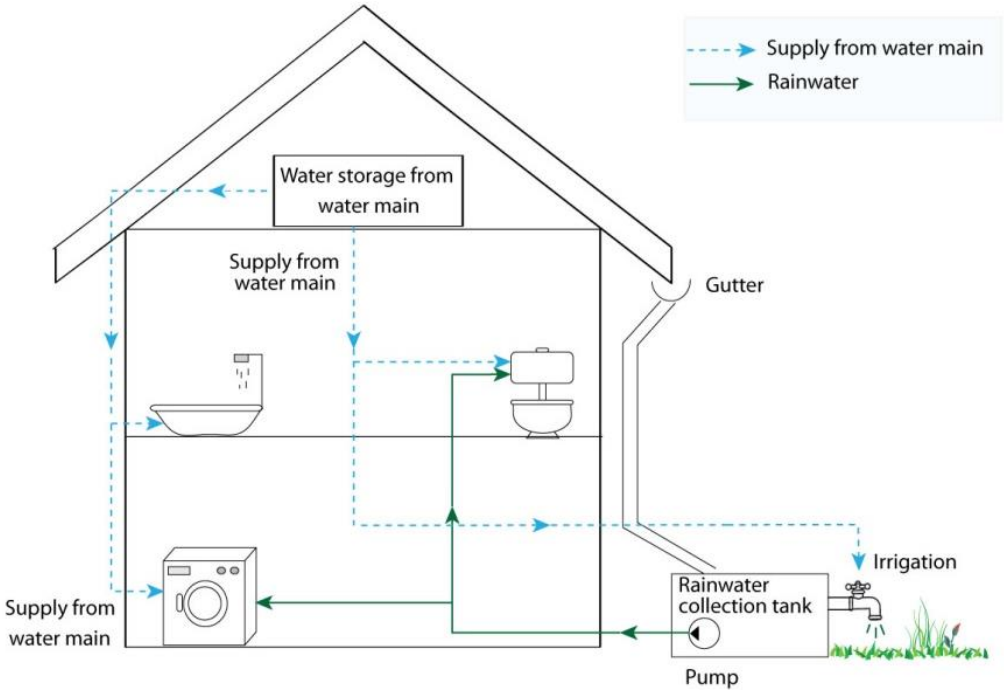

Figure W.2: Rainwater harvesting system

HVAC condensate is produced by air-conditioning systems as they remove moisture from the air during the cooling process. This water is most of the time discarded and sent to sewer. However, especially in hot and humid climates, a large amount of condensate water can be produced and, as it is considered good water (as pure as distilled water, low in mineral content), it can be recovered and used for many applications.

Strategy B: Swimming Pool Water Efficiency

Swimming pools can be major water users. Indeed, big amounts of water are required to fill the volume of a pool and water loss can be substantial because of evaporation, splashing, leaks or filtering.

Strategy C: Cooling Tower Water Efficiency

Cooling towers dissipate heat from recirculating water used to cool chillers or air conditioners to the ambient air. Heat is rejected to the environment from cooling towers through the process of evaporation. By design, cooling towers use significant amounts of water through:

- Evaporation: water evaporated to reject heat from the cooling tower system
- Drift: water droplets carried out of the cooling tower with the exhaust air
- Blowdown: water removed to maintain the dissolved solids concentration at an acceptable level in the circulating water system.

Strategy D: Drinking Water

Municipal tap water can contain many kinds of contaminants such as dissolved metals (including lead and iron), nitrates, chlorine and mineral salts. It can also contain other undesirable substances such as sulfates, mercury, asbestos and arsenic.
Installing a proper drinking water filtration system can help to provide clean drinking water to occupants and reduce the use of plastic water bottles and the environmental impact associated to their production and transportation.

Approach & Implementation

Strategy A: Water recycling/reuse/harvest

Gray water Recycling and Reuse:

Gray water reuse can occur with or without purification. When the gray water is being collected but is not subject to purification, the following strategies can be used to capture and reuse gray water:

- Install a gray water diversion system directing water from shower drains, bathtubs and laundries to gardens for irrigation or to WCs for flushing. A simple filter is needed to remove suspended solids

- Install a gray water diversion system which directs wastewater through a filtration system (to remove suspended solids and contaminants) to a storage tank. Gray water is recommended not to stay in the storage tank longer than 24 hours to avoid damaging storage equipment

If gray water is to be purified for use in domestic water systems, the following strategies can be applied:

- Mechanical treatments: sand filtration, activated carbon filtration, ultraviolet light or ozone disinfection techniques can be implemented to remove pathogens
- Biological treatments: plant systems (e.g. treatment ponds, constructed wetlands, living walls, biofiltration swales) and compact systems (e.g. activated sludge systems, aerobic and anaerobic bio-filters, submerged aerated filters)

Any basic gray water system should ensure that gray water is tightly controlled and not mixed with clean/domestic water and black water. Measures such as storage tanks, color-coded piping, filters, pumps, valves, and controls should be clearly defined.

Black water Recycling and Reuse:

Black water is more difficult than gray water to process as it requires a combination of physical, biological and chemical treatment and disinfection before use.
A normal black water treatment would require four stages:

- The removal of solid objects, sand, gravel, and other heavy material from the water
- A primary treatment separating solids and greases
- A secondary treatment removing dissolved organic material from wastewater
- Tertiary disinfection to kill harmful micro-organisms

Rainwater harvesting:

Rainwater can be collected from impervious surfaces to reduce rainwater runoff and control infrastructure demands. Rainwater can be stored in storage tank(s) for non-potable use. Air pollution can contaminate rainwater with pollutants which can potentially damage storage tanks and plumbing systems. In this case, rainwater should be filtered before entering the tanks. Instead of a filtration system, a mechanism where the initial water flow is sent to waste by a diverter can be used to minimize contamination of storage supply, since airborne pollutants and pollutants on the collection surface are usually washed away by the initial rainfall. In such case, simple but regular inspection and maintenance of the mechanism is necessary.

Harvested rainwater can only be reused if there is sufficient storage available. Designers are encouraged to undertake a water balance based on daily or monthly rainfall and demand data for a period of at least one year to appropriately size the storage tank.

HVAC condensate harvesting:

HVAC condensate can be recovered and used without treatment for cooling tower makeup, industrial process makeup or drip irrigation.
As condensate may contain bacteria, untreated condensate should be handled in a manner to eliminate any possibility of creating aerosols that can be inhaled by humans. As such, condensate water can be used for flushing toilets or lawn sprinklers only if filtered and disinfected first.

Water recycling, reuse and harvest:

To ensure that the uses associated with recycled, reused or harvested water are always supplied (e.g. so that the tanks can continuously discharge), the systems should be complemented by another source of water supply.

Review and control of sanitary risk must be conducted at appropriate intervals to avoid the generation of pathogenic micro-organisms.

Recycled, reused or harvested water must comply at the point of delivery with minimum quality requirements of national or international standards, such as:

- QCVN 39:2011/BTNMT National technical regulation on Water Quality for irrigated agriculture
- QCVN 02:2009/BYT National technical regulation on domestic water quality
- NSF/ANSI Standard 350: On-site Residential and Commercial Water Reuse Treatment Systems

<u>Strategy B: Swimming Pool Water Efficiency</u>

Implement 2 of the following strategies to reduce water consumption for swimming pools:

- Reduce evaporation with the installation of a pool cover. The pool should be covered anytime it is not being used.
- Use more water efficient filter systems such as cartridge filters which do not need backwashing. If sand filter is used, a pressure drop sensor should be installed in order to know when backwash is needed, and the backwash water should be reused to water plants or for any other beneficial use.

- Monitor pool filling to be able to detect leaks (when a sharp increase of the amount of water needed to fill the pool is noticed.)
- Other strategies may be applied but shall be subject to VGBC approval

Also, to be awarded points with Strategy B, projects must meet following requirements:

- Maximum depth of swimming pool for adults: 2 meters
- Maximum depth of swimming pool for kids: 1.3 meters

Strategy C: Cooling Tower Water Efficiency

The cycles of concentration of a cooling tower represents the accumulation of dissolved solids in the recirculating cooling water. Water blowdown is used to control the build-up of these solids which can cause scale (deposit minerals) and corrosion problems.

The number of cycles of concentration is calculated as the ratio of the concentration of dissolved solids in the blowdown water compared to the make-up water. Also, because dissolved solids enter the system in the make-up water and exit the system in the blowdown water, the cycles of concentration are approximately equal to the ratio of volume of make-up to blowdown water.

By maximizing cycles of concentration, the quantity of blowdown water will be minimized and make-up water demand will be reduced. However, it is only possible to increase the number of cycles of concentration within the constraints of the make-up water and cooling tower water chemistry (amount of dissolved minerals).

First step to maximize the number of cycles of concentration is to determine the maximum cycles of concentration the cooling tower system can safely achieve. Then different strategies can be used to allow and to maintain the system running at higher cycles of concentration:

- Treatment of the make-up water: use of corrosion and scaling inhibitors, acid treatment, installation of a softening system, etc.
- Filtration and ultrafiltration of the recirculating water
- Installation of a conductivity controller to automatically control blowdown

Strategy D: Drinking Water

Install a proper drinking water filtration system to get clean drinking water complying with requirements of QCVN 01:2009/BYT National technical regulation on drinking water quality.
A drinking water filtration system including filters such as sediment filters, reverse-osmosis filters, ultrafiltration (UF) filters and activated carbon filters is advised.

Access to drinking water should be provided through fountain taps located at each occupied floors of the building in the common areas.

Calculations

Strategy A: Water recycling/reuse/harvest

The volume of harvested water, recycled water and reused water should be estimated using reasonable assumptions.

The tool 'LOTUS Calculator - Water Calculations' contains calculations embedded into the tool and projects are encouraged to use it instead of manually performing the calculations.

Gray and Black water recycling and reuse:

If the volume of recycled and reused water is estimated, the calculation should be the same as the calculation of the annual domestic water use in Credit W-1, except that only the fixtures connected to gray or black water collection system are included in the calculation.

To use the following equation, projects should demonstrate that the storage tank is properly sized to provide a balance between supply and demand.

$$\text{Annual Water Collected [L/year]} = [\sum(F \times Q_{flush} \times n \times P) + \sum(F \times Q_{flow} \times t_{flow} \times n \times P)] \times O$$

F = Proportion of fixtures

$$F = \frac{\text{Number of Fixtures with a Specific Flush/Flow Rate}}{\text{Total Number of Fixtures of This Type}}$$

n = Number of daily uses per person per each fixture type

P = Number of building occupants

Q_{flush}= Water used per flush for each type of flush fixture [L]

Q_{flow}= Flow rate of flow type fixture [L/s]

t_{flow} = Time of use of flow type fixture [s]

O = Number of operation days during the year

** Fixtures concerned in this calculation must be connected to a gray/black water collection system*

The water collected will have to pass through different treatment systems, from simple filtration to comprehensive treatment, depending on where it will be used. During the treatment process some water will be lost, therefore, the amount of water collected that will be actually used should be calculated using the coefficient of water efficiency of the treatment method.

$$\text{Annual Water Collected Actually Used for a Demand [L/year]}$$
$$= E_t \times \text{Annual Water Collected Distributed Towards a Demand [L/year]}$$

E_t = Water efficiency of the treatment system (amount of water out/amount of water in)

Rainwater harvesting:

As not all collected rainwater is reused due to storage limitations, it is necessary to determine the amount of rainwater that is actually used. This should be done by calculating a water balance for the building's collection and consumption for at least 12 months based on the storage volume and average or recorded rainfall data.

To estimate the amount of harvested rainwater that will be used on the project, applicants can use either the LOTUS Calculator - Water Calculations or their own method that shall be subject to VGBC approval.

HVAC condensate harvesting:

To estimate the amount of HVAC condensate that can be harvested and used on the project, applicants can use either the LOTUS Calculator - Water Calculations or their own method that shall be subject to VGBC approval.

Total water recycled, reused or harvested:

In order to calculate the proportion of total water consumption supplied by harvested water, recycled water or reused water, this value should be compared to the total water consumption of the project.

$$\text{Water recycled, reused or harvested [\%]} = \frac{\text{Annual Recycled, Reused and Harvested Water Used}}{\text{Annual Water Consumption}} \times 100$$

Where:

$$\text{Annual Water Consumption [L/year]} = \text{Annual Water Use through fixtures} + \text{Annual Water Use for irrigation} + \text{Annual Water use for cooling towers} + \text{Annual Water use for other needs}$$

With:

- Annual Water Use through fixtures equal to the design water use through fixtures as calculated in W-1 Water Efficient Fixtures credit.
- Annual Water Use for irrigation equal to the annual irrigation demand calculated in W-2 Water Efficient Landscaping credit.

- Annual Water use for cooling towers equal to the annual amount of water consumed through cooling towers (calculated in the LOTUS Calculator - Water Calculations or estimated by the project)
- Annual Water use for other needs equal to the annual amount of water consumed through all other needs (estimated by the project)

Strategy C: Cooling Tower Water Efficiency

Cycles of concentration can be calculated using system flow rate measurements or by chemical measurements.

With water flow meters installed on the makeup and blowdown lines, the cycles of concentration can be calculated with the following formula:

$$\text{Cycles of concentration} = \frac{\text{Makeup water flow}}{\text{Blowdown water flow}}$$

Measuring the conductivity or the chloride concentration in the makeup water and the tower water, the cycles of concentration can be calculated with the following formula:

$$\text{Cycles of concentration} = \frac{\text{Tower Water Conductivity (or Chloride content)}}{\text{Makeup Water Conductivity (or Chloride content)}}$$

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates through Strategy A that recycled, reused or harvested water contributes to more than 60% of the project's total water consumption.

- AND/OR -

One point in EP-1 can be awarded if the project demonstrates that at least 6 points can be achieved under the 4 Strategies of the credit.

Submissions

Provisional Certification Stage
Strategy A: Water recycling/reuse/harvest
• Report describing and detailing the proposed strategy of water recycling/reuse and/or water harvesting system including collection, distribution and storage • Hydraulic plans and schematics of the proposed gray and black water system and/or rainwater harvesting system, including collection distribution and storage • LOTUS Calculator - Water Calculations fully completed to include water recycling, reuse and/or water harvesting

Strategy B: Swimming Pool Water Efficiency
• Report describing the strategies to be implemented to reduce water use for swimming pool and showing the depth of swimming pools. Depending on the strategies implemented: • Technical specifications showing the type of filter to be installed or showing that a pressure drop sensor is to be installed • Hydraulic plans and schematic drawings showing location and type of water meter for the monitoring of the water used for swimming pool.
Strategy C: Cooling Tower Water Efficiency
• Technical specifications for the cooling tower and treatment/filtration systems to be installed. • Report describing the strategies to be implemented to maximize cycles of concentration without compromising water quality and operational performance • Hydraulic plans and schematic drawings showing design and location of the cooling tower and the treatment/filtration systems
Strategy D: Drinking Water
• Evidence showing the future installation of a drinking water filtration system such as tender specifications, signed supply and installation contract, design document, etc.

Full Certification Stage
Strategy A: Water recycling/reuse/harvest
• As-built hydraulic plans and schematics of the water recycling/reuse system and/or water harvesting system, including collection distribution and storage • Evidence showing main equipment and components installed such as photographs, invoices, etc.
If not already approved at Provisional Certification or if there is any change: • Final report describing and detailing the strategy of gray/black water recycling/reuse and/or water harvesting system including collection, distribution and storage • LOTUS Calculator - Water Calculations fully completed to include water recycling, reuse and/or water harvesting
Strategy B: Swimming Pool Water Efficiency
• Evidence showing equipment installed (pool cover and/or filters and/or pressure drop sensor and/or water meter) and the depth of swimming pools such as photographs, invoices, etc. • As-built stage hydraulic plans showing location and type of water meter for the monitoring of the water used for swimming pool.
If not already approved at Provisional Certification or if there is any change: • Final report describing the strategies implemented to reduce water use for swimming pool.
Strategy C: Cooling Tower Water Efficiency
• As-built hydraulic plans and schematic drawings showing design and location of the cooling tower and the treatment/filtration systems • Onsite testing report showing the cycles of concentration achieved • Operation and maintenance manual indicating the procedures for operation, adjustment and maintenance of the cooling tower water treatment system

If not already approved at Provisional Certification or if there is any change: • Final report describing the strategies to be implemented to maximize cycles of concentration without compromising water quality and operational performance
Strategy D: Drinking Water
• Manufacturer's published data showing the types of filters contained in the water filtration system • Evidence showing that the drinking water filtration system and the fountain taps have been installed such as photographs, invoices, receipts, etc. • Test report showing water quality measurements and indicating that the drinking water complies with QCVN 01:2009/BYT requirements.

Materials & Resources

With one of the fastest urbanization rates in the world and a population living in urban areas that reached 34.24% in 2016 (World Bank), construction sites are rising in all corners of Vietnam and the demand of construction materials is continuously increasing.

During the lifecycle of any construction material, its extraction, processing, transportation, use and disposal can have negative effects on the environment. Especially, the acquisition of virgin material destroys natural habitats, pollutes air and water, and depletes energy and natural resources. Therefore, to mitigate the negative impacts of construction on the natural environment, usage of materials produced from virgin sources must be limited.

Also, Vietnam's urban areas generate over 11 million tonnes of solid waste per year, of which 84% is collected and treated (report from the Centre for Environmental Monitoring Portal under the Vietnam Environment Administration, 2014). This means almost 2 million tonnes of untreated solid waste is released into the environment each year.

The Materials & Resources Category of LOTUS includes three main goals which are to reduce the amount of virgin natural resources used, to promote the use of low-energy embodied materials, and to reduce the amount of waste generated. To achieve the goals, credits within this category encourage the reuse and recycling of building materials, and the use of recycled materials, materials from sustainable sources and unbaked materials.

Credit	Title	NR	Residential
MR-1	Reduced Concrete Use	2 points	2 points
MR-2	Sustainable Materials	5 points	5 points
MR-3	Non-Baked Materials	2 points	2 points
MR-PR-1	Demolition and Construction Waste	Prerequisite	Prerequisite
MR-4	Demolition and Construction Waste	2 points	2 points
MR-5	Operation Waste Management	1 point	2 points
	Total of points available	12 points	13 points

MR-1 Reduced Concrete Use

Scope

MR-1 credit applies to NR and Residential projects.

Intent

To encourage projects to consider and implement strategies that minimize the use of concrete in buildings.

Requirements

NR & Residential (1-2 points)

Criteria	Points
Strategy A: Reduce concrete usage for slabs	
Design and construct slabs that reduce concrete use	1
Strategy B: Reduce concrete usage for beams and columns	
Design and construct beams and columns that reduce concrete use	1
Strategy C: Reduce concrete usage for non-structural systems	
Design and construct non-structural systems that reduce concrete use	1

Overview

Concrete is the most commonly used man-made material on earth. It is used extensively in buildings mainly as it is durable, affordable and strong. However, the use of concrete causes some significant environmental impacts in terms of CO_2 emissions, embodied energy consumption and natural resources depletion.

Through efficient building design and innovative solutions, it is possible to reduce concrete use without compromising on construction safety and productivity. Some of these solutions can even reduce floor-to-floor height and thus building height leading to further savings in materials.

Approach & Implementation

Strategy A: Reduce concrete usage for slabs

One-story buildings are not eligible to follow this strategy and slab foundations should not be considered in this strategy.

Design and construct slabs of any of the following types:

- pre-stressed slabs which have longer spans and/or reduced depths thanks to the strengthening of concrete. It is important to note that pre-stressing requires specialized expertise and a high level of quality control and inspection.
- voided slabs which are a form of structural slab system in which voids are introduced to reduce the concrete usage. There are in general two types of voided slab: hollow-core slabs (precast concrete slabs with repetitive-shaped voids) and biaxial voided slab (structural slabs where voids are introduced using spherical or torus hollow shells).
- ribbed slabs which are made up of wide band beams running between columns with narrow ribs spanning the orthogonal direction.
- waffle slabs which have a thin topping slab and narrow ribs spanning in both directions between column heads or band beams.
- steel-concrete composite slabs which comprise reinforced concrete cast on top of profiled steel decking.
- high strength concrete slabs. High strength concrete is a type of specially designed concrete mix which achieves a compressive strength of more than 60N/mm^2.

Major refurbishment projects that reuse existing slabs are also compliant.

Strategy B: Reduce concrete usage for beams and columns

Design and construct any of the following solutions:

- pre-stressed beams and columns which have longer spans and/or reduced width thanks to the strengthening of concrete.
- structural steel beams and columns
- steel-concrete composite beams and columns
- high strength concrete beams and columns

Major refurbishment projects that reuse existing columns and beams are also compliant.

Strategy C: Reduce concrete usage for non-structural components

90% of the non-structural interior walls installed should be of any of the following types:

- Drywall partitions
- Engineered wood wall panels
- Glass partitions

- AND -

90% of the non-structural exterior walls installed should be of any of the following types:

- Curtain walls (with glass, spandrel glass, stone veneer, aluminium, etc.)
- Metal building walls
- Sandwich wall panels

Major refurbishment projects that reuse existing non-structural walls are also compliant.

Calculation

Strategy C: Reduce concrete usage for non-structural components

The following calculation method should be followed to demonstrate that more than 90% of non-structural interior walls and more than 90% of non-structural exterior walls are compliant.

Calculation is based either on volume (m^3) or on area (m^2).
Percentage of compliant non-structural walls should be calculated by the following method:

- Quantify the volume or area of non-structural walls and required in the project
- Quantify the volume or area of compliant non-structural walls
- Demonstrate the percentage of compliant non-structural walls with the following formulae:

$$\text{Compliant non} - \text{structural interior walls } [\%] = \left(\frac{\text{IW}_\text{C}}{\text{IW}_\text{tot}}\right) \times 100$$

IW_c = Volume or area of compliant non-structural interior walls [m^3 or m^2]

IW_{tot} = Total volume or area of non-structural walls interior in the project [m^3 or m^2]

$$\text{Compliant non} - \text{structural exterior walls } [\%] = \left(\frac{\text{EW}_\text{C}}{\text{EW}_\text{tot}}\right) \times 100$$

EW_c = Volume or area of compliant non-structural exterior walls [m^3 or m^2]

EW_{tot} = Total volume or area of non-structural walls exterior in the project [m^3 or m^2]

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that the requirements set in the 3 Strategies of the credit have been met.

Submissions

Provisional Certification Stage
For each of the strategies targeted:
• Report detailing all the design solutions to reduce concrete use • Tender detail drawings and/or Tender specification extracts showing the solutions designed to reduce concrete use

Full Certification Stage
For each of the strategies targeted:
• Technical data of the building systems installed • Evidence showing the building systems installed such as-built drawings, photographs, invoices, receipts, etc.
If not already approved at Provisional Certification or if there is any change: • Final report detailing all the solutions that have been used to reduce concrete use

MR-2 Sustainable Materials

Scope

MR-2 credit applies to NR and Residential projects.

Intent

To encourage projects to use sustainable materials minimizing the use of natural resources.

Requirements

NR & Residential (1-5 points)

This credit is only available at Full Certification.

Criteria	Points
10% of the total value of the materials in the project is from sustainable materials	1
1 point for every additional 5% of the total value of the materials that is from sustainable materials (up to 30%)	5

Overview

With building construction consuming about 40% of the world's raw materials, the environmental impacts associated with the extraction, harvest, manufacturing and transportation of building construction materials are significant.

Sustainable materials are construction materials that minimize the use of natural resources (through reuse or recycling) or that are made from sustainable natural resources. They help to reduce the environmental impacts associated with extraction and processing of virgin resources.

Approach & Implementation

All building materials or products are considered, excluding mechanical, electrical and plumbing equipment such as HVAC systems, water fixtures, elevator systems, etc.

Select sustainable materials among the following list:

- Reused materials which are materials that have been salvaged, refurbished or reused.
- Materials with recycled content which are materials with a proportion of recycled materials. ISO 14021 defines recycled content as "the proportion, by mass, of recycled materials in a product or packing". Only pre-consumer and post-consumer materials shall be considered as recycled content where:

- A pre-consumer material is a material diverted from waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.
- A post-consumer material is a material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

- Rapidly renewable materials which are natural building materials planted and harvested within a 10-year cycle. The following is a partial list of rapidly renewable materials which can be used: Bamboo, Cork, Coconut, Reed, Straw board, etc.
- Sustainable timber which is timber coming from sustainable sources, preferably accredited by the Forest Stewardship Council in Vietnam (FSC), Malaysia Tiber Certification Council (MTCC) or other.
- Materials third-party certified based on whole lifecycle analysis (LCA), such as Global GreenTag LCARate, Cradle to Cradle, NSF Sustainability Assessment, etc.

Sustainability value of the above-listed sustainable materials can be increased with the following additional sustainable features:

- Materials have been manufactured in an ISO 14001 certified facility. In order to comply, 80% of the mass of the product or materials must be sourced from manufacturing facilities that are certified to ISO 14001.
- Environmental claims from the manufacturer have been third-party verified through claim verification or through certification under third-party ecolabels such as Global GreenTag, Cradle to Cradle, Singapore Green Building Product, etc.
- An environmental product declaration (EPD) have been produced by the manufacturer.
- The EPD produced by the manufacturer has been third-party verified.
- Materials are local materials:
  - that have been extracted, harvested and manufactured in Vietnam within a 500 km radius of the project site
  - that have been manufactured in Vietnam within a 500 km radius of the project site
  - that have been salvaged in Vietnam within a 500 km radius of the project site

Materials which have not been defined as sustainable materials cannot contribute towards the achievement of this credit even if they have some sustainable features.

Calculations

Calculation is based on cost of materials excluding labor and equipment but including delivery and taxes. When the actual cost of materials is not available, a default cost equal to 45% of the total construction costs should be used.

Percentage of sustainable materials used on a project should be calculated by the following method:

- Quantify the total cost of the materials used in the project
- Quantify the cost of the sustainable materials in the project
- Evaluate the sustainability value (Table MR.1) and sustainability factors (Table MR.2) for the sustainable materials
- Present materials in table form (Table MR.3) and demonstrate the percentage of sustainable materials by using the following formulae:

$$\text{Sustainable materials } [\%] = \sum_{\text{i}} \frac{C_{\text{i}} \times \text{S}_{\text{i}}}{\text{C}_{\text{tot}}}$$

C_i = cost of material (i) [VND]

C_{tot} = Total cost of materials in the project [VND]

S_i = sustainability coefficient of material (i) [-].

Where S_i is calculated with the following formula:

$$\text{S}_{\text{i}} = \text{V}_{\text{i}} \times (0.5 + F_i)$$

V_i = sustainability value of material (i) (values from Table MR.1) [-]

F_i = sum of the sustainability factors for the additional sustainable features of material (i) (values from Table MR.2). F_i cannot be superior to 0.5. [-]

Table MR.1: Sustainability value of the different types of sustainable materials

Sustainable materials Criteria	Materials sustainability value
Reused materials	100%
Materials with reused components	% of reused components (by mass)
Materials with recycled content	% of post-consumer recycled content + 0.5 x % of pre-consumer recycled content
Rapidly renewable material	% of rapidly renewable materials (by mass)
Sustainable timber	0.5 x % of timber from sustainable sources (by mass)
Materials third party certified based on whole LCA	• Platinum & Gold (or equivalent): 100% • Silver (or equivalent): 80% • Bronze (or equivalent): 60% • Basic (or equivalent): 40%

Table MR.2: Sustainability factors for additional sustainable features

Sustainable features Criteria	Sustainability factors
Manufacturer with ISO 14001 certification	0.1
Materials with self-declared EPD	0.1
Materials manufactured locally	0.2
Materials with third-party verified EPD	0.3
Environmental claims third party verified	0.3
Materials extracted, harvested and manufactured locally	0.3
Materials salvaged locally	0.5

Example of Calculation:

Table MR.3: Example of Calculation of the percentage of sustainable materials

Building materials	Sustainable material?	Sustainable features?	Sustainability coefficient	Cost of Materials (1000 VND)	Sustainable material value (1000 VND)
Steel	60% post-consumer recycled content	claim third-party verified	60% x (0.5 + 0.3) = 0.48	300,000	144,000
Concrete	20% pre-consumer recycled content	/	(0.5 x 20%) x (0.5 + 0) = 0.05	400,000	20,000
Timber flooring	Rapidly renewable (bamboo)	third-party verified EPD + ISO 14001	100% x (0.5 + 0.3 + 0.1) = 0.9	50,000	45,000
Gypsum board	10% pre-consumer recycled content	self-declared EPD	0.5 x 10% x (0.5 + 0.1) = 0.03	60,000	1,800
Bricks	Reused	salvaged locally	100% x (0.5 + 0.5) = 1	40,000	40,000
Others	No	/	0	350,000	0
Total				1,200,000	250,800
Percentage of sustainable materials				20.9%	

With 20.9% of sustainable materials, this project would be awarded 3 points.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that more than 35% of the total value of the materials in the project is from sustainable materials.

Submissions

Provisional Certification Stage

This Credit is not available at Provisional Certification Stage and no submissions are required.

Full Certification Stage

- Report detailing all the sustainable materials to be installed, indicating location/use
- Bill of quantities detailing the cost of all materials installed in the project and the cost of all sustainable materials
- Calculations demonstrating compliance with the requirements
- Manufacturer's published data indicating recycled content -OR- signed and stamped letter from the manufacturer indicating recycled content
- Evidence that the sustainable materials were installed such as photographs, invoices, receipts, commissioning report, etc.

MR-3 Non-baked Materials

Scope

MR-3 credit applies to NR and Residential projects.

Intent

To reduce the use of baked materials and replace them with non-baked materials.

Requirements

NR & Residential (1-2 points)

Criteria	Points
80% of all non-structural walls are made up of non-baked materials	1
100% of all non-structural walls are made up of non-baked materials	2

Overview

A non-structural wall is a wall that only bears the load of itself. Typical construction practices in Vietnam involve a post and beam structure with non-structural internal and external walls constructed from bricks. As a result, most of the building envelope is constructed by bricks, which are mainly baked.

In Vietnam, about 25 billion bricks have been consumed in 2017 among which only 7 billion were non-baked bricks and 18 billion were clay bricks. This results in the exploitation of billions of cubic meters of clay annually and thousands of agricultural-cultivated areas are exploited for improper purposes, which leads to instability of national food security. Moreover, the exploiting and manufacturing processes in Vietnamese brick-kilns, which are mostly small and technically underdeveloped, have resulted in high coal use, large CO_2 emissions, material inefficiency and a higher amount of toxic smoke causing serious impacts on the environment.

In December 2017, circular No.13/2017/TT-BXD has been issued by the Ministry of Construction. It forces all state-funded construction works in Hanoi and Ho Chi Minh City to be built with 100% of non-baked materials for masonry. Also, all building projects having more than 9 floors must use at least 80% of non-baked materials for masonry. Other constructions are also encouraged to use this type of materials by specific solutions in terms of policy, scientific engineering and information dissemination.

Approach & Implementation

In this credit, the following should be considered as non-structural walls:

- Non-load bearing exterior walls
- Internal partitions
- Column cladding

Exceptions: Glass and laminate partitions (for toilet partitions) should not be considered as non-structural walls and included in the calculations.

For compliance with the credit, the project should use non-baked building materials such as:

- Concrete bricks
- Gypsum panels
- Pre-cast concrete panels
- Aerated Autoclaved Concrete (AAC) blocks

Calculation

Calculation is based either on volume (m^3) or on area (m^2).
Percentage of non-baked materials use can be calculated by the following method:

- Quantify the volume or area of non-structural walls in the project
- Quantify the volume or area of non-baked materials used in the non-structural walls
- Present materials in table form (Table MR.4) and demonstrate the percentage of non-baked materials use with the following formula:

$$\text{Non} - \text{Baked Materials Use } [\%] = \left(\frac{W_b}{W_{tot}}\right) \times 100$$

W_b = Volume or area of non-structural walls made up of non-baked materials in the building [m^3 or m^2]

W_{tot} = Total volume or area of non-structural walls in the project [m^3 or m^2]

Table MR.4: Example of Non-Baked Materials Percentage Calculation

Project non-structural walls	Non-Baked Material?	Area [m^2]	Compliant Area [m^2]
Gypsum board	Yes	475	475
Clay bricks	No	200	0
AAC blocks	Yes	600	600
Total		1,275	1,075
Percentage of Non-Baked Materials		84.3 %	

This building, with 84.3% of the non-structural walls that are non-baked materials, would achieve 1 point in the credit.

Submissions

Provisional Certification Stage
• Narrative detailing all non-baked materials to be installed and indicating location • Tender stage plans and elevations indicating location of all non-structural walls and highlighting non-structural walls made from non-baked materials • Calculations demonstrating compliance with the requirements

Full Certification Stage
• As-built plans and elevations indicating the location of all non-structural walls and highlighting non-structural walls made from non-baked materials • Evidence showing that the non-baked materials were installed, such as photographs, invoices, receipts, commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: • Final narrative detailing all non-baked materials installed and indicating location • Final as-built calculations demonstrating compliance with the requirements

MR-PR-1 and MR-4 Demolition and Construction Waste

Scope

MR-PR-1 prerequisite and MR-4 credit apply to NR and Residential projects.

Intent

To encourage the reuse, salvage and recycling of demolition and construction waste and to minimize disposal in landfill.

Requirement

NR & Residential (Prerequisite)

Criteria	PR
Develop and implement a demolition and construction waste management plan	M&R Prerequisite 1

NR & Residential (1-2 points)

This credit is only available at Full Certification.

Criteria	Points
Strategy A: Waste Diversion	
Reuse, salvage and/or recycle 50% of the demolition and construction waste	1
Reuse, salvage and/or recycle 70% of the demolition and construction waste	2
Strategy B: Reduction of Waste Generation	
Implement 2 strategies to reduce the waste generation during construction	1

Overview

Demolition and construction waste can be considered a valuable resource for reuse and recycling. By replacing the demand for virgin resources, demolition and construction waste reuse and/or recycling can significantly reduce the environmental impacts resulting from new material exploitation and production.

Approach & Implementation

Materials & Resources Prerequisite 2

The project must develop and implement a Waste Management Plan (WMP) that specify:

- Goals of waste management: percentage demolition and construction wastes to be diverted from landfill
- For each material, strategies to reduce the generation of waste on site and strategies to reuse, salvage or recycle waste
- Parties responsible for carrying out various aspects of the WMP: recycling coordinator, recycling contractor, licensed haulers and processors, etc.
- Description of disposal methods, handling procedures and monitoring of wastes

Strategy A: Waste Diversion

Provide a recycling waste storage area on the construction site for collection and separation of recyclable demolition and construction waste. Recycle or reuse typical demolition and construction waste such as:

- Brick
- Concrete
- Metals
- Plastic
- Glass
- Timber
- Roofing materials
- Corrugated cardboard
- Drywall

Excavated soil and land-clearing debris shall not be considered in this credit.

Strategy B: Reduction of Waste Generation

Implement at least 2 of the following strategies to reduce waste generation during construction:

- Design solutions for resource efficiency (design to use fewer materials, optimization of the design such as matching building and product dimensions, etc.)
- Material Procurement (order only the amount of materials needed, use standard sizes and plan ahead to reduce offcuts)
- Construction Logistics (make sure materials are delivered, handled and stored properly to avoid damage)
- Offsite prefabrication (use pre-fabricated systems)
- Packaging reduction (buy materials with less packaging, reduce the use of adhesives in favor of interlocking tabs, have items such as sand and aggregate delivered in bulk and not in multiple bags, ask suppliers to take back packaging, etc.)

Calculation

Strategy A: Waste Diversion

Calculation is based on volume or weight. Units selected must be applied consistently across the entire credit. If necessary, the conversion factors in Table MR.5 should be used.

Table MR.5: Weight-to-volume conversion factors

Solid waste material	Density (tonnes/m^3)
Cardboard	0.06
Gypsum board	0.3
Mixed waste	0.21
Rubble	0.83
Steel	0.59
Wood	0.18

The project should present data on all the demolition and construction waste generated in a table form as in the example below (Table MR.6) and the percentage of reused/salvaged/recycled waste should be calculated with the following formula:

$$C\&D\ Waste\ Reused/Salvaged/Recycled\ [\%] = \frac{W_D}{W_G} \times 100$$

W_D = Waste diverted from landfill [tonnes or m^3]

W_G = Total waste generated by demolition and construction activities [tonnes or m^3]

Table MR.6: Example of calculation of demolition and construction waste diverted from landfill

Materials	Quantity (tonnes)	Disposal Option	Where/Construction haulers & recyclers	Handling Procedure
Asphalt from parking lot	2	Reused as fill	On site	Ground on site
Concrete	4	Recycle	Recycling Facility	Keep separated in "Container for Concrete" in designated areas on site.
Scrap Metal	3	Recycle	Recycling Facility	Keep separated in "Container for Metal" in designated areas on site.
Plastics	1	Recycle	Recycling Facility	Keep separated in "Container for Plastic" in designated areas on site.
Cardboard	1	Recycle	Recycling Facility	Keep separated in "Container for Cardboard" in designated areas on site.
All other wastes	10	Landfill	Landfill	Dispose of in "Container for Trash" in designated areas on site.

In this example, out of 21 tonnes of waste generated, 11 tonnes are diverted from landfill.

$$C\&D\ Waste\ Reused/Salvaged/Recycled\ [\%] = \left(\frac{11}{21}\right) \times 100 = 52.3\%$$

With 52.3% of the waste diverted from landfill, this project would achieve 1 point in the credit.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates through Strategy A that 90% of the demolition and construction waste has been reused, salvaged and/or recycled.

- AND -

One point in Credit EP-1 can be awarded if the project demonstrates that 2 points can be achieved under Strategy A and 1 point can be achieved under Strategy B.

Submissions

Provisional Certification Stage
Materials & Resources Prerequisite 1
• Copy of the demolition and construction waste management plan -OR- • Tender stage specification extracts and signed letter from the owner/developer indicating that the demolition and construction waste management plan will be produced and followed
Materials & Resources Credit 4
This Credit is not available at Provisional Certification Stage and no submissions are required.

Full Certification Stage
Materials & Resources Prerequisite 1
• Summary log of all construction waste generated by type, the quantities of each type that were diverted and landfilled • Removal contracts and/or sales/trade documents covering all waste removal compiled month by month • Evidence that the waste management plan was followed such as photographs, receipts, etc.
If not already approved at Provisional Certification or if there is any change: • Final Demolition and construction waste management plan that has been implemented
Strategy A: Waste Diversion
• Calculation of the amount of demolition and construction waste diverted from landfill
Strategy B: Reduction of Waste Generation
• Report describing the strategies implemented to reduce waste generation • Evidence showing that the strategies to reduce the waste generation have been implemented such as drawings, receipts, report, photographs, etc.

MR-5 Operation Waste Management

Scope

MR-5 credit applies to NR and Residential projects.

Intent

To implement waste sorting and facilitate the recycling of waste generated during the operations of the building.

Requirements

NR (1 point)

Only Option A can be pursued with a maximum of 1 point available.

Residential (1-2 points)

Only Option B can be pursued with a maximum of 2 points available.

Option A: Dedicated recycling storage area

Criteria	Points
Provide a dedicated recycling storage area for use by all building occupants	1

Option B: Management and sorting of wastes

Criteria	Points
Strategy B1: Management and sorting of recyclables	
Manage and sort the recyclables	1
Strategy B2: Management and sorting of organic wastes	
Manage and sort the organic wastes	1

Overview

Operational buildings will produce a considerable amount of wastes that should be diverted from landfill for recycling or reuse. Good practice and the provision of separation facilities to allow for recycling and reuse is a simple way to reduce the amount of waste generated.

Approach & Implementation

Option A: Dedicated recycling storage area

NR Projects

Provide a dedicated recycling storage area with recycling storage spaces for the collection, separation and storage of recyclables.

The dedicated recycling storage area should meet all the following requirements:

- it should be located in the basement or at the ground level for convenient access by occupants and collection vehicles.
- it should allocate separated and clearly marked storage spaces for at least the following recyclable materials:
  - Paper (including newspaper)
  - Corrugated cardboard
  - Plastics
  - Metals
  - Glass

  Other recyclable materials to be considered include fluorescent tubes, organic wastes for composting and batteries.
- it should have storage spaces sufficiently sized based on waste generation and frequency of recycling pick-up.

Also, the project should provide short-term storage areas located all over the project with smaller bins allocated for the different types of recyclable waste generated. For instance, in an office space, at a minimum, bins for paper should be provided; in a cafeteria space, different bins for paper, plastics and metals should be provided.

Option B: Management and sorting of wastes

Residential Projects

All strategies:

Meet the following requirements to manage and sort the different types of waste:

- A common waste storage area for all the types of waste that are managed and sorted by the project should be provided. It should be located in the basement or at the ground level for convenient access by occupants and collection vehicles.
- A space sufficiently sized for bulky wastes (considering the intended frequency of collection) should be provided in the common waste storage area
- A space for interim storage of all the types of waste that are managed and sorted by the project should be provided on each floor.

- Signs should be displayed in the whole project to indicate the waste storage areas.
- All the different storage spaces should be clearly marked for each type of waste

Strategy B1: Management and sorting of recyclables

Meet the following requirements to manage and sort recyclables:

- A recycling storage area should be provided in the common waste storage area.
- The recycling storage area should either:
  - allocate different recycling bins for the following recyclable materials: paper, corrugated cardboard, plastic, metal and glass, or
  - provide commingled recycling bins (for aluminum and steel cans, glass bottles, plastic bottles and containers, newspapers).
- Recycling bins should be provided in all the interim storage areas located on each floor
- Recycling bins in the recycling storage area and the interim storage areas should be sufficiently sized based on the number of residents and frequency of recycling pick-up
- If possible, a storage place with a recycling bin should be provided in each dwelling-unit
- A description of the different types of recyclables should be included in the Building User's Guide (c.f. Management Prerequisite 2).

Strategy B2: Management and sorting of organic wastes

Meet the following requirements to manage and sort organic wastes:

- A bin for organic wastes should be provided in the common waste storage area.
- A bin for organic wastes should be provided in all the interim storage areas
- If possible, a storage place with a bin for organic wastes should be provided in each dwelling-unit
- A description of the different types of organic wastes should be included in the Building User's Guide (c.f. Management Prerequisite 2).
- Organic wastes should be composted (onsite or by hiring a compost company).
- The compost should either be used onsite or made available for people to use it.

Mixed-use Residential/NR Projects

- For projects considered as NR projects: For 1 point to be awarded, requirements of Option A should be achieved for the NR components of the project -AND- requirements of one strategy under Option B should be achieved for the Residential components of the project.
- For projects considered as Residential projects: To be able to score points in Option B, requirements of Option A should be achieved for the NR components of the project.

Submissions

Provisional Certification Stage	Option A NR	Option B R
• Report indicating that the design provides adequate space for recyclable materials storage, how recycling materials will be sorted, and which materials will be recycled	✓	
• Tender plans indicating the location of the dedicated recycling storage area and access routes to the recycling storage area(s) for building occupants and recycling contractors	✓	
• Report describing how the different types of waste will be managed and sorted		✓
• Tender plans showing location of all the waste storage areas and showing the spaces reserved for the different types of waste managed and sorted by the building		✓

Full Certification Stage	Option A NR	Option B R
• As-built plans indicating the location of dedicated recycling storage area and access routes to the recycling storage area(s) for building occupants and recycling haulers	✓	
• Photographs showing the dedicated recycling storage area and the different storage spaces	✓	
• Copy of contract or receipts showing collection of recycling materials by a recycling hauler.	✓	
• Photographs showing the waste storage areas, the bins reserved for the different types of waste managed and the signs displayed to show the location of storage areas		✓
• As-built plans showing location of all the waste storage areas and the size of the dedicated recycling storage area		✓
If not already approved at Provisional Certification or if there is any change:		
• Final report indicating the materials recycled, how they are sorted and the frequency of pick-up	✓	
• Final report describing how the different types of waste are managed		✓
Strategy B1: Management and sorting of recyclables		
• Extract of the Building User's Guide showing the description of the different types of recyclables		✓
Strategy B2: Management and sorting of organic wastes		
• Extract of the Building User's Guide showing the description of the different types of organic wastes		✓
If the project composts organic wastes onsite:		
• Photographs showing the compost bins		✓
• Evidence showing that a staff member is taking care of the composting		✓
If the project hires a company to compost organic wastes:		
• Extract of the contract with the company hired to compost organic wastes		✓

Health & Comfort

The World Health Organization reported in its Air Quality Guidelines (2nd Edition) that most of an individual's exposure to air pollutants comes from inhalation of indoor air. Besides air quality, the amount of noise and light pollution can also affect occupants as well as the surrounding communities. As the population of Vietnam is increasingly urbanized, it is estimated by the Ministry of Construction that urbanization rate will reach 50% for about 52 million people in 2025. This urban migration results in an increasing number of people spending an increasing amount of their time within the built environment. As a result, building occupants quality of life depends greatly on the indoor environment quality (IEQ).

Ensuring workers' productivity is done most effectively by maintaining and increasing the building's IEQ which results in reduced cases of asthma, allergies, respiratory disease and other occupant ailments described as "sick building syndrome". Reduced absenteeism and increased productivity can translate into reduced costs and increased savings for building owners and operators. Proper IEQ also increase the resale value of any building.

All credits within the Health & Comfort Category of LOTUS NC targets the overall improvement of the indoor environment in buildings with four different aspects considered. First and most important aspect is the indoor air quality: the building has to ensure fresh, clean air free of toxic chemicals and dust for occupants. Moreover, a healthy indoor environment should be comfortable visually, acoustically and thermally for most of the occupants of the building.

Credit	Title	NR	Residential
H-PR-1	Indoor Smoking	Prerequisite	Prerequisite
H-1	Ventilation for indoor air quality	3 points	3 points
H-PR-2	Low-Emission Products	Prerequisite	Prerequisite
H-2	Low-Emission Products	2 points	3 points
H-3	Biophilic Design	1 point	1 point
H-4	Daylighting	3 points	3 points
H-5	External Views	2 points	N/A
H-6	Thermal Comfort	2 points	2 points
H-7	Acoustic Comfort	1 point	2 points
	Total of points available	14 points	14 points

H-PR-1 Indoor Smoking

Scope

H-PR-1 prerequisite applies to NR and Residential projects.

Intent

To minimize the effect of passive smoking.

Requirements

NR & Residential (Prerequisite)

Criteria	PR
Prohibit smoking in the building	H&C Prerequisite 1

Overview

Second-hand smoking (or passive smoking) is the inhalation of smoke from tobacco products used by others. It occurs when tobacco smoke permeates any environment, causing its inhalation by people within that environment. Scientific evidence shows that health effects of exposure to second-hand smoke include lung cancer, nasal sinus cancer, respiratory tract infections and heart disease.

Approach & Implementation

Smoking should be banned inside the whole building at the exception of the following spaces:

- dwelling-units in Residential buildings
- designated areas inside buildings listed in Decision 1315/QĐ-TTg (such as exhibition centers, sporting halls, hotels, etc.). These designated areas must have a separated ventilation system.

Projects should ensure all building users are aware of the smoking ban by:

- Including information regarding indoor smoking ban in the Building User's Guide (c.f. Management Prerequisite 2).
- Displaying "No Smoking" signs (in area of prominence that may be frequented by smokers)

Also, projects are encouraged to install outdoor designated smoking areas.

If any outdoor designated smoking area is installed, it should be:

- located 8 meters away from building entrances, outdoor intakes and operable windows
- indicated with signs
- equipped with ashtrays, and trash bins
- equipped with extinguishers, if located near flammable materials

Submissions

Provisional Certification Stage
• Letter of intent from owner indicating that smoking will be banned inside the whole building
If any designated smoking area is to be installed: • Tender stage site plan indicating the location of designated smoking areas • Tender stage mechanical drawings showing the ventilation system for the designated smoking areas inside the building (if any)

Full Certification Stage
• Photographs showing the “no smoking” signs
If any designated smoking area has been installed: • Photographs showing the designated smoking areas • As-built stage site plan annotated to indicate the location of designated smoking areas • As-built stage mechanical drawings showing the ventilation system for the designated smoking areas inside the building (if any)

H-1 Ventilation for indoor air quality

Scope

H-1 credit applies to NR and Residential projects.

Intent

To maintain a good indoor air quality during occupancy.

Requirements

NR (1-3 points)

Only Strategies A, B and C can be pursued with a maximum of 3 points available.

Residential (1-3 points)

Only Strategies A, B and D can be pursued with a maximum of 3 points available.

Criteria	Points
Strategy A: Fresh Air Supply	
Provide sufficient fresh air supply to a minimum of 95% of the net occupied area of the building	2
Strategy B: Air filtration	
Install air filters on fresh air intake	1
Strategy C: CO_2-based demand-controlled ventilation	
Install a CO_2-based demand-controlled ventilation system	1
Strategy D: Ventilation in Wet Areas	
Install a local exhaust system in wet areas to remove moisture and odors from wet areas	1

Overview

Ventilation helps remove or dilute indoor airborne pollutants coming from indoor sources. This reduces the level of contaminants and improves indoor air quality (IAQ).

Fresh air supply refers to the volumetric flow rate of fresh air (outdoor air) being introduced to an occupied space. Increased fresh air supply can help decrease respiratory illnesses and associated absenteeism. Reduced instances of sick building syndrome symptoms and improved productivity are also results of high fresh air intake rates.

However, with today's polluted air in urban environments, fresh air is rarely free of contaminates and clean filtered air may be necessary to effectively improve the indoor air quality.

In order to maintain a good indoor air quality, CO_2 monitoring can be used as a general indicator. High CO_2 concentrations indicate poor indoor air quality and inadequate ventilation in enclosed spaces.

As for wet areas, they are subject to high levels of moisture from direct wetting, high humidity levels and condensation. Mold can grow and can contribute to poor indoor air quality and health problems. Along with good design and installation of waterproof membranes and impervious finishes to manage the moisture generated, proper exhaust ventilation is necessary to prevent mold from growing.

Approach & Implementation

Strategy A: Fresh Air Supply

This strategy applies to all occupied spaces in the building in order to provide good air quality for all occupants. Habitable areas in dwelling units are occupied spaces.

A minimum of 95% of the total net occupied area should meet with the following requirements depending on the ventilation type.

- Mechanically ventilated spaces:

HVAC systems and distribution ductwork must meet or surpass the requirements on ventilation rates of one of the following international standards:

- TCVN 5687:2010 - Ventilation - Air Conditioning, Design Standards
- ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (from 2007 or later)
- AS 1668.2 - The use of ventilation and air-conditioning in buildings

These standards determine the minimum fresh air volumetric flow rate to be supplied to occupied spaces as a function of the space type and occupancy.

In mechanical ventilation systems, air supply and exhaust in the different spaces should be designed carefully to avoid any short circuiting of the supplied air and ensure well mixed air within the space, with a particular focus on fresh air reaching the breathing zone.

- Naturally ventilated spaces:

Naturally ventilated spaces (or mechanically assisted naturally ventilated spaces) must either comply with Strategy A of Credit E-4 or meet the following requirements (adapted from section 5.1.1 of ASHRAE 62.1-2007 and QCVN 09:2017/BXD):

- All naturally ventilated spaces shall be within 8 meters of (and permanently open to) an operable wall or roof opening
- The total area of wall or roof openings shall be at least 5% of the naturally ventilated spaces' floor area
- Interior spaces without direct openings to the outdoors can be naturally ventilated through adjoining rooms if the unobstructed openings between the rooms are at least 8% of the floor area (with a minimum of 2.3 m^2)

To be considered as a naturally ventilated space, the openings in the space shall be permanently opened and the space should not be equipped with air-conditioning units.

In the case that a project implements an engineered natural ventilation system, the project must provide all necessary information to demonstrate that the provision of fresh air will ensure a good air quality for all occupants. This shall be subject to VGBC approval.

- Mixed-mode ventilated occupied spaces:

Mixed-mode ventilated spaces (combination of natural ventilation from operable openings, and mechanical systems that include air distribution equipment and HVAC) must meet both the above requirements for mechanically ventilated spaces and naturally ventilated spaces.

Strategy B: Air Filtration

This strategy can only be followed by projects with 95% of the total net occupied area meeting the requirements for mechanically ventilated spaces set in Strategy A.

Install air filters on all the fresh air intakes to ensure that clean air is brought in the building.

Filter are generally classified under:

- MERV (Minimum efficiency reporting value) rating, which is a measurement scale designed by ASHRAE to rate the effectiveness of air filters from MERV 1 to MERV 16; or
- Classes from European standards (EN 779 and EN 1822) with G1-G4 for coarse filters, M-5-F9 for medium and fine filters and E10 to U17 for HEPA and ULPA filters.

Buildings located in Hanoi (with an annual average PM2.5 concentration of 42.6 µg/m3 in 2017 according to AirNow DOS) should install an air filtration level of MERV 16 or E10.

Buildings located in Ho Chi Minh City (with an annual average PM2.5 concentration of 29.4 µg/m3 in 2017 according to AirNow DOS) should install an air filtration level of MERV 14 or F8.

These represent the minimum air filtration levels necessary to bring the entering concentrations down to 10 µg/m^3 (WHO air quality guidelines).

Buildings located in industrial zones with coal power plants, in areas with a large number of brick kilns and inside a city other than Hanoi and Ho Chi Minh City should install an air filtration level of MERV 12 or F6.

For all other locations in Vietnam, an air filtration level of MERV 6 or G3 should be installed.

Also, it is advised that supply air filters are equipped with on-board pressure sensors or filter change indicator that signal when filter requires replacement.

Strategy C: CO_2-based demand-controlled ventilation

NR Projects

This strategy can only be followed by projects with all the high density occupied areas meeting the requirements for mechanically ventilated spaces set in Strategy A.

Install a CO_2-based demand-controlled ventilation system that regulates the fresh air ventilation rate to keep a CO_2 concentration at maximum intended occupancy lower than 900 ppm in all the high density occupied spaces (1 person/3 m^2) of the project.

At least one permanent CO_2 sensor should be used in all the high density occupied spaces. CO_2 sensors should be located in the breathing zone between 1 and 2 meters above the finished floor and away from doors, windows, air supply and zones where occupants may exhale directly into the sensor. When monitoring large open spaces with largely uniform concentration levels, it is also acceptable to mount sensors in return air ducts.

The demand-controlled ventilation system should ensure continuous adjustments of the fresh air supply to adapt to the occupancy:

- at maximum intended occupancy, a fresh air flow rate higher than the minimum required to keep a CO_2 concentration lower than 900 ppm (c.f. Calculations section) should be supplied
- at no occupancy, a fresh air flow rate of zero (where allowed in ASHRAE 62.1 - 2016) or the fresh air flow rate based on area as required in ASHRAE 62.1- 2016 should be supplied

Strategy D: Ventilation in Wet Areas

Residential Projects

This strategy applies to all the following rooms in the building:

- kitchens;
- bathrooms (any room containing a bathtub, shower, spa, or similar source of moisture);
- toilets (a space containing one or more water closets or urinals);

For each room, either the requirements on continuous local ventilation exhaust or on intermittent local ventilation exhaust should be met.

- Continuous Local Ventilation Exhaust

  The local exhaust system should operate continuously and automatically, and meet the following minimum airflow rates:

  - Kitchen: airflow of at least 5 air changes per hour
  - Bathroom: airflow of at least 10 L/s
  - Toilets: airflow of at least 10 L/s

- Intermittent Local Ventilation Exhaust

  The local exhaust system should be designed to be operated as needed by the occupant and the following minimum air flow rates must be met:

  - Kitchen: airflow of at least 50 L/s. If the airflow of the local exhaust system represents less than 5 kitchen air changes per hour, a vented range hood should be installed.
  - Bathroom airflow of at least 25 L/s
  - Toilets: airflow of at least 25 L/s

Control of the exhaust can be a manual switch or an automatic control using occupancy sensor or humidity sensor. All sorts of controls can be accepted as long as it does not impede the occupant control.

The kitchen exhaust requirement can be met with either a ceiling or wall mounted exhaust fan or with a vented range hood.
Systems with multiple speeds and switches with a delayed shutoff function that continues the exhaust fan flow for a set time after the occupant leaves the bathroom can also be used.

Calculations

Strategy A: Fresh Air Supply

- Mechanically ventilated and mixed-mode ventilated occupied spaces:

For each of these occupied spaces, calculate minimum ventilation rates (fresh air supply) in accordance to one of the standards from the above list and demonstrate that designed ventilation rates meet the requirements of the selected standard.

- Naturally ventilated and mixed-mode ventilated occupied spaces:

For each of these occupied spaces, perform calculations to show compliance with Strategy A of Credit E-4 requirements or with the above requirements adapted from section 5.1.1 of ASHRAE 62.1-2007 and QCVN 09:2017/BXD.

Strategy C: CO_2-based demand-controlled ventilation

NR Projects

For each high density occupied space, the minimum amount of fresh air supply to be provided to maintain a CO_2 concentration lower than 900 ppm at maximum intended occupancy should be calculated.

The following mass-balance equation assuming steady-state conditions within the space should be used:

$$V_0 = \frac{N}{C_S - C_{FA}}$$

Where,

Vo = outdoor airflow rate, liters/second

C_S = CO_2 concentration in the space, ppm (a value of 0.0009 should be used)

C_{FA} = CO_2 concentration in the fresh air, ppm (a value of 0.0004 should be used)

N = CO_2 generation rate, liters/person

$$N = k \times m \times P$$

Where,

k = generation rate of CO_2, a value of 0.003964 liters/second/met/person should be used

m = activity level of the people in the space, met (see values in Table H.1)

P = maximum intended occupancy in the space, number of persons

Table H.1: Typical met levels for various activities
(*Source: Table A-A of ASHRAE 62.1-2010 User's Manual*)

Activity	met value
Seated, quiet	1.0
Reading and writing, seated	1.0
Typing	1.1
Filing, seated	1.2
Filing, standing	1.4
Walking, at 3 km/h	2.0
House cleaning	2.0 – 3.4
Exercise	3.0 – 4.0

Strategy D: Ventilation in Wet Areas

Residential Projects

The minimum airflow rate for the continuous local ventilation exhaust in kitchen areas should be verified the following way:

- Measure the length, width and height of the room to calculate the volume of the room in m^3
- 5 air changes per hour is equivalent to an exhaust rate 5 times the volume of the room per hour.
- Verify that the capacity of the exhaust fan(s) in m^3/h is higher than 5 air changes per hour

In other configurations, simply install an exhaust fan with an airflow rate higher than requirements.

Exceptional Performance

NR Projects

One point in EP-1 can be awarded if the project demonstrates that 4 points can be achieved under the Strategies A, B and C of the credit.

Residential Projects

One point in EP-1 can be awarded if the project demonstrates that 4 points can be achieved under the Strategies A, B and D of the credit.

Submissions

Provisional Certification Stage
Strategy A: Fresh Air Supply
For mechanically ventilated spaces and mixed-mode ventilated spaces: • Schedule outlining every occupied space along with each space's ventilation type, fresh air supply rate and AHUs or fans serving the space. • Calculations demonstrating that the requirements of the national or international standard selected are met • Tender schematic mechanical drawings showing fresh air supply rates of AHUs and fans • Inventory of proposed HVAC equipment
For naturally ventilated spaces and mixed-mode ventilated spaces: • Tender stage elevations and plans marking all operable wall and roof openings • Tender stage window schedule indicating the number, location and size of all operable wall and roof openings or room data sheets that indicate area and window specifications (glazing type, size and whether the window is operable). • Calculations demonstrating that naturally ventilated occupied spaces conform to the requirements
Strategy B: Air Filtration
• Tender schematic mechanical drawings showing supply air filters • Tender specifications and/or manufacturer's published data showing the air filtration level of the proposed supply air filters

Strategy C: CO_2-based demand-controlled ventilation
• Tender stage specifications of the CO_2 based demand-controlled ventilation system showing compliance with requirements • Tender schematic drawings showing location of the CO_2 sensors • Schedule listing the high density occupied spaces along with their floor areas, occupancies and number of CO_2 sensors • Calculations of the minimum amount of fresh air supply to be provided to maintain a CO_2 concentration lower than 900 ppm at maximum intended occupancy
Strategy D: Ventilation in Wet Areas
• Table outlining every wet space along with each space's ventilation exhaust rate • Calculations of the minimum airflow rates required for every wet space • Tender schematic mechanical drawings showing location and flowrate of the exhaust fans • Schedule of proposed exhaust fans equipment

Full Certification Stage
Strategy A: Fresh Air Supply
For mechanically ventilated spaces and mixed-mode ventilated spaces: • As-built schematic mechanical drawings showing fresh air supply rates of AHUs and fans • Evidence of the HVAC equipment installed, such as photographs, invoices, receipts, commissioning report, etc. If not already approved at Provisional Certification or if there is any change: • Final schedule outlining every occupied space along with each space's ventilation type, fresh air supply rate and AHU's or fans serving the space • Final inventory of HVAC equipment • Final as-built calculations demonstrating that the requirements of the national or international standard selected are met
For naturally ventilated spaces and mixed-mode ventilated spaces: • As-built stage elevations and plans marking all operable wall and roof openings • As-built stage window schedule indicating the number, location and size of all operable wall and roof openings or room data sheets that indicate area and window specifications (glazing type, size and whether the window is operable). If not already approved at Provisional Certification or if there is any change: • Final calculations demonstrating that naturally ventilated occupied spaces conform to the requirements
Strategy B: Air Filtration
• As-built schematic mechanical drawings showing supply air filters • Evidence of the supply air filters installed, such as photographs, invoices, receipts, commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: • Manufacturer's published data showing the air filtration level of the proposed supply air filters

Strategy C: CO_2-based demand-controlled ventilation
• Operation and maintenance manual indicating the procedures for operation, adjustment and maintenance of the CO_2 based demand-controlled ventilation system • As-installed schematic drawings of the CO_2 based demand-controlled ventilation system
If not already approved at Provisional Certification or if there is any change: • Final schedule listing the high density occupied spaces along with their floor areas, occupancies and number of CO_2 sensors • Final calculations of the minimum amount of fresh air supply to be provided to maintain a CO_2 concentration lower than 900 ppm at maximum intended occupancy
Strategy D: Ventilation in Wet Areas
• As-built schematic mechanical drawings showing location and flowrate of the exhaust fans • Manufacturer's data of the exhaust fans showing fan capacity • Evidence of the exhaust fans installed, such as photographs, invoices, receipts, commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: • Final table outlining every wet space along with each space's ventilation exhaust rate • Final calculations of the minimum airflow rates required for every wet space • Final schedule of the installed exhaust fans equipment

H-PR-2 & H-2 Low-Emission Products

Scope

H-PR-2 prerequisite and H-2 credit apply to NR and Residential projects.

Intent

To minimize the negative impacts of hazardous materials such as volatile organic compounds (VOCs) & Formaldehydes from building materials on occupant's health.

Requirements

NR & Residential (Prerequisite)

Criteria	PR
Specify and install low-VOC emission interior paints and coatings	H&C Prerequisite 2

NR (1-2 points) & Residential (1-3 points)

Criteria	Points
Strategy A: Adhesives and sealants	
Specify and install low-VOC emission adhesives and sealants	1
Strategy B: Floorings	
Specify and install low-VOC emission floorings	1
Strategy C: Composite wood	
Specify and install low-formaldehyde emission composite wood	1
Strategy D: Ceilings, partitions and insulation	
Specify and install low-VOC emission ceilings, partitions and insulation	1

Overview

Volatile organic compounds (VOCs) are organic origin gases emitted from certain solid or liquid materials. VOCs feature in a wide range of chemicals, including some that have short and long-term negative effects on human health. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors and can cause significant health problems for frequent occupants. VOCs are emitted from a variety of products (e.g.

paints and lacquers, cleaning supplies, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, etc.).

Formaldehyde is a type of VOC used widely by industry to manufacture building materials and numerous household products. The most significant sources of formaldehyde are likely to be pressed wood products made using adhesives that contain urea-formaldehyde (UF) resin or phenol-formaldehyde (PF) resin. Pressed wood products made for indoor use include: particleboard (used as sub-flooring and used in cabinets and furniture); hardwood plywood paneling (used for decorative wall covering and used in cabinets and furniture); and medium density fiberboard (used for drawer fronts, cabinets, and furniture tops). Medium density fiberboard contains the highest resin-to-wood ratio and is generally recognized as being the highest formaldehyde-emitting pressed wood product.

Approach & Implementation

In this prerequisite and credit, only interior products should be considered.

Are considered as low-VOC emissions products in LOTUS NC, the products which either:

- are certified/labelled as low-VOC products by an internationally or regionally recognized authority such as Singapore Green Label, GREENGUARD, Global Green Tag, Green Seal, SCS Indoor Advantage. Other labels/certificates shall be subject to VGBC approval
- or, have a VOC content lower than the limits set in any internationally or regionally recognized regulation (e.g. South Coast Air Quality Management District Rule 1113 or Rule 1168, Hong Kong Air Pollution Control VOC Regulation, California Air Resources Board, etc.). The VOC content shall be demonstrated with laboratory test results following relevant test methods such as US EPA Reference Method 24 or EN 16516.
- or, are inherently non-emitting VOC (stone, ceramic, powder-coated metal, plated metal, anodized metal, glass, concrete, clay brick, and unfinished/untreated solid wood)

Are considered as low-formaldehyde emission products, the products which either:

- are certified/labelled as low-formaldehyde products by an internationally or regionally recognized authority such as Singapore Green Label, GREENGUARD, Global Green Tag, Green Seal, SCS Indoor Advantage, CARB Phase 2. Other labels/certificates shall be subject to VGBC approval.
- or, do not exceed a concentration limit of 0.05 ppm of formaldehyde (0.06 mg/m2.h when expressed as emission rate) as tested following an internationally recognized standard
- or, do not contain any added UF resin and PF resin
- or, are classified as ULEF (ultra-low-emitting formaldehyde) or NAF (no added formaldehyde)

Also, are considered as low-VOC / low-formaldehyde emission products, the products which:

- are salvaged and reused with more than one year old at the time of use, provided that the finishing products (paints, coatings, adhesives, and sealants) used, if any, are low-VOC emission products.
- are compliant with CDPH Standard Method Version V1.1 - 2010 or CDPH/EHLB Standard Method V1.2 - 2017 using the applicable exposure scenario

Health & Comfort Prerequisite 2

Install only low-VOC emission paints and coatings.

Strategy A: Adhesives and sealants

Install only low-VOC emission adhesives and sealants.

Strategy B: Floorings

Install only low-VOC emission flooring products and systems.
For floorings with inherently non-emitting products (ceramic tiles, solid timber, stone, polished concrete, etc.), the finishing products used must be low-VOC emission products.
Epoxy floor coatings should be considered in this strategy but composite wood floorings should be considered under Strategy C: Composite wood.

Strategy C: Composite wood

Install only low-formaldehyde emission composite wood products.
Composite wood products (also called engineered wood products) include plywood and all types of fiberboards: particle board, medium-density fiberboard (MDF) and hardboard.

Strategy D: Ceilings, partitions and insulation

Install only low-VOC emission ceiling, partition and insulation (including thermal and acoustic insulation but not HVAC ductwork insulation) products and systems.

Exceptional Performance

NR Projects

One point in EP-1 can be awarded if the project demonstrates that 3 points can be achieved under the 4 Strategies of the credit.

Residential Projects

One point in EP-1 can be awarded if the project demonstrates that 4 points can be achieved under the 4 Strategies of the credit.

Submissions

Provisional Certification Stage
Health & Comfort Prerequisite 2
• Tender schedule of all the paint and coating products to be used • Tender specifications indicating the VOC limits for each paint and coating product -OR- • Manufacturer's published data or test reports showing that the paint and coating products are low-VOC emission products.
For each of the strategies targeted:
• Tender schedule of all the products classified in the strategies targeted • Tender specifications indicating the VOC/formaldehyde limits for each product -OR- • Manufacturer's published data or test reports showing that the products are low-VOC/low-formaldehyde emission products.

Full Certification Stage
Health & Comfort Prerequisite 2
• Final schedule of all the paint and coating products installed on the project • For each installed paint and coating product, manufacturer's published data or test reports showing that the product is a low-VOC emission product. • Evidence showing that the low-VOC emission paint and coating products have been installed such as photographs, invoices, receipts, commissioning reports, etc.
For each of the strategies targeted:
• Final schedule of all the products classified in the strategies targeted • For each installed product, manufacturer's published data or test reports showing that the product is a low-VOC/low-formaldehyde emission product. • Evidence showing that the low-VOC/low-formaldehyde emission products have been installed such as photographs, invoices, receipts, commissioning reports, etc.

H-3 Biophilic Design

Scope

H-3 credit applies to NR and Residential projects.

Intent

To incorporate natural environment in the project to nurture the human-nature relationship.

Requirements

NR & Residential (1 point)

Criteria	Points
Provide building occupants access to natural environment	1

Overview

Biophilia (from bio-, meaning "life," and -philia, meaning "friendly feeling toward") is a concept implying that humans possess an innate tendency to seek connections with nature. In urban areas, people now spend about 90% of their time indoors, in a built environment that is often sensory-deprived. Providing occupants with access to nature in the built spaces could play a key role to improve experience, mood and happiness.

Approach & Implementation

Incorporate natural environment in the project by meeting at least two of the following requirements:

- Provide occupants access to outdoor spaces (such as: landscaped grounds, internal courtyards or green roofs) that meet following requirements:
  - An outdoor space should be an unbroken space that:
    - is vegetated and can achieve a Green Plot Ratio of at least 4
    - provide seats and walkways for occupants to use.

    Small strips of greenery located here and there around the project site cannot be considered as outdoor spaces.
  - The total area of outdoor spaces should represent at least 15% of the total site area. Walkways, playgrounds, vegetation and ponds should be considered in the area of outdoor spaces.

  If an outdoor space includes a water body (such as: pond, pool, fountain, etc.), the area of the water body can be counted as part of the total area of outdoor spaces. But, when

calculating the Green Plot Ratio of the outdoor space, the area of the water body can be excluded from the area of the outdoor space.

- Provide interior plants (potted plants, planted beds or wall plants) suited for indoor environment in the occupied areas of the project. The density of plants should be higher than one plant unit for 2 full time occupants and higher than one plant unit for every 50 m^2 of occupied area.
- Provide one indoor water feature (fountain, water wall, fish tank, etc.) of at least 1.8 m in height or 4 m^2 in area OR provide few indoor water features of at least 1.8 m in height or 2 m^2 in area. Ultraviolet sanitation or other technology should be used for water safety.
  In buildings that are not 100% owner-occupied, the indoor water feature(s) should be located in the common areas of the building.
- Provide nature views to 70% of the net occupied area. To comply, an area should have a direct line of sight to an external view that shows vegetation, fauna or water.

Calculations

- For access to outdoor spaces, the green plot ratio of each of the outdoor spaces should be calculated with the following formula:

$$Green\ Plot\ Ratio\ (GnPR) = \frac{Total\ leaf\ area\ of\ the\ outdoor\ space}{Outdoor\ space\ area}$$

  The calculation method provided in credit SE-3 should be followed to calculate the total leaf area of one outdoor space.
  Only the plants located in the outdoor spaces should be used in calculations.
- For interior plants, the number of pot plant units should be calculated based on the width at the opening of the pot in accordance with Table H.2.

Table H.2: Equivalence between plant unit number and width at the opening of the pot

Width at the opening of the pot (mm)	Plant unit number
< 100	0.2
≥ 100 and < 200	0.33
≥ 200 and < 250	0.5
≥ 250 and < 320	1
≥ 320 and < 400	2
≥ 400 and < 550	3
≥ 550	4
Bed & Vertical Planting	Determine number of equivalent pots based on a width of 250mm.

- For nature views, calculations should be made in accordance with credit H-5 External Views.

Submissions

Provisional Certification Stage
For outdoor spaces: • Master plan of the project site showing the outdoor spaces • Landscape plans of the outdoor spaces that indicate the plants, the pathways and outdoor furniture to be installed • Calculations of the total area and the green plot ratio of the outdoor spaces
For interior plants: • Evidence showing the number and the species of plants to be installed such as tender layout plans, schedule of interior plants, specifications, etc.
For indoor water feature: • Evidence showing the indoor water feature to be installed such as tender layout plans, schedule of interior plants, specifications, etc.
For nature views: • Narrative demonstrating compliance with the nature views strategy • Floor plans indicating net occupied area and showing all areas with nature views

Full Certification Stage
For outdoor spaces: • As-built master plan of the project site showing the outdoor spaces • As-built landscape plans of the outdoor spaces that indicate the plants, the pathways and outdoor furniture installed If not already approved at Provisional Certification or if there is any change: • Final as-built calculations of the total area and the green plot ratio of the outdoor spaces
For interior plants: • Evidence showing that the plants installed are suitable to indoor environments such as letter of confirmation from the plant supplier, published document, etc. • Evidence showing the number and the species of plants that have been installed such as as-built layout plans, photographs, as-built schedule of interior plants, invoices, etc.
For indoor water feature: • Photographs showing the indoor water feature installed.
For nature views: • Photographs showing the nature views • As-built floor plans indicating net occupied area and showing all areas with nature views • Final narrative demonstrating compliance with the nature views strategy

H-4 Daylighting

Scope

H-4 credit applies to NR and Residential projects.

Intent

To encourage building designs which maximize the use of daylight.

Requirements

NR & Residential (1-3 points)

Only one of the 2 following options can be pursued:

Option A: Daylight Factor

Criteria	Points
60% of the net occupied area has an average daylight factor between 1.5% and 3.5%	1
80% of the net occupied area has an average daylight factor between 1.5% and 3.5%	2

Option B: Daylight Autonomy

Criteria	Points
Achieve a spatial daylight autonomy$_{300/50\%}$ (sDA$_{300/50\%}$) of more than 50% of the net occupied area while controlling solar glare	1
1 point for every additional 15% of the net occupied area that achieves a spatial daylight autonomy$_{300/50\%}$ while controlling solar glare (Up to 80%)	3

Overview

Daylighting involves the introduction of natural light, as opposed to artificial light, into an occupied space. This increases building occupant comfort while reducing the energy required for lighting. When designing for natural light, designers must balance many factors, such as solar heat gain, glare, light availability, visual quality and occupant requirements.

The positioning of glazing should consider how to allow the largest ingress of natural light while minimizing the solar heat gains. The use of glazing can provide less insulation resulting in higher energy costs. These costs can often be outweighed by the increase in productivity and comfort that occupants typically display in naturally lit areas.

Approach & Implementation

Natural light promoting designs strategies include:

- Building atria
- Window arrangement
- Skylights
- Interior light shelves
- Open plan design

Spaces that are not compatible with the provision of daylight (such as: auditoriums and conference rooms dedicated to video conferencing) can be exempted from this credit. Other space types not compatible with the provision of daylight shall be subject to VGBC approval.

Option A: Daylight Factor

Achieve an average daylight factor (DF) between 1.5% and 3.5% in the occupied spaces. DF is the ratio of the illuminance at a point on the indoors working plane relative to the horizontal illuminance outdoors at the same time under overcast sky conditions.

Option B: Daylight Autonomy

Use Climate Based Daylight modelling (CBDM) to optimize the daylight design and calculate the spatial daylight autonomy$_{300/50\%}$ (sDA$_{300/50\%}$) achieved in the net occupied area.
The sDA$_{300/50\%}$ results represent the percentage of the net occupied area that exceeds an illuminance of 300 lux for at least 50% of the operating hours per year.

To be compliant with Option B, not only the sDA$_{300/50\%}$ should be higher than 50% of the net occupied area but also the solar glare should be controlled. For this, either one of the two following should be achieved:

- Annual sunlight exposure of ASE$_{1000,250}$ of no more than 10% of the net occupied area. ASE$_{1000,250}$ is the percentage of operating hours during which the light level from direct sun alone exceeds an illuminance of 1000 lux for 250 hours.
- All exterior envelope glazing in the occupied spaces should have glare-control devices that are controllable by the occupants. Automatic devices can be provided but there should be a manual override. Preferably, devices that reduce glare while not blocking the view (such as solar screen shades made from screen fabrics or blinds made with sheer fabrics) should be provided.

Calculations

Option A: Daylight Factor

The prediction of daylight factor (DF) requires knowledge of the proposed building and its surroundings. DF must be calculated for all occupied spaces (spaces included in the net occupied area).

Calculations for this credit can be done using a daylight modelling software or using a spreadsheet. Spreadsheet calculations are suitable for simple, rectilinear buildings. More complicated buildings, such as curved or faceted buildings, cannot be assessed with this methodology and should be assessed using daylight modelling software.

Daylight modelling software:

Use daylight factor outputs from a daylight modelling software to justify average daylight factor values in the different occupied spaces. The design day used for daylight factor calculations should be on the 21st of September at 12:00pm. Any permanent interior obstruction should be considered in the modelling, but moveable furniture and partitions, and glare-control devices should not be considered.

Spreadsheet calculations:

The average DF for each occupied space is calculated as follows (methodology developed by the Building Research Establishment in the UK):

$$DF = \frac{A_g \times \alpha \times M \times t \times 100}{A_{total} * (1 - \rho^2)}$$

DF = Average Daylight Factor of the occupied space [%]

A_g = Glazed area of windows in the occupied space (excluding frames or obstructions) [m^2]

A_{total} = Total internal surface area of the occupied space [m^2]

α = Angle of visible sky from the mid-point of the window [Rad]. Angle of visible sky is determined as per the below figure (Figure H.1).

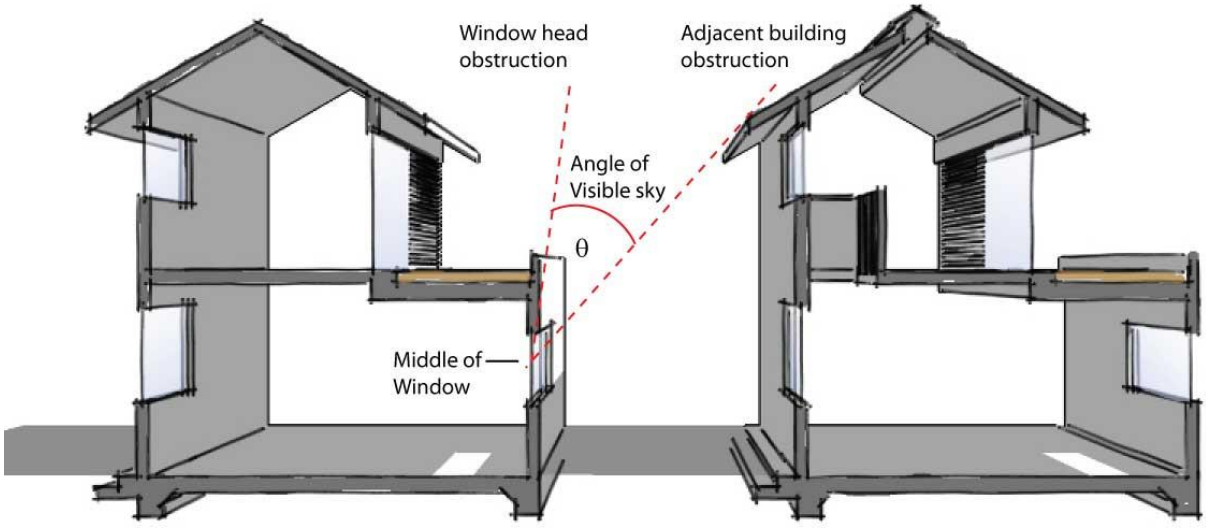

Figure H.1: Angle of visible sky from the mid-point of the window

M = Maintenance factor, which considers the dirt on the exterior surface of the glass and takes into account the location of the building, the use of the room and the slope of the fenestration (Table H.3)

Table H.3: Maintenance factors
(*Source: Introduction to Architectural Science. Steven V. Szokolay*)

Location	Slope	Window Condition	
		Clean	Dirty
Non-Industrial Area	Vertical	0.9	0.8
	Sloping	0.8	0.7
	Horizontal	0.7	0.6
Industrial Area	Vertical	0.8	0.7
	Sloping	0.7	0.6
	Horizontal	0.6	0.5

t = Visible light transmission (Values of Table H.4 can be used if manufacturer's data is not available)

Table H.4: Visible light transmission
(*Source: Efficient Windows Collaborative*)

Glazing Type		Glazing Transmission
Single-Glazed	Clear	0.90
	Tinted	0.68
	Reflective	0.27
Double-Glazed	Clear	0.81
	Tinted	0.62
	Reflective	0.10
	High-solar-gain low-E	0.75
	Low-solar-gain low-E	0.64

ρ = Area-weighted average reflectance of surrounding room surfaces (recommended reflectance values in Table H.5 can be used)

Table H.5: Recommended reflectance for ceiling, walls and floor
(Source: CIBSE Guide F Energy Efficiency in Buildings)

Room Surface	Recommended Reflectance
Ceiling	0.7
Walls	0.5
Floor	0.2

In both calculation methods, the suggested method shall be followed:

- Calculate the average DF in all the rooms part of the net occupied area
- Identify all the rooms that have an average DF value between 1.5% and 3.5%
- All these rooms are considered as compliant

- Also, all the rooms with a DF above 3.5% which are equipped with glare-control devices controllable by the occupants can also be considered as compliant
- Sum the areas of all the compliant rooms and compare the sum to the net occupied area of the building using the following formula:

$$\text{Compliant Area Percentage } [\%] = \frac{A_C}{A_O} \times 100$$

A_C = Total compliant occupied area (sum of the areas of the compliant occupied rooms) [m^2]

A_O = Net occupied area [m^2]

Option B: Daylight Autonomy

Use Climate Based Daylight modelling (CBDM) to optimize the daylight design and calculate the spatial daylight autonomy$_{300/50\%}$ (sDA$_{300/50\%}$) achieved in the net occupied area at hours between 8 am and 6 pm.

An hourly time-step analysis based on typical meteorological year data, or an equivalent, for the nearest available weather station should be used and the same inputs as presented above for daylight factor should be used for surface reflectance and visible light transmission.

If no glare-control devices are provided in all the occupied spaces, the ASE$_{1000,250}$ should be calculated through daylight modelling. ASE$_{1000,250}$ should represent no more than 10% of the net occupied area.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates under Option B that a spatial daylight autonomy300/50% of more than 95% of the net occupied area can be achieved while controlling solar glare.

Submissions

Provisional Certification Stage	Option A	Option B
• Tender stage floor plans and elevations outlining all occupied spaces and indicating all glazing	✓	✓
• Average daylight factor values from spreadsheet calculations -OR- • Report including average daylight factor output results and indicating inputs from daylight modelling software	✓	
• Calculations of the percentage of the net occupied area that is compliant	✓	
• Report including sDA$_{300/50\%}$ (and ASE$_{1000,250}$ if necessary) output results, indicating inputs from daylight modelling software and outlining the glare-control devices to be installed		✓

Full Certification Stage	Option A	Option B
• As-built floor plans and elevations	✓	✓
• Photographs showing the exterior envelope glazing and the glare-control devices	✓	✓
If not already approved at Provisional Certification or if there is any change:		
• As-built floor plans and elevations outlining all occupied spaces and indicating all glazing	✓	✓
• Final as-built average daylight factor values from spreadsheet calculations - OR- • Final report showing average daylight factor output results and indicating inputs from daylight modelling software	✓	
• Final as-built calculations of the percentage of the net occupied area that is compliant	✓	
• Final report including $sDA_{300/50\%}$ (and $ASE_{1000,250}$ if necessary) output results, indicating inputs from daylight modelling software and outlining the glare-control devices installed		✓

H-5 External Views

Scope

H-5 credit only applies to NR projects.

Intent

To increase the occupants' connection to the outdoors by providing views to the exterior.

Requirements

NR (1-2 points)

Criteria	Points
Strategy A: External views	
70% of the net occupied area achieves a direct line of sight to the outdoor environment	1
90% of the net occupied area achieves a direct line of sight to the outdoor environment	2
Strategy B: Quality views	
70% of the net occupied area has quality views	1

Overview

Windows and openings provide a direct connection between the building's occupants and the outdoor environment. This connection improves occupants' well-being, which can lead to increased health, comfort and productivity.

The potential for increases in glazing area must be carefully considered when applying for this credit. Windows providing views to the exterior must be positioned to reduce solar and thermal loads on the building. Proper materials must be considered for glazing to further reduce associated energy loss and requirements.

Approach & Implementation

Many strategies can be considered to offer occupants views to the outdoors, including:

- Locating open areas near the perimeter of the building
- Locating unoccupied spaces within the core of the building
- Application of glazing for internal partitions
- Locating glazing at appropriate height to provide line of sights

For this credit, a glazing can be considered as an external view only if:

- It is present between 0.8 m and 2.2 m above the finished floor
- And it provides a clear image of the exterior, not obstructed by frits, fibers, patterned glazing, or added tints that distort color balance.

Spaces that are not compatible with the provision of external views (such as: theaters, auditorium, conference rooms dedicated to video conferencing and gymnasiums) can be exempted from this credit. Other space types not compatible with the provision of external views shall be subject to VGBC approval.

Calculations

Strategy A: External views

Present calculations in a spreadsheet format indicating adherence to the requirements (see Table H.6 below). Compliant areas shall be calculated using the following procedure:

- Identify all occupied spaces and their areas
- Identify all areas within these occupied spaces that have a direct line of sight to the exterior. This line of sight begins at 45 degrees from the edge of each external view. Lines of sight can pass through 2 interior glazing surfaces, but not a doorway with a solid door. Moveable partitions and non-fixed furniture shall not be taken into account
- If at least 75% of a room's floor area has a direct line of sight to the outdoor, the entire floor area shall be counted towards having a view to the outdoors. If less than 75% of the area has a view, calculate/estimate the total area with a direct line of sight to the outdoors
- Calculate the percentage of the floor space that is compliant using the following formula:

$$\text{Compliant Area } [\%] = \frac{\text{Total compliant floor space}}{\text{Net occupied space}} \times 100$$

Figure H.2 and Table H.6 give an example of the calculation method.

Table H.6: Example of Calculation Method for External Views

Room	Total Occupied Area [m^2]	External View? [Y or N]	Area with External Views		Compliant Area [m^2]
			[m^2]	[% of room's floor area]	
Office 101	25	Y	20	80%	25
Office 102	25	N	/	/	0
Office 103	25	Y	10	40%	10
Open Office Area	145	Y	145	100%	145
TOTAL	220	-	175	-	180

Figure H.2: Example of Calculation Method for External Views

$$\text{Compliant Area } [\%] = \frac{180}{220} \times 100 = 81.8\ \%$$

In this example, it can be shown that 81.8% of the net occupied area is compliant and 1 point can be awarded.

Strategy B: Quality views

To qualify as an area with quality views, the area must at least meet two of the following requirements:

- have a direct line of sight to an external view that is unobstructed for at least 8 meters from the exterior of the glazing;
- have a direct line of sight to an external view that includes vegetation, fauna or sky;
- have a direct line of sight to an external view that includes movement;
- have multiple lines of sight to the outdoors via external views in different directions at least 90 degrees apart.

Compliant areas shall be calculated using the following procedure:

- Identify all occupied spaces and their areas
- Identify all areas within these occupied spaces that have quality views (areas where at least 2 of the requirements listed above are met)
- For each occupied space, if at least 75% of a room's floor area has quality views, the entire room floor area shall be counted towards having quality views. If less than 75% of the area has a quality view, the actual area with quality views shall be counted as compliant.
- Calculate the percentage of the floor space that is compliant using the following formula:

$$\text{Compliant Area } [\%] = \frac{\text{Total compliant floor space}}{\text{Net occupied area}} \times 100$$

For each occupied space, it is possible to have different areas with different types of quality views. For example, in one room, a part of the room may have a direct line of sight with a view including both vegetation and movement while another part of the room may have multiple lines of sight to the outdoors including a line of sight to an unobstructed external view.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that 2 points can be achieved under Strategy A and 1 point can be achieved under Strategy B.

Submissions

Provisional Certification Stage
For both strategies:
• Floor plans indicating net occupied area and showing all areas with direct lines of sight • Sections and elevations of compliant spaces demonstrating the height and location of external views and the height of internal partitions.
Strategy A: External views
• Calculations demonstrating compliance with the requirements
Strategy B: Quality views
• Narrative demonstrating compliance with the quality views strategy • Floor plans indicating net occupied area and showing all areas with quality views

Full Certification Stage
For both strategies:
• As-built floor plans, sections and elevations
Strategy A: External views
• Photographs showing the external views
If not already approved at Provisional Certification or if there is any change: • As-built floor plans indicating net occupied area and showing all areas with direct lines of sight • As-built sections and elevations of compliant spaces demonstrating the height and location of external views and the height of internal partitions. • Final as-built calculations demonstrating compliance with the requirements
Strategy B: Quality views
• Photographs showing the quality views
If not already approved at Provisional Certification or if there is any change: • As-built floor plans indicating net occupied area and showing all areas with quality views • Final narrative demonstrating compliance with the quality views strategy, including a plan of the surroundings

H-6 Thermal Comfort

Scope

H-6 credit applies to NR and Residential projects.

Intent

To encourage designs which achieve comfortable thermal conditions for occupants.

Requirements

NR & Residential (2 points)

Criteria	Points
Design the building to avoid overheating under hot summer conditions in a minimum of 95% of occupied spaces	2

Overview

Human thermal comfort is the condition of mind that expresses satisfaction with the thermal environment. It is a combination of a subjective sensation (how we feel) and several objective interactions with the environment (heat and mass transfer rates). Factors directly affecting thermal comfort are then both personal factors (metabolic rate and clothing level) and environmental factors (air temperature, radiant temperature, air speed and humidity).

Operative temperature (which can be defined as the average of the mean radiant and ambient air temperatures) describes combined effects of convective and radiant heat transfer. It is used in ASHRAE 55 – Thermal Environmental Conditions for Human occupancy and other standards as a means to assess thermal comfort.

Approach & Implementation

Air-conditioned spaces and mixed-mode ventilated spaces:

During cooling period (summer conditions), air-conditioning systems shall be designed to maintain consistent indoor conditions with a dry-bulb temperature set between 24° to 26°C.

To achieve the credit, design the building and air-conditioning systems with:

- Effective building envelope (c.f. credit E-3)
- Properly sized efficient air-conditioning system
- Appropriate thermal zoning

Non-air-conditioned spaces:

In non-air-conditioned spaces, to avoid overheating during the hottest days of the year, it is necessary to provide appropriate air velocity in the space and to limit to a minimum all types of external and internal heat gain (solar, artificial lighting, equipment, occupancy, etc.).

Design the building to employ the following strategies can help achieve this credit:

- Enhance indoor air velocity using fans or through carefully designed natural ventilation
- Limit solar radiation on glazing by installing effective external shadings on windows
- Limit solar radiation on opaque walls and roofs
- Limit internal heat gains (from artificial lighting and equipment)
- Optimize daylighting (and thus limit the use of internal artificial lighting)

Two different methods are proposed to projects to justify compliance with the credit for non-air-conditioned occupied spaces:

Method 1: Spaces shall meet the requirements of Section 5.3 of ASHRAE 55-2004. In particular, at design conditions, indoor operative temperature of the spaces should be within the 80% acceptability limits given in Figure 5.3 of ASHRAE 55-2004.

Method 2: Spaces shall comply with at least one requirement set in each of the three following categories:

A. Indoor air velocity

A1. requirements in strategy A of credit E-4 Building Cooling are met

A2. ceiling or wall fans are installed with at least one fan for every 20 m^2

A3. high-volume low-speed (HVLS) fans are installed

Residential projects

A4. requirements in strategy A2 of credit E-4 Building Cooling are met for living rooms and bedrooms only.

B. Reduction of external heat gains

If the spaces are naturally ventilated:

B1. effective external shadings are installed on all fenestrations of the space.

B2. exterior walls and roofs surrounding the space have a solar reflectivity > 0.7 or are vegetated or have external shadings.

If the spaces are mechanically ventilated:

B3. SHGC value of the glazing are 20% lower than QCVN 09:2017/BXD requirements.

B4. R-values of the exterior walls surrounding the space are 20% higher than QCVN 09:2017/BXD requirements.

C. Reduction of internal heat gains

C1. LPD of the space is reduced by more than 30% compared to the LPD value set for the same space type in Table 3.5.1 of LOTUS NC V3 Guidelines - Energy Performance Calculation Method

C2. 50% of all the equipment installed in the space have an energy label

C3. The average daylight factor of the space is between 1.5% and 3.5%

Calculations

Air-conditioned spaces and mixed-mode ventilated spaces:

The building energy simulation performed in the scope of the Prerequisite E-PR-3 and Credit E-2 shall be used to demonstrate that the selected indoor conditions can be maintained consistently throughout the occupied cooling period.
All the thermal zones modelled in the simulation that are including occupied spaces should be considered in calculations. For an occupied space to comply with the requirements of the credit, it should be located in a thermal zone that has a number of unmet load hours during the occupied cooling period that does not exceed 2% of the occupied hours. For this credit, an unmet load hour is defined as an hour in which a thermal zone is outside of the thermostat setpoint plus or minus 1.1°C (= 2°F).

Non-air-conditioned spaces:

Method 2: The following calculations should be realized for each occupied space:

A. Indoor air velocity

A1. Calculations in accordance with strategy A of credit E-4

A2. Density of ceiling or wall fans in the space should be calculated as the number of fans divided by the area of the space. At least one ceiling or wall fans per 20 m^2 should be installed (QCXDVN 09:2005 requirement).

A3. Density of high-volume low-speed fans in the space should match with manufacturer's recommendations based on the size of the fans

Residential projects

A4. Calculations in accordance with strategy A2 of credit E-4

B. Reduction of external heat gains

B1. The effectiveness of the external shadings installed on windows shall be demonstrated using the passive design analysis realized for the E-PR-2 Prerequisite.

B3. Calculate the QCVN 09:2017/BXD requirements on SHGC value depending on the orientation(s) of the space following method outlined in E-PR-1 Prerequisite.

B4. Area-weighted average R-value of the exterior walls surrounding the space should be higher than 0.67 m^2.K/W.

C. Reduction of internal heat gains

C1. LPD reduction: LPD value of the space should be calculated following explanations in credit E-5. This value should be compared with the LPD value of the same space type in Table 3.5.1 of the Energy Performance Calculation Method in order to calculate the percentage of LPD reduction.

C2. Calculate the percentage of equipment installed (based on power ratings) that meet the requirements of any recognized energy label: Energy Star, VNEEP (minimum 4 stars), etc.

C3. Perform calculations in accordance with Strategy A of credit H-4 Daylighting to demonstrate the daylight factor of the space is between 1.5% and 3.5%. Unlike in credit H-4, spaces with a daylight factor higher than 3.5% and using internal manual shadings are not compliant within this credit.

Example of calculation:

A building located in Hanoi is occupied 10 hours a day during 300 days per year and is divided in 4 thermal zones as shown in Table H.7.

Table H.7: Example – Thermal zones of the building

Thermal zone	Cooling mode	Occupied Area (m^2)	Occupied hours
TZ 1	Air-conditioning	550	2,700
TZ 2	Air-conditioning	780	2,700
TZ 3	Air-conditioning	80	2,700
TZ 4	HVLS fans	240	1,200

After performing an energy simulation, the building obtained the results in Table H.8.

Table H.8: Example - Unmet load hours during the occupied cooling period

Thermal zone	Unmet load hours during occupied cooling
TZ 1	25
TZ 2	2
TZ 3	67
TZ 4	/
Whole building	72

Thermal zone TZ 4 is composed of 2 spaces which both include HVLS fans, the R-value of the external walls surrounding the 2 spaces is equal to 0.73 m^2.K/W (30% higher than QCVN 09:2017/BXD requirements at 0.56 W/m^2.K). The average daylight factor of the first space is equal to 2.8%. The second space is only equipped with appliances that are energy-labelled.

Table H.9: Example – Thermal Comfort compliance for air-conditioned spaces

Thermal zone	Unmet load hours during occupied cooling	Occupied hours	% of unmet load hours	Compliant?
TZ 1	25	2,700	0.93%	Yes
TZ 2	2	2,700	0.07 %	Yes
TZ 3	67	2,700	2.48 %	No

Table H.10: Example – Thermal Comfort compliance for non-air-conditioned spaces

Space	Indoor air velocity?	Reduction of external heat gains?	Reduction of internal heat gains?	Compliant?
Space 1 in TZ 4	HVLS fans	High R-value	Daylight factor = 2.8%	Yes
Space 2 in TZ 4	HVLS fans	High R-value	Energy-labelled equipment	Yes

Table H.11: Example – Occupied area compliant with Thermal Comfort

Thermal zone	Compliant?	Occupied Area (m^2)	Compliant area (m^2)
TZ 1	Yes	550	550
TZ 2	Yes	780	780
TZ 3	No	80	0
TZ 4	Yes	240	240
Total		1,650	1,570
Percentage of occupied area compliant		95.1 %	

95.1 % of the occupied area is compliant with the requirements of the credit and this building can achieve 2 points.

Submissions

Provisional Certification Stage
For all the air-conditioned spaces and mixed-mode ventilated spaces of the building:
• Report using inputs/outputs of the building energy simulation showing the temperature setpoints used and the number of unmet load hours.
For all the non-air-conditioned spaces of the building:
If method 1 is followed: • Report showing calculation of the maximum indoor operative temperature during design day and demonstrating compliance with Section 5.3 of ASHRAE 55-2004.
If method 2 is followed: • Calculations showing compliance with the strategies pursued to limit heat gains and to enhance air velocity • Narrative demonstrating that the strategies implemented effectively improve thermal comfort in the non-air-conditioned spaces.

Full Certification Stage
For all the air-conditioned spaces and mixed-mode ventilated spaces of the building:
If not already approved at Provisional Certification or if there is any change: • Final report using inputs/outputs of the building energy simulation showing the temperature setpoints used and the number of unmet load hours
For all the non-air-conditioned spaces of the building:
If method 1 is followed: If not already approved at Provisional Certification or if there is any change: • Final report showing calculation of the maximum indoor operative temperature during design day and demonstrating compliance with Section 5.3 of ASHRAE 55-2004.
If method 2 is followed: If not already approved at Provisional Certification or if there is any change: • Final calculations showing compliance with the strategies pursued to limit heat gains and to enhance air velocity. • Final narrative demonstrating that the strategies implemented effectively improve thermal comfort in the non-air-conditioned spaces. This can include a survey of the building occupants if the building has been occupied during one hot season.

H-7 Acoustic Comfort

Scope

H-7 credit applies to NR and Residential projects.

Intent

To ensure a proper acoustic comfort within buildings.

Requirements

NR (1 point)

Only one of the 2 following options can be pursued:

Option A: Internal Noise Levels

Option A is only available at Full Certification.

Criteria	Points
Limit internal noise to recommended levels in all occupied spaces	1

Option B: Noise absorption and insulation

Criteria	Points
Average reverberation time (T60) in the occupied spaces meet requirements of the Performance Measurement Protocols for Commercial Buildings - AND - Design all walls and floors to comply with the requirements of TCXDVN 277:2002 on airborne and impact sound insulation	1

Residential (1-2 points)

Criteria	Points
Design all walls and floors to comply with the requirements of TCXDVN 277:2002 on airborne and impact sound insulation	1
Exceed requirements of TCXDVN 277:2002 to achieve: • Airborne Sound Insulation = CKtc + 5 dB • Impact Sound Insulation = CVtc – 5 dB	2

Overview

Acoustic comfort is one of the most critical factors to ensure wellbeing and wellness of occupants but it is often overlooked with the primary focus given to functionality and aesthetics of the space.

Noise can come from many different sources, such as interior noise, impact noise, background noise (from HVAC equipment and appliances) and exterior noise. It is important to take into account all these potential noise sources to design buildings that can ensure occupants privacy, speech intelligibility, and acceptable ambient noise levels.

Approach & Implementation

NR Projects

Option A: Internal Noise Levels

Many strategies can be applied to reduce noise levels in the building:

- Use wall, window and roof materials which provide good acoustic insulation properties
- Locate noise-sensitive areas away from noise-producing areas
- Place acoustic buffers, such as corridors, lobbies, stairwells, electrical/janitorial closets and storage rooms, between noise-producing and noise-sensitive spaces
- Proper slab construction between floors
- Screens to reduce the impact of noise from external sources
- Consider acoustic properties when selecting surface finishes
- Avoid locating outside air intakes or exhaust-air-discharge openings near windows, doors, or vents where noise can re-enter the building
- Wrapping or enclosing rectangular ducts with insulation materials and use sound attenuators and acoustic plenums to reduce noise in ductwork

For public buildings, spaces should meet requirements set in TCXDVN 175:2005 – Maximum permitted noise levels for public buildings – Design standard. Table H.12, which is an extract of Table 2 from TCXDVN 175:2005, shows the maximum allowable noise levels applicable to spaces that do not require high acoustic quality.
The maximum allowable noise level is the noise level in the room that must not be exceeded in order to ensure acoustic comfort suitable for the activity in the room.
More information and guidance can be found within the standard for spaces that require high acoustic quality.

For industrial buildings, manufacturing spaces should meet requirements set in QCVN 24:2016/BYT – National technical regulation on noise – Permissible exposure levels of noise in the workplace. Other spaces such as offices spaces, medical rooms should follow requirements set in TCXDVN 175:2005.

Table H.12: Maximum allowable noise level for public buildings *(Source: Extract from Table 2 - TCXDVN 175:2005 - Maximum permitted noise levels for public buildings – Design standard)*

Space type	Time (hr)	Maximum noise level (dB,A)
EDUCATION FACILITIES		
1 - Kindergarten, nursery, boarding primary schools		
Bedrooms in kindergarten, boarding primary schools	6 - 22	45
	22 - 6	35
Classrooms	-	50
Playground (outside)	-	55
Areas around schools (outside)	-	60
2 - Secondary or tertiary schools, universities, colleges, vocational schools		
Conference hall	-	45
Lecture hall, classrooms	-	50
Labs	-	50
Offices in schools	-	50
Staff rest rooms	-	55
OFFICES		
3 - Office buildings, Design and Research facilities		
Working spaces, with office equipment, computers	-	50
Reception rooms	-	50
4 - Court		
Court room	-	45
Working spaces	-	50
COMMERCIAL & SERVICE FACILITIES		
5 - Shops, malls, supermarkets	-	60
6 - Restaurants, beverage shops	-	55
7 - Public service centers: laundry, clothes tailor, equipment and electronics repair, hairdresser, etc.	-	60
8 - Central market (with or without roofs)	-	60

Internal noise levels should be measured in accordance with TCVN 5964 - 1995: Description and measurement of environmental noise.

Option B: Noise absorption and insulation

Reverberation time:

Average reverberation time (T_{60}) in the occupied spaces of the project must meet values from Table H.13 for the frequencies of 500 Hz, 1000 Hz, and 2000 Hz.

A reverberation is the overall effect of reflected sound and the time required for reflected sound to become inaudible. The reverberation time (T_{60}) measures the reflectivity of a room and consequently a room's absorbance to sound waves.

The reverberation time is proportional to the volume of the space, and inversely proportional to the amount of sound absorbing material within the space. Also, the reflectivity will depend on the geometry of the room, the room fitting and the nature of noise source.

High reverberation times lead to poor speech intelligibility even if noise levels are maintained to acceptable levels. For classrooms, conference/meeting rooms, it is of first importance to ensure that low reverberation times are achieved.

Table H.13: Reverberation time requirements (*Source: Performance Measurement Protocols for Commercial Buildings: adapted from ASHRAE (2007d), ASA (2008), ANSI (2002), and CEN (2007))*

Space type	Application	T_{60} (sec)
Apartment & condominium	-	< 0.6
Hotel/motel	Individual room or suite	< 0.6
	Meeting or banquet room	< 0.8
Office building	Executive or private office	< 0.6
	Conference or Teleconference room	< 0.6
	Open-plan office	< 0.8
Hospital & Clinic	Private rooms	< 0.6
	Wards	< 0.6
Courtroom	Unamplified speech	< 0.7
	Amplified speech	< 1.0
Performing arts space	Drama theaters, concert and recital halls	Varies by application
Laboratories	Testing or research with minimal speech communication	< 1.0
	Extensive phone use and speech communication	< 0.6
Library	-	< 1.0
Indoor stadium, gymnasium	Gymnasium and natatorium	< 2.0
	Large-capacity space with speech amplification	< 1.5
School	Classroom	< 0.6
	Large lecture room with speech amplification	< 0.7
	Large lecture room without speech amplification	< 1.0

NR and Residential Projects

Noise Insulation:

TCXDVN 277-2002 sets forth minimum requirements on sound insulation in buildings (Table H.14). CK^{tc} index is equivalent to the weighted noise reduction index (Rw) and CV^{tc} is equivalent to the weighted normalized impact level (Ln,w). The standard introduces classes for defining wall and floor insulation requirements depending on the types of rooms they divide (Table H.15).

Table H.14: Minimum requirements for airborne and impact sound insulation of building elements between rooms (*Source: TCXDVN 277-2002*)

Class	Airborne Sound Insulation	Impact Sound Insulation
Class I	$CK^{tc} \geq 55$	$CV^{tc} \leq 58$
Class II	$CK^{tc} \geq 50$	$CV^{tc} \leq 62$
Class III	$CK^{tc} \geq 45$	$CV^{tc} \leq 66$

Table H.15: Definition of floor and walls included in the noise classes of TCXDVN 277-2002.

Class	Building types and types of separation between rooms
Class I	Elements requiring good sound insulation level: • Cultural buildings, music schools: floors and walls between music practicing rooms and music performing rooms; • Administration buildings, offices, hospitals: floors and walls of areas that require a high level of quietness; • Hotels of ≥ 4-star: floors and walls between guest rooms; • Residential buildings, hotels, administration offices: floors and walls between bedrooms and working rooms adjacent to high noise-activity rooms;
Class II	Elements requiring medium sound insulation level: • Multifamily residential buildings: floors and walls between bedrooms, common areas of dwelling units; walls between bedrooms, common rooms and kitchen, bathroom, WC, stairway area; • Apartments, dormitories, unranked hotels: floors and walls between guest rooms; walls between guest room and corridor, stairway area; • Administration buildings, offices: floors and walls between working rooms, conference rooms; • Hospitals, hotels: floors and walls between guest rooms, patient's rooms, operation rooms, doctor's rooms, TV-watching rooms, reading rooms; • Schools, colleges, universities: walls between classrooms, amphitheaters, laboratories, reading rooms;
Class III	Elements requiring low sound insulation level: • Multifamily residential buildings: wall between rooms within a dwelling unit; • Hotels: wall between in-room facilities within a room unit; • Administration buildings, offices, restaurants: floors and walls between transaction rooms, withdrawing rooms, waiting rooms; • Schools, colleges, universities: floors between classrooms, amphitheaters; walls between classroom, amphitheater and corridor.

Many strategies can be applied to improve sound insulation:

- Locate noise-sensitive areas away from noise-producing areas
- Place acoustic buffers, such as corridors, lobbies, stairwells, electrical/janitorial closets and storage room, between noise-producing and noise-sensitive spaces
- Proper slab construction between floors
- Screens to reduce the impact of noise from external sources
- Consider acoustical properties when selecting surface finishes
- Avoid locating outside air intake or exhaust-air-discharge opening near windows, doors, or vents where noise can re-enter the building
- Wrapping or enclosing rectangular ducts with isolation materials and use sound attenuators and acoustic plenums to reduce noise in ductwork

Mixed-use Residential/NR Projects

- For projects considered as NR projects:
  To be able to score 1 point in the credit, both NR components should meet requirements for NR projects -AND- Residential components of the project should meet the requirements to achieve at least 1 point for Residential projects.
- For projects considered as Residential projects:
  For points to be awarded, both Residential and NR components should meet requirements for Residential projects.

Calculations

NR Projects

Reverberation Time:

At design stage, reverberation time can be calculated theoretically using a modelling software that includes an acoustic component or by using the Sabine formula:

$$T_{60} = \frac{0.161 \times V}{A}$$

V = Volume of the space (m^3)

A = Sound absorption of the space (m^2 metric sabin)

With:

$$A = \sum S_i \times \alpha_i$$

S_i = area of the surface i (m^2)

α_i = absorption coefficient (or attenuation coefficient) of the surface i at a specific frequency

All surfaces (walls, floors, ceilings) of the spaces should be taken into account in the calculation of A, the sound absorption of the space.

Reverberation times should be calculated for all spaces at each frequency (500 Hz, 1000 Hz, and 2000 Hz) and all calculated values should comply with requirements in Table H.13.

At the end of construction, reverberation time values can be found through measurements in accordance with ISO 3382 Acoustics - Measurement of the reverberation time for rooms with reference to other acoustical parameters. Reverberation times should be measured for the frequencies of 500 Hz, 1000 Hz, and 2000 Hz.

NR and Residential Projects

Noise Insulation:

The calculations of CKtc and CVtc shall be made according to:

- ISO 717-1 – Rating sound insulation in buildings and of building elements. Part 1: Airborne Sound Insulation
- ISO 717-2 – Acoustics – Rating sound insulation in buildings and of building elements. Part 2: Impact Sound Insulation

Submissions

Provisional Certification Stage	NR Option A	NR Option B	R
Reverberation Time:			
• Tender drawings showing the surface materials of all the occupied spaces		✓	
• Tender specification extracts -OR- Manufacturer's data of the surface materials proposed to absorb sound.		✓	
• Calculations of the reverberation times for all the occupied spaces		✓	
Noise Insulation:			
• Report detailing the design strategies and technologies employed to ensure the proper level of acoustic insulation		✓	✓
• Tender schedule listing all the designed floor and wall classes (as specified in TCXDVN 277-2002) and showing CKtc and CVtc values calculated		✓	✓
• Tender detailed drawings showing sections of all the classes of floor and walls, as well as their junctions		✓	✓
• Tender specification extracts -OR- Manufacturer's data of the materials proposed to ensure the proper level of acoustic insulation, indicating their acoustic properties		✓	✓
• Calculations of CKtc and CVtc values		✓	✓

Full Certification Stage	NR Option A	NR Option B	R
Internal Noise Levels: • Test reports showing internal noise levels measurements and showing compliance with TCXDVN 175:2005	✓		
Reverberation Time: Either: • As-built drawings showing the surface materials of all the occupied spaces • Manufacturer's data of the surface materials installed to absorb sound • Final calculations of the reverberation times for all the occupied spaces -OR- • Test reports showing the results of the measurements of the reverberation times for all the occupied spaces and showing compliance with requirements		✓ ✓ ✓ ✓	
Noise Insulation: • As-built detailed drawings showing sections of all the classes of floor and walls, as well as their junctions • Manufacturer's data of the materials installed to ensure the proper level of acoustic insulation, indicating their acoustic properties • Evidence that the acoustic insulation materials and strategies were employed such as photographs, invoices, receipts, commissioning report, etc.		✓ ✓ ✓	✓ ✓ ✓
If not already approved at Provisional Certification or if there is any change: • Final report detailing the strategies and technologies employed to ensure the proper level of acoustic insulation • Final schedule listing all the designed floor and wall classes (as specified in TCXDVN 277-2002) and showing CKtc and CVtc values calculated • Final calculations of CKtc and CVtc values		✓ ✓ ✓	✓ ✓ ✓

Site & Environment

Climate change is widely accepted as being among the greatest challenges to face the human race this century. Today, the term climate change is generally used with regard to changes in global climate, which result from human activities. The impacts of climate change can be seen in the form of stronger and more frequent storms, frequent flooding and drought, sea level rise, and other extreme weather phenomena.

In the first part of the century, it has been predicted that Vietnam will be one of the five countries most affected by climate change. Therefore, it is crucial for buildings to start incorporating design strategies and technologies to improve resilience to natural disasters and maximize life span.

All credits within the Site & Environment Category target the building's resistance towards natural disasters, the protection of the ecology of the site and the reduction of pollution including GHG emissions. A green building has to account for natural disaster risks and, at the same time, should alleviate its own impacts on climate change by increasing the perviousness of the site and reducing the amount of paved surface that contributes to the heat island effect. It should also reduce the consumption of fossil fuels required for transport by inhabitants, throughout the life of the building.

Credit	Title	NR	Residential
SE-1	Flooding Resistance	1 point	1 point
SE-2	Development Footprint	2 points	2 points
SE-3	Vegetation	4 points	4 points
SE-4	Stormwater Management	2 points	2 points
SE-5	Heat Island Effect	2 points	2 points
SE-6	Refrigerants	2 points	1 point
SE-7	Construction Activity Pollution Control	1 point	1 point
SE-8	Light Pollution Minimization	1 point	1 point
SE-9	Green Transportation	3 points	3 points
SE-10	Community Connectivity	1 point	1 point
SE-11	Outdoor Communal Space and Facilities	2 points	2 points
	Total of points available	21 points	20 points

SE-1 Flood Resistance

Scope

SE-1 credit applies to NR and Residential projects.

Intent

To encourage flood resistant designs and building features to adapt to climate change.

Requirements

NR & Residential (1 point)

Criteria	Points
Building design resists current highest flood level	1

Overview

Flooding is one of the biggest problems for urban areas as it causes severe damage to communities, buildings and the local economy. It is expected that flooding frequency and intensity will increase dramatically due to the impacts of climate change. In addition, the rapid growth of both Vietnam's economy and population has contributed to a great pressure on its aging and inadequate infrastructure system. Drainage systems in highly populated cities are seasonally overloaded and natural drainage systems are gradually disappearing in the rapid expansion of population and urban structures.

Currently flood hazard mapping is very limited in Vietnam but there will be increasing availability of useable maps over the next few years as research in this area grows in popularity amongst universities as well as the government.

Approach &Implementation

To demonstrate that the building design resists current highest flood level, the project shall prepare a local flood risk report including the following information:

- A Flood map, if available, identifying whether the selected site is within flood prone area
- All relevant published data from local hydrometeorology institutes or other qualified organizations including:
  - Precipitation/rainfall level and history
  - Local history of storms
  - Tropical low pressure and flooding

  - Predicted climate change impacts like increased storm frequency or sea level rise
- A local flood survey that must be conducted to collect information from local communities and authorities regarding flooding in the past 15 years. The following information must be collected:
  - Local flood condition type(s)
  - Average and highest frequency per year
  - Annual flood peaks
  - Average and highest intensity/water height
  - How long the area remains flooded after all inputs halt
  - Existing flood hazards
  - Main cause(s) of flooding
- Potential flood damage to buildings
- If possible, flooding trend for the next 50 years and worst-case scenario

Then, based on the flood risk report, the project should employ strategies to increase building's ability to resist flood damage, such as:

- Elevate buildings above the predicted flood level by piers, piles, columns or bearing walls
- Flood-proof the lower levels of buildings by sealing them against water penetration
- Employ wet flood-proofing methods
- Arrange all mechanical and electrical equipment in water-tight units or higher than the highest predicted flood level in the building
- Install water resistant and easy-to-clean materials for lower floors

Submissions

Provisional Certification Stage
• Local flood risk report • Report indicating the strategies employed for the building to resist current highest flood level • Tender stage plans indicating the flood resistance factors and strategies employed

Full Certification Stage
• As-built plans indicating the flood resistance factors and strategies employed
If not already approved at Provisional Certification or if there is any change: • Local flood risk report • Final report indicating the strategies employed for the building to resist current highest flood level

SE-2 Development Footprint

Scope

SE-2 credit applies to NR and Residential projects.

Intent

To minimize the area affected by any development activity.

Requirements

NR & Residential (1-2 points)

Criteria	Points
Reduce the development footprint and/or provide open space within the project boundary to exceed the local open space requirement for the site by 10%	1
Reduce the development footprint and/or provide open space within the project boundary to exceed the local open space requirement for the site by 20%	2

Overview

Minimizing the development footprint helps conserve the existing natural areas and restore damaged areas to provide habitat and promote biodiversity. Providing open space can contribute to the mitigation of environmental impacts including land consumption and rainwater runoff and create physiological as well as psychological benefits for building occupants and the community.

Approach & Implementation

The development footprint is the total area of the building footprint and areas affected by the development or by project site activity. Building footprint is the area used by the building structure and defined by the perimeter of the building. Parking lots, parking garages, access roads and other non-building facilities are not included in the building footprint, but they are included in the development footprint (Figure G1 of the Glossary).

In Vietnamese setting, open space is the space not used for the purpose of construction of buildings and facilities, adjacent to the space used for residential or non-residential buildings.

Building footprint, construction density and open space are governed by local departments of planning and architecture in accordance with a master plan. Projects however can adopt effective strategies for the site design to remain compliant and better than the mandatory requirements while creating environmental benefits and improving building functionality.

Strategies that can be considered include but are not limited to:

- Making provision for more dense development
- Ensuring the efficient use of land by designing blocks, lots and buildings together
- Increasing setback distances to protect natural areas
- Design responding to the environmental constraints of the location
- Retain existing vegetation and ecology
- Enhance natural and heritage features and views
- Reinforce and continue existing open-space networks and greenbelts, through and between settlements

Another strategy can be followed to increase the open space of the project, which is to make the roof accessible to occupants. Will qualify as open space, the area of the roof that is accessible to all occupants and that is vegetated and/or provides social / recreational value (seating, swimming pool, playground, etc.).

Calculation

Calculation is based on area. Percentage of development footprint reduction can be calculated by the following method:

- Quantify allowed construction density
- Quantify development footprint area of the project
- Quantify open space area on the roof
- Demonstrate development footprint reduction with the following formula:

$$\text{Development Footprint Reduction } [\%] = \left(\frac{D_f - R_{open}}{C_d \times A_{site}}\right) \times 100$$

C_d = Allowed construction density [%]

A_{site} = Total site area [m^2]

D_f = Development footprint area of the project [m^2]

R_{open} = Area of the roof qualifying as open space [m^2]

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that the development footprint local has been reduced by more than 30% or that the open space requirement for the site is exceeded by more than 30%.

Submissions

Provisional Certification Stage
• Documents provided by local planning and architecture department with instructions based on 1:2000 detailed urban construction plan on building heights, number of stories, GFA, construction density, land-use ratio • Planning and Architectural Certificate, issued to the project by local department of planning and architecture • 1:500 urban construction plan prepared by the project owner • Narrative report showing criteria compliance of the site planning. In order to be awarded with points, the reduction of development footprint, building footprint and increase of open space must be calculated.

Full Certification Stage
• As-built drawings showing the project has been constructed as previously intended.
If not already approved at Provisional Certification or if there is any change: • Submit all the submittals required at Provisional Certification stage

SE-3 Vegetation

Scope

SE-3 credit applies to NR and Residential projects.

Intent

To encourage the introduction of more sustainable greenery into the built environment.

Requirements

NR & Residential (1-4 points)

Criteria	Points
Strategy A: Greenery Index	
Provide greenery to achieve a Greenery Index higher than 1.0	1
1 point for every additional 0.5 point of Greenery Index achieved	4
Strategy B: Landscape management plan (Not applicable to projects with a Greenery Index lower than 1.0)	
Establish and implement a landscape management plan	1

Overview

Site vegetation greatly contributes to the improvement of the site's microclimate, ventilation and scenery. Moreover, vegetation can lead to the restoration of topsoil, prevent erosion, enhance biodiversity onsite and increase the size of the carbon sink and the ability of the area to absorb greenhouse gases.

For these reasons, maximizing the amount of vegetation is encouraged; however, introduced species (non-native species) and more particularly invasive species must be avoided as they risk changing an entire habitat, placing ecosystems at risk, crowding out or replacing native species that are beneficial to a habitat and damaging undeveloped habitats.

The traditional strategy to maximize the area of on-ground vegetation is less and less appropriate with the increasing urban areas and new strategies that maximize green while minimizing land use are encouraged, such as: green roofs, green sky terraces, green walls, etc.

Once vegetation is introduced onsite, focused efforts and planning should be made to maintain the landscape to ensure a healthy habitat whilst minimizing the use of water and chemical fertilizers.

Approach & Implementation

Strategy A: Greenery Index

Maximize greenery onsite with the following solutions:

- Install vegetation on ground, walls, roofs, sky terraces and balconies (Figure SE.1)
- Select tree species with dense and large canopies
- Plant cluster of palm trees

Figure SE.1: Different types of vegetated areas that can be incorporated within a development (*Source: URA - Urban Redevelopment Authority of Singapore*)

Strategy B: Landscape management plan

The landscape management plan shall at a minimum address the following points:

- Vegetation map and list of species: A framework and commitment to maintain the same vegetation patterns for at least 5 years
- Inspection and records: A framework and commitment to maintain records of maintenance activities
- Sustainable landscape maintenance: Details of the landscape's maintenance needs and appropriate landscape practices. A commitment and schedule for actions such as mulching, composting, weeding, sweeping, pruning and removal of diseased plants
- Water conservation: Details of the landscape's irrigation methods and needs and a commitment to water only when necessary
- Chemical fertilizers and pesticides: Details of the landscape's chemical fertilizer needs (if any) and a commitment to prioritize the use of organic fertilizers, organic compost and/or minimize the use of chemical fertilizers and pesticides
- Native plant species selection: A commitment to plant native species wherever practical

Calculation

Strategy A: Greenery Index

Projects should perform calculations using the LOTUS NC V3 Calculator – Greenery Index in which the Greenery Index is calculated with the following formula:

$$Greenery\ Index = Green\ Plot\ Ratio\ (GnPR) + W = \frac{Total\ leaf\ area}{Site\ area} + W$$

Where the total leaf area is calculated as:

$$Total\ leaf\ area = \sum A_i \times B_i \times C_i$$

With:

A_i = LAI (Leaf Area Index) Value of plant species i

B_i = Canopy area of plant species i

C_i = Quantity (number) or planted area (m^2) of plant species i

A_i, B_i, C_i should be determined based on table SE.1.

Table SE.1: Determination of A_i, B_i, C_i values for total leaf area computation
(Source: URA - Urban Redevelopment Authority of Singapore)

Category	Subcategory	LAI Value (A)	Canopy Area (B)	Quantity / Planted area (C)	Leaf Area (A)x(B)x(C)
Trees	Open Canopy	2.5	60 m^2	Quantity	
	Intermediate Canopy	3.0	60 m^2	Quantity	
	Dense Canopy	4.0	60 m^2	Quantity	
	Columnar canopy	(as above)	12 m^2	Quantity	
	Trees planted at ≤ 2.0m trunk to trunk	(as above)	NA	planted area (m^2)	
	Low trees	(as above)	NA	planted area (m^2)	
Palms	Solitary	2.5	20 m^2	Quantity	
	Cluster	4.0	17 m^2	Quantity	
	Solitary planted at ≤ 2.0m trunk to trunk	2.5	NA	planted area (m^2)	
Shrubs & groundcovers	Monocot	3.5	NA	planted area (m^2)	
	Dicot	4.5	NA	planted area (m^2)	
Turf	Turf	2.0	NA	planted area (m^2)	
Vertical greenery	/	2.0	NA	planted area (m^2)	
				Total leaf area (m^2)	

Definitions:

- LAI (Leaf Area Index) is a dimensionless quantity that characterizes plant canopies.
- Columnar trees are tall and very thin, with upright branches of uniform length.
- Low trees are trees with a height of 1.0 m or lower at the time of planting.

Notes on calculations:

- To be included in calculations, plants should be incorporated permanently in planting beds with sufficient soil depth to accommodate plants and landscaping. Potted plants should not be counted, at the exception of planters/containers with a volume of 100 liters or more and planter boxes for vertical greenery.
- Many plant species sub-categories and LAI values can be obtained online from NParks' Flora Fauna Web (http://florafaunaweb.nparks.gov.sg) by searching the scientific names of plants or in the database of plant species included in LOTUS NC V3 Calculator – Greenery Index. In case that the information is not available for some tree species, projects should assume they have an intermediate canopy.
- As shown in Table SE.1, for all trees (even trees with columnar canopies) and palms planted with a trunk-to-trunk distance of less than 2 meters and for all low-trees, the leaf area should be calculated as the product of the LAI value and planted area.
- Planted area of shrubs, groundcovers, turf, low-trees and trees/palms planted with a trunk-to-trunk distance of less than 2 meters should be calculated as the overall vegetative area coverage as if seen from above. For trees and palms, the area within the canopy perimeter (the rectangle shown in Figure SE.2) should be considered.

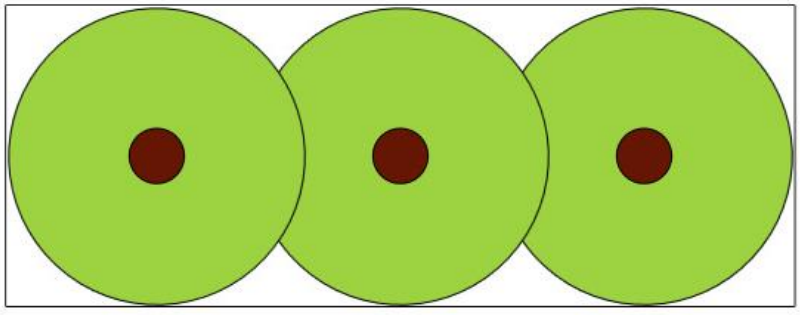

Figure SE.2: Determination of planted area for overlapping trees canopies

- Planted area for vertical greenery should be calculated as:
  - the vertical area the plants are expected to cover at the time of maturity for climbing plants growing on trellises, lattices or cables and for green facades where plants grow upwards from pots fastened to the facade or from a substrate attached to it.
  - the horizontal length of the green area multiplied by 1.0 m for self-climbing plants or for hanging plants

- When trees or palms are planted into turf or groundcover, the full area can be considered as planted area for turf of groundcover (the area of trunks doesn't need to be counted).
- Bamboo species should be considered as shrubs
- All herbaceous plants that are not turf should be considered as groundcovers.

Example of plants in the different sub-categories are given in Table SE.2.

Table SE.2: Example of plants in the different sub-categories
(Source: NParks' Flora Fauna Web, http://florafaunaweb.nparks.gov.sg)

Category	Subcategory	Example of plants (Scientific name / Vietnamese name)
Trees	Open Canopy	- Araucaria heterophylla / Cây tùng bách tán - Cassia fistula L. / Cây Muồng hoàng yến
	Intermediate Canopy	- Ficus superba Miq / Cây Sộp - Terminalia mantaly / Cây Bàng Đài Loan
	Dense Canopy	- Mimusops elengi L. / Cây Viết - Mangifera indica. L. / Cây xoài
Palms	Solitary	- Elaeis guineensis / Cây Cọ Dầu
	Cluster	- Chryslidocarpus lutesceus, Dypsis lutescens / Cây Cau vàng
Shrubs & Groundcovers	Monocot	- Heliconia psittacorum / Cây Hoa Chuối Mỏ Két - Bambusa vulgaris / Cây Tre Vàng Sọc
	Dicot	- Arachis pintoi / Cỏ đậu phộng, Cỏ Lạc - Tabernaemontana divaricate / Cây Hoa Lài Trâu

W represents the overall additional weight coefficient calculated as follows:

$$W = \frac{\sum W_i \times A_i \times B_i \times C_i}{Site\ area}$$

With:

A_i, B_i and C_i as determined above

W_i = Additional weight coefficient given to group of plants i and calculated as the sum of the weight coefficients allocated for sustainable planting strategies or invasive species for the group of plants i

For all the following sustainable planting strategies, a weight coefficient of 0.5 is allocated:

- Conserve/retain plants from existing site
- Use plants native to Southeast Asia
- Install plants that attract biodiversity (birds, bees, butterflies, etc.)
- Grow plants on preserved/restored topsoil.
  - If the site has a healthy topsoil, it should be preserved by limiting disturbance and protecting it from erosion and compaction or by removing, stockpiling and reusing it.
  - If the topsoil in the project site has already been disturbed, depending on the quantity and quality of the existing topsoil, projects should use appropriate methods to restore a healthy topsoil, such as: importing a topsoil, using a soil blend, tilling the soil to correct compaction, importing organic matter (such as compost), adding sand, etc.

- Provide on-site food production with fruit trees, vegetables, herb plants or other edible uses. The project should ensure through a policy that the plants will be well-maintained and that all food produced will be made available to the building occupants and/or local communities.
- Grow medicinal plants. The project should ensure through a policy that the plants will be well-maintained, that they will be used for identified medicinal purposes and that they will be made available to the building occupants and/or local communities.

For invasive plant species that can be found on the Global Invasive Species Database (www.iucngisd.org) and are not native plants, a negative coefficient of -0.5 should be used.

Example of calculation:

A project with a total site area of 2,400 m^2 has installed the following plants:

- 6 trees of species Mangifera indica. L. / Cây xoài
- 13 palm trees of species Elaeis guineensis / Cây Cọ Dầu
- 20 m^2 of groundcover of species Spathiphyllum Wallisii / Cây Lan Ý
- 150 m^2 of groundcover of species Wedelia trilobata / Cỏ Xuyến Chi

Table SE.3: Example: Calculation of total leaf area of the site

Plant species	Category	LAI Value (A)	Canopy Area (B)	Quantity / Planted area (C)	Leaf Area (A)x(B)x(C)
Mangifera indica. L. / Cây xoài	Tree – Dense canopy	4.0	60 m^2	6 trees	1440 m^2
Elaeis guineensis / Cây Cọ Dầu	Palm - Solitary	2.5	20 m^2	13 palms	650 m^2
Spathiphyllum Wallisii / Cây Lan Ý	Groundcover - Monocot	3.5	NA	20 m^2	70 m^2
Wedelia trilobata / Cỏ Xuyến Chi	Groundcover - Dicot	4.5	NA	150 m^2	675 m^2
				Total leaf area	2835 m^2

Table SE.4: Example: Calculation of the overall additional weight W

Plant species	Leaf Area (A)x(B)x(C)	Sustainable planting strategies / invasive plants	Additional weight (W_i)	Total additional weight (A)x(B)x(C)x(W_i)
Mangifera indica. L. / Cây xoài	1440 m^2	Plant retained from existing site , native plant and fruit tree	0.5 + 0.5 + 0.5 = 1.5	2160 m^2
Elaeis guineensis / Cây Cọ Dầu	650 m^2	/	0	0 m^2
Spathiphyllum Wallisii / Cây Lan Ý	70 m^2	- Native plant	0.5	35 m^2
Wedelia trilobata / Cỏ Xuyến Chi	675 m^2	- Invasive plant species	- 0.5	- 337.5 m^2
			Total additional weight	1820 m^2

The Greenery Index can be calculated as the sum of the total lead area and the total additional weight divided by the project site area as follows:

$$Greenery\ Index = \frac{2835 + 1820}{2400} = 1.94$$

For this project, a Greenery Index of 1.94 is achieved and three points can be awarded.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates through Strategy A that a Greenery Index higher than 3.0 has been achieved.

- AND -

One point in Credit EP-1 can be awarded if the project demonstrates that 4 points are achieved under Strategy A and 1 point is achieved under Strategy B.

Submissions

Provisional Certification Stage
For both strategies:
• Landscape plans showing all the plants to be provided on the project and showing the number and/or area to be provided • Fully completed LOTUS NC V3 Calculator – Greenery Index If claiming additional weight in calculations for preserved/restored topsoil: • Report describing the strategies to be implemented to preserve and/or restore topsoil If claiming additional weight in calculations for on-site food production or medicinal plants: • Report describing the strategies to be implemented to produce food and medicinal plants
Strategy B: Landscape management plan
• Copy of the landscape management plan -OR- Tender specifications showing that a landscape management plan will be produced

Full Certification Stage
For both strategies:
• As-built landscape plan • Evidence showing the greenery installed on the project such as photographs, delivery orders, material approval requests, etc. If claiming additional weight in calculations for preserved/restored topsoil: • Evidence showing that a healthy topsoil has been preserved and/or restored such as photographs, soil test results, receipts, etc. If claiming additional weight in calculations for on-site food production or medicinal plants: • Copy of the policy from building owner committing to maintain plants and to make all food produced and medicinal plants available to the building occupants and/or local communities

If not already approved at Provisional Certification or if there is any change:

- Fully completed LOTUS NC V3 Calculator – Greenery Index
- As-built landscape plan showing all the plants that have been installed on the project and showing the number and/or area that have been installed

If claiming additional weight in calculations for preserved/restored topsoil:

- Final report describing the strategies implemented to preserve and/or restore topsoil

If claiming additional weight in calculations for -site food production or medicinal plants:

- Final report describing the strategies implemented to produce food and medicinal plants

Strategy B: Landscape management plan

- Final landscape management plan
- Evidence showing that the landscape management plan was included in specifications for the building / landscape management team and showing that the plan is implemented.

SE-4 Stormwater Management

Scope

SE-4 credit applies to NR and Residential projects.

Intent

To reduce stormwater runoff and thus reduce temporary load to municipal drainage system, reduce urban flooding risks and improve groundwater recharge.

Requirements

NR & Residential (1-2 points)

Only one of the 2 following options can be pursued:

Option A: Site perviousness

Option A is only available to projects that have a non-building area + green roof area that makes up more than 20% of the total site area or makes up more than 200 m^2.

Criteria	Points
Average perviousness of the site is at least 30%	1
Average perviousness of the site is at least 50%	2

Option B: Stormwater Control

Option B is available to all projects.

Criteria	Points
Decrease volume of on-site stormwater runoff from the 2-year storm event by 30%	1
Decrease volume of on-site stormwater runoff from the 2-year storm event by 50%	2

Overview

Stormwater runoff is the water created during precipitation events which is then fed into sewer or river systems. All precipitation that falls on surfaces within the building's site boundary is considered to be stormwater runoff.

Reducing storm water runoff decreases the site's contribution to downstream flooding. This is increasingly important as high intensity precipitation resulting from climate change threatens to increase flood levels and flooding frequency. The reduction of storm water runoff quantity and/or the improvement of its quality will reduce the amount of pollutants washed into water bodies.

One way to maximize site perviousness is to minimize hard surfaces and where hard surfaces are required, use pervious surface materials that allow water to pass through them. These strategies allow the site to take advantage of the infiltration capacity of the native soil. This is critical in minimizing the impact on ground water quantity and quality, and reducing local flooding. Moreover, this strategy also prevents soil erosion.

Stormwater management is the overall culmination of techniques used to reduce surface run-off from causing flooding and dispersing pollutants. Stormwater management consists in detaining, retaining, or providing a discharge point for stormwater to be reused or infiltrated into the groundwater. It should best preserve or mimic the natural hydrologic cycle and fit within the capacity of existing infrastructure.

Approach & Implementation

Option A: Site perviousness

The most effective way to control storm water runoff quantity and quality is to increase the permeability of outside areas and to restore the site's natural functions.
Strategies to increase the site perviousness include:

- Maximize vegetated areas, such as gardens and lawns.
- Use permeable hardscaping materials for driveways, parking lots and walkways such as:
  - Permeable paving blocks or open-grid pavement
  - Porous asphalt or porous concrete
  - Unbound gravel
  - Wood
  - Mulch
  - Brick, cobbles or natural stone arranged to promote infiltration
- Installation of green roofs

Option B: Stormwater Control

The following stormwater control practices can be used to decrease the volume of on-site stormwater runoff by capturing and/or infiltrating stormwater:

- Use of vegetated swales, biofiltration swales, wetlands, dry wells and rain gardens improving water quality and infiltration

- Installation of retention and/or detention systems
- Installation of bioretention basins
- Installation of stormwater harvesting systems capturing stormwater from impervious surfaces

Note: Swimming pools and ponds not designed for stormwater management are not able to capture stormwater runoff and are to be considered as impervious.

Calculations

Option A: Site perviousness

The calculation shall take into account the entire site, less the area of any building footprint not covered by a green roof.

Use the following method to determine the perviousness of the site:

- Quantify site area not occupied by a building
- Identify the area of each type of space (hardscaping, landscaping and green roof) used
- Identify the runoff coefficient of each these spaces
- Calculate the average site perviousness using the following formula:

$$\text{Site Perviousness } [\%] = \frac{\sum A_i \times (1 - C_i)}{A_{site} + A_{green}} \times 100$$

A_i = Area of space type i (hardscaping, landscaping and/or green roof) [m^2]

C_i = Run-off coefficient of covering surface for space type i

A_{site} = Total site area minus building footprint(s) [m^2]

A_{green} = Green roof area [m^2]

Runoff coefficients in Table SE.5 should be used for the average site perviousness calculation unless manufacturer's published data is available for a specific surface material.

Table SE.5: Runoff Coefficients of different surfaces
(Source: Adapted from TCVN 7957:2008, American Society of Civil Engineers)

Character of surface	Runoff Coefficient
Pavement	
Roofs	0.92
Asphalt	0.90
Brick pavers	0.80
Concrete	0.92
Gravel (unbound)	0.7
Permeable pavers	0.5

Lawns (Sandy soil)	
Average slope 0-2%	0.1
Average slope 2-7%	0.15
Average slope > 7%	0.2
Lawns (Heavy soil)	
Average slope 0-2%	0.15
Average slope 2-7%	0.2
Average slope > 7%	0.25
Others	
Garden bed/rain garden	0.15
Playgrounds	0.25

Option B: Stormwater Control

Reduction of the volume of stormwater runoff from the 2-year storm event can be calculated by the following method:

- Calculate the total volume of stormwater runoff from the site for the 2-year storm event following section 4.2 of TCVN 7957:2008 - Drainage and sewerage - External Networks and Facilities - Design Standard. The amount of stormwater to be drained from site through public stormwater system should not be excluded from the total volume.
- Estimate the volume of stormwater captured in the stormwater harvesting systems and in the detention/retention basins.
- Estimate the volume of stormwater infiltrated through bioretension, dry wells, infiltration basins, bioswales, etc.
- Reduction of the volume of stormwater runoff should be calculated with the following formula:

$$\text{Stormwater volume reduction } [\%] = \frac{\text{Stormwater volume captured/infiltrated}}{\text{Total stormwater runoff volume}} \times 100$$

Exceptional Performance

Option A: Site perviousness

One point in Credit EP-1 can be awarded if the project demonstrates in Option A that the average perviousness of the site is at least 70%.

Option B: Stormwater Control

One point in Credit EP-1 can be awarded if the project demonstrates in Option B that the volume of on-site stormwater runoff from the 2-year storm event has been decreased by more than 70%.

Submissions

Provisional Certification Stage	Option A	Option B
• Tender site plan indicating all types of hardscape/landscape areas proposed and/or all types of stormwater control practices proposed to capture and/or infiltrate stormwater	✓	✓
• If runoff coefficients other than those from Table SE.5 have been used in calculations, manufacturer's data or logical justification indicating all runoff coefficients used	✓	✓
• Calculation of the average site perviousness indicating adherence to the credit requirements	✓	
• Report explaining the stormwater control practices to be implemented to decrease the volume of stormwater runoff		✓
• Calculation of the reduction of the volume of stormwater runoff		✓

Full Certification Stage	Option A	Option B
• As-built site plan	✓	✓
• Evidence showing the landscaped area, the different materials used for hardscape and the green roof if any, such as photographs, invoices, receipts, etc.	✓	✓
If not already approved at Provisional Certification or if there is any change:		
• As-built site plan indicating all types of hardscape/landscape areas installed and/or all types of stormwater control practices installed to capture and/or infiltrate stormwater	✓	✓
• If runoff coefficients other than those from Table SE.5 have been used, manufacturer's data or logical justification indicating all runoff coefficients used	✓	✓
• Final calculation of the average site perviousness indicating adherence to the credit requirements	✓	
• Final report explaining the stormwater control practices implemented to decrease the volume of stormwater runoff		✓
• Final calculation of the reduction of the volume of stormwater runoff		✓

SE-5 Heat Island Effect

Scope

SE-5 credit applies to NR and Residential projects.

Intent

To minimize heat island effect and to reduce the impact of the built environment on microclimates, as well as human and wildlife populations.

Requirements

NR & Residential (1-2 points)

Criteria	Points
30% of the paved and roof area limits heat island effect	1
50% of the paved and roof area limits heat island effect	2

Overview

A microclimate is a local atmospheric zone that has distinct characteristics relative to its adjacent areas. Built environments can alter existing microclimates if their materials absorb and reradiate solar energy more than pre-existing and surrounding environments. This change in microclimate is known as the urban heat island effect (Figure SE.3).

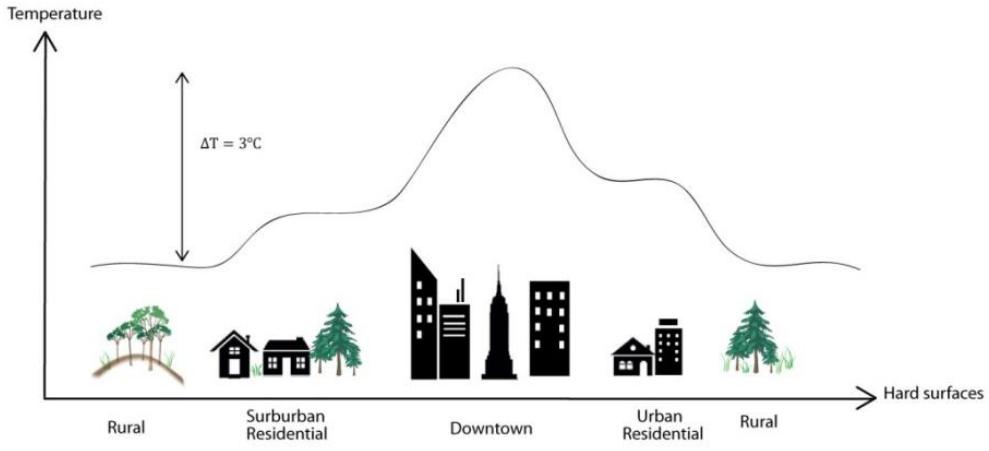

Figure SE.3: Heat island effect

It occurs when the temperature gets warmer in urban landscapes than rural areas and it can cause detrimental effects on air quality, energy consumption and human health.

Urban heat islands are caused by surfaces made of brick, concrete and asphalt (such as streets, sidewalks, parking lots and buildings) that retain the solar energy and reradiate that heat back into the surrounding atmosphere.

Approach & Implementation

Reducing the heat island effect can be achieved by using design strategies below:

- Roofing materials with SRI higher than 78 for low sloped roof (i.e. less than 2:12 rise over run) and 29 otherwise.
- Green roofs covered with real vegetation (no artificial turf grass)
- Open grid pavement systems to reduce paved areas
- Shading devices with solar reflectance index (SRI) higher than 29
- Shading from existing trees canopy or within 10 years of landscape installation (shades must cover paved or roof areas)
- Paving materials with SRI higher than 29
- Solar panels
- Water bodies (pond, pool, fountain)

This list constitutes an exhaustive list of surfaces considered as limiting heat island effect.

Exception: Concrete pavements, due to weathering and accumulation of dust, darken over time. As a result, typical gray concrete pavements that have an SRI at around 35 when new will rapidly have an SRI lower than 29. As concrete is a good alternative to asphalt to reduce the heat island effect, gray concrete can still qualify as compliant but a factor of 0.5 will have to be considered in calculations. As for white concrete pavements, they are still accepted as fully compliant as they can maintain an SRI above 29. In case the whiteness or SRI values of the concrete are not known, all the concrete mixtures using slag cement or white cement can be considered as white concrete.

Calculation

Calculation is based on paved and roof area. All areas on site that are paved or covered so that natural soil is not exposed to sunlight are counted as paved area. Areas covered with mechanical equipment or skylights should be deducted from the roof area.

Percentage of area that limits heat island effect can be calculated by the following method:

- Quantify total site's paved and roof area
- Quantify areas to consider as limiting heat island effect:
  - For shading devices, the area of the device as it can be seen from above.

- For trees, shade must be calculated at 10 a.m., 12 noon, and 3 p.m. on the summer solstice. The arithmetic mean of the 3 values will be used as the effective shaded area. For simplification, 1 m² per tree can also be considered.
- For open-grid pavements, if they are more than 50% unbound, the total area covered should be considered. Else, only the total unbound area can be considered.
- For the other surfaces, the area to consider should be equal to their actual areas.

- Quantify areas that should be deducted from the total paved and roof area
- Calculate the proportion of surfaces limiting heat island effect with the following formula:

$$\text{Limiting Heat Island Effect Surface } [\%] = \frac{\text{A}_{\text{low}} + 0.5 \times A_{gc}}{\text{A}_{\text{total paved + roof area}}} \times 100$$

A_{low} = Area limiting heat island effect [m^2]

A_{gc} = Area of grey concrete pavements [m^2]

$A_{total\ paved\ +\ roof\ area}$ = Sum of the roof area and total site's paved area minus deducted areas [m^2]

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that 70% of the paved and roof area limits heat island effect.

Submissions

Provisional Certification Stage
• Tender stage site plan indicating landscape, paved and roof areas as well as materials proposed for those areas • Tender stage specification extracts -OR- Manufacturer's published data indicating SRI value of all proposed materials -OR- SRI value of materials (data must be from a VGBC approved source) • Calculations demonstrating compliance with the requirements

Full Certification Stage
• As-built roof plan and site plan • Evidence of the materials installed, such as photographs, invoices, receipts, commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: • Manufacturer's published data indicating SRI value of all materials installed -OR- SRI value of materials (data must be from a VGBC approved source) • Annotated roof plan and site plan indicating the different paved and roof areas as well as materials installed in those areas • Final calculations indicating adherence to the credit requirements

SE-6 Refrigerants

Scope

SE-6 credit applies to NR and Residential projects.

Intent

To encourage the selection and use of refrigerants that do not increase global warming nor damage the ozone layer.

Requirements

NR (1-2 points)

Only one of the 3 following options can be pursued with a maximum of 2 points available.

Residential (1 point)

Only Option A or Option B can be pursued with a maximum of 1 point available.

Option A: No Refrigerant Use

Criteria	Points
Residential No air-conditioning system is installed in dwelling-units	1
NR No refrigerant is used in the building	2

Option B: Refrigerant Atmospheric Impact (RAI) of Air-conditioning systems

Criteria	Points
Average Refrigerant Atmospheric Impact of all the air-conditioning systems installed in the building is below 12	1
Average Refrigerant Atmospheric Impact of all the air-conditioning systems installed in the building is below 10	2

Option C: Strategies to limit emissions

Only applicable for non-residential projects with commercial refrigeration systems

Criteria	Points
1 point granted for each of the following strategies implemented for air-conditioning, heat pump and commercial refrigeration systems: - No centralized direct expansion system is used - All refrigerants used have a GWP100 below 2000 and ODP ≤ 0.02 - At least one system (not a stand-alone equipment) is using natural refrigerants - The commercial refrigeration system is an indirect (secondary) system	2

Overview

Common chemical refrigerants used in buildings such as Chlorofluorocarbons (CFCs) and Hydrochloroflourocarbons (HCFCs) have significant Ozone Depleting Potential (ODP) and Global Warming Potential (GWP), thus they contribute to ozone depletion and global warming when emitted to the atmosphere.

HCFCs are being used as a transition chemical to aid the phase out of CFCs due to lower ODP compared to CFCs. These refrigerants are considered as interim medium-term alternatives and not long-term replacements. Under the 2007 Montreal Adjustment on Production and Consumption of HCFCs, Vietnam (Article 5 (developing country) Parties) committed to completely phase out HCFCs (including R-22) by 2030.

Other refrigerants such as HFCs have zero ODP (as they do not contain chlorine), thus they are the current favorable replacements. However, HFCs may have a high GWP (up to 12240). In selecting an ideal refrigerant, a trade-off should be sought between ODP and GWP. The VGBC is aware that refrigerants with lower GWP such as HFOs are beginning to come onto the market.

Approach & Implementation

All options

- No CFC refrigerant or refrigerants with an ODP higher or equal to 0.05 should be installed in the building to be eligible for the credit.
- Systems using less than 250 grams of refrigerant should not be considered in the credit.

Option A: No Refrigerant Use

NR Projects

Buildings using no refrigerants (naturally ventilated buildings) are the most effective to prevent atmospheric impact from the use of refrigerants.

Residential Projects

This option is only applicable for residential projects with effective natural ventilation, which are projects achieving at least 4 points in Strategies A1 and A2 of credit E-4 Building Cooling.

No air-conditioning system shall be installed in the dwelling-units and some information indicating that the building is effectively naturally ventilated and that the use of air-conditioning might not be necessary shall be included in the Building User's Guide required in Management Prerequisite 2.

Option B: Refrigerant Atmospheric Impact of Air-conditioning systems

NR Projects

Projects with commercial refrigeration systems shall meet the requirements of at least one strategy of the Option C to be eligible for points under option B.

Refrigerants that have a limited atmospheric impact such as those in Table SE.6 should be selected. In general, such refrigerants should have both low GWP_{100} values (under 2000) and ODP values of 0.

The atmospheric impact of refrigerants can also be limited by using equipment which uses a low refrigerant charge (centralized direct expansion systems to be avoided) and which can ensure a lower leakage rate of the refrigerant (under 2% per year).

Table SE.6: List of some selected refrigerants that have a limited atmospheric impact (Source: values from IPCC Fifth Assessment Report 2013)

Refrigerant	ODP	GWP_{100}
R134a	0	1,300
R407A	0	1,923
R407C	0	1,624
R410A	0	1,924
CO_2	0	1

Option C: Strategies to limit emissions

NR Projects

This option is only applicable for projects with commercial refrigeration systems. Commercial refrigeration equipment includes the following:

- Walk-in refrigerators
- Walk-in freezers
- Refrigerated casework

To reduce the refrigerant atmospheric impact of commercial refrigeration and heat pump systems, different strategies can be implemented:

- Centralized direct expansion systems shouldn't be used as such systems have high refrigerant charge and high leakage rate.
- All the refrigerants should have a GWP_{100} below 2000 and an ODP ≤ 0.02. Refrigerants like the R404A, still commonly used and with a high GWP_{100} (3943 under IPCC fifth assessment) should be discouraged as many alternatives from other HFCs (such as R134a, R407A...) to HFOs exist.

- Natural refrigerants should be used in as many systems as possible; they have extremely low GWP_{100} values and can be used efficiently for heat pumps (with CO_2) and for commercial refrigeration in configurations such as cascade or indirect systems (with CO_2, propane, etc.).
- Indirect (also called secondary loop) systems are systems that use a chiller to cool a secondary fluid that is then circulated throughout the building to the cases and coolers. With a much lower refrigerant charge, these systems are effective to limit the warming impact of commercial refrigeration.

Mixed-use Residential/NR Projects

- For projects considered as NR projects: To be able to score points, the Residential components of the project should meet requirements for Residential projects (in Option A or Option B).
- For projects considered as Residential projects: For 1 point to be awarded, both Residential components should meet requirements for Residential projects (in Option A or Option B) -AND- NR components should meet requirements for NR projects for at least 1 point.

Calculation

Option B: Refrigerant Atmospheric Impact of Air-conditioning systems

Using the following equation, the Refrigerant Atmospheric Impact of all the air-conditioning equipment using more than 250 grams of refrigerant in the building should be calculated.

$$\text{Refrigerant Atmospheric Impact} = \frac{\sum_{\text{unit}} [(\text{LCGWP} + \text{LCODP} \times 10^5) \times \text{Q}_{\text{unit}}]}{\text{Q}_{\text{total}}}$$

Where:

Q_{unit} = Cooling capacity of an individual air-conditioning equipment (kW)

Q_{total} = Total cooling capacity of all air-conditioning equipment (kW)

LCGWP, the Lifecycle Global Warming Potential (kg CO_2/kW/Year) and LCODP, the Lifecycle Ozone Depletion Potential (kg CFC 11/kW/Year) are calculated as follows:

LCGWP = [GWPr × (Lr ×Life + Mr) × Rc] / Life

LCODP = [ODPr × (Lr ×Life + Mr) × Rc] / Life

GWPr = Global Warming Potential of Refrigerant (0 to 12,000 kg CO_2/kg r) coming from the IPCC Fifth Assessment Report (AR5) in 2013.

ODPr = Ozone Depletion Potential of Refrigerant (0 to 0.2 kg CFC 11/kg r) coming from the stratospheric ozone protection regulations at 40 CFR Part 82

Lr = Refrigerant Leakage Rate (0.5% to 2.0%; default of 2% unless otherwise demonstrated)

Mr = End-of-life Refrigerant Loss (2% to 10%; default of 10% unless otherwise demonstrated)

Rc = Refrigerant Charge (0.2 to 2.3 kg of refrigerant per kW of rated cooling capacity)

For VRV/VRF systems, the total refrigerant charge including the initial refrigerant quantity charged into the unit at the factory and the additional refrigerant charge for piping should be considered.

Life = Equipment Life (default based on Table SE.7, unless otherwise demonstrated)

Table SE.7: Recommended Lifetime values for different types of equipment (*Source: ASHRAE Applications Handbook, 2007*)

Equipment type	Recommended Lifetime (years)
Window air-conditioning units and heat pumps	10
Unitary, split, and packaged air-conditioning units and heat pumps	15
Reciprocating compressors, scroll compressors and reciprocating chillers	20
Absorption chiller	23
Water cooled packaged air-conditioners	24
Centrifugal and screw chillers	25

Exceptional Performance

Option B: Refrigerant Atmospheric Impact of Air-conditioning systems

One point in EP-1 can be awarded if the project demonstrates through Option B that the average Refrigerant Atmospheric Impact of all the air-conditioning systems is below 8.

Submissions

Provisional Certification Stage	Option A NR	Option A R	Option B	Option C
• Mechanical tender drawings showing that no HVAC/R systems are to be installed	✓	✓		
• Tender schedule of all HVAC/R systems proposed indicating the type, volume and weight of refrigerants used			✓	✓
• Tender stage specification extracts -OR- manufacturer´s published data indicating the proposed types of systems with the type and volume of refrigerants used			✓	✓
• Tender mechanical drawings of the HVAC/R systems showing location and type of all the systems using refrigerants			✓	✓
• Calculation of the Refrigerant Atmospheric Impact of the air-conditioning systems			✓	
• Report demonstrating compliance with the requirements				✓

Full Certification Stage	Option A NR	Option A R	Option B	Option C
• Mechanical as-built drawings showing that no HVAC/R systems have been installed	✓			
• Extract of the Building User's Guide showing that some information indicating that the use of air-conditioning can be reduced have been included.		✓		
• As-built schedule of all HVAC/R equipment installed proposed indicating the type and volume of refrigerants used			✓	✓
• Manufacturer's published data of the systems installed indicating the type and volume of refrigerants used			✓	✓
• As-built mechanical drawings of the HVAC/R systems showing location and type of all the systems using refrigerants			✓	✓
If not already approved at Provisional Certification or if there is any change:				
• Final calculation of the Refrigerant Atmospheric Impact of the air-conditioning systems installed			✓	
• Final report demonstrating compliance with the requirements				✓

SE-7 Construction Activity Pollution Control

Scope

SE-7 credit applies to NR and Residential projects.

Intent

To limit pollution arising from construction activities.

Requirements

NR & Residential (1 point)

Criteria	Points
Implement strategies to limit pollution arising from construction activities	1

Overview

During the construction process, a large number of activities can generate pollution and have environmental impacts. Air, land and water pollution can be caused by soil erosion and sedimentation or by pollutants (fuel, paint, litter, etc.).

With activities such as clearing, grading and filling, soil is highly vulnerable to erosion by wind and water. Soil erosion is defined by the wearing away, detachment and movement of soil from the land surface and is mainly caused by vegetation removal and disturbance during construction activities. Sedimentation occurs when erosion is severe and soil particles leave the disturbed site, mainly due to stormwater runoff. Erosion and sedimentation can significantly affect the surrounding environment by compromising water quality and generating dust. Along with sediment, typical construction site pollutants include fluids from construction equipment, adhesives, paints, cleaners, masonry, cement, fertilizers, pesticides, and wastes from electrical, plumbing, heating, and air conditioning installations.

Approach & Implementation

Analyze potential sources of pollution during construction and implement appropriate strategies to limit air, water and land pollution during the construction process.

At least, 2 measures in each of the following categories should be implemented. Measures that are not listed below shall be subject to VGBC approval.

- Erosion control measures to limit erosion, including:
  - Limit disturbed areas to only those necessary for the construction of your project
  - Minimize duration of exposed soil by proper scheduling of construction works
  - Stabilize soils where construction activities have temporarily or permanently ceased. Temporary-cover measures include temporary seeding, mulches, blankets and mats, and the use of soil binders. Permanent-cover measures include permanent seeding and planting, channel stabilization, and vegetative buffer strips.
  - Protect slopes (if any) with erosion control blankets, bonded fiber matrices or turf reinforcement mats for steep slopes, or with silt fences or fiber rolls for moderate slopes.

- Sediment control measures to keep eroded soil on the construction site and prevent associated water pollution and soil loss, including:
  - Control stormwater flowing on the site with ditches or berms that divert stormwater away from the disturbed areas
  - Protect storm drain inlets by surrounding or covering the inlet with a filtering material such as silt fence, rock-filled bags, or block and gravel.
  - Establish perimeter controls by installing temporary sediment barriers (such as: silt fences, fiber rolls, etc.) around the perimeter of disturbed areas
  - Retain sediment on-site with temporary sediment traps or sediment basin.
  - Install stabilized construction exits (where vehicles enter and exit the site) made from aggregate or concrete.

- Dust control measures to reduce or prevent the surface and air transport of dust, including:
  - Spray/mist water over the disturbed areas with exposed soil
  - Apply mulch and/or vegetation to protect exposed soil
  - Use tackifiers and soil stabilizers
  - Install silt fences and other types of barriers around the disturbed areas

- Pollutant control measures to prevent pollutants that may be generated onsite (gasoline, oils, paints, solvents, cement, litters, etc.) to enter stormwater, including:
  - Implement waste management procedures and practices with:
    - Proper material use, storage and waste disposal
    - clean-up measures
    - toilet facilities with treatment or disposal of sanitary and septic waste
  - Implement handling and management procedures for hazardous and toxic building materials, including:

    - hazardous materials or any building materials that have the potential to contaminate stormwater should be stored indoors or under cover whenever possible or in areas with secondary containment.
    - staging areas for activities such as fueling vehicles, mixing paints, plaster, mortar, etc. should be designated
    - employees and subcontractors should be trained in proper handling and management of hazardous materials.
- Provide paint and concrete washout areas and design facilities to handle washout water
- If equipment/vehicle fueling and maintenance are performed on-site, create a fueling and maintenance area that is clean and dry, and equipped with a spill kit.
- Control equipment/vehicle washing by:
    - using off-site facilities,
    - washing in designated, contained areas only,
    - eliminating discharges to the storm drain by infiltrating the wash water or routing to the sanitary sewer; and
    - training employees and subcontractors in proper cleaning procedures.
- Develop a spill prevention and response plan that identifies ways to reduce the chance of spills, stop the source of spills, contain and clean up spills, dispose of materials contaminated by spills, and train personnel responsible for spill prevention and response.

Also, to evaluate and to maintain the effectiveness of the measures implemented throughout the construction process, the project should perform regular inspection and maintenance activities following requirements below:

- Develop an inspection schedule with inspections occurring at a weekly or bi-weekly frequency and after each significant rainfall event.
- Complete inspection reports after each inspection, including:
    - Inspection date
    - Inspector information
    - Weather information
    - Description and location of measures that need to be maintained
    - Description and location of measures that are inadequate
    - Description and location of additional measures needed
    - Corrective actions required
    - Dated photographs of the measures implemented and of the problems identified

- Perform maintenance or corrective action whenever an inspection identifies a problem or potential issue. Example of maintenance activities include:
  - Clean up trash and debris
  - Check and cover dumpsters
  - Nearby streets and sidewalks should be swept,
  - Remove sediment accumulated in sediment control measures implemented and properly dispose of sediment into controlled areas
  - Replace damaged measures, such as silt fences, that no longer operate effectively
- Keep a record of all maintenance activities, including the date, the measure maintained, location and maintenance performed

Submissions

Provisional Certification Stage
• Tender specification extracts -OR- report indicating measures which will be implemented

Full Certification Stage
• Report indicating the measures that have been implemented to reduce pollution from construction activities • Inspection reports and maintenance records showing implementation and maintenance of the measures • Dated photographs showing the measures implemented throughout construction

SE-8 Light Pollution Minimization

Scope

SE-8 credit applies to NR and Residential projects.

Intent

To minimize light pollution into the night sky.

Requirements

NR & Residential (1 points)

Only one of the 2 following options can be pursued with a maximum of 1 point available.

Option A: Light trespass

Criteria	Points
Limit illuminance at the site boundary during nighttime	1

Option B: Fully shielded fixtures

Criteria	Points
All exterior lighting fixtures are fully shielded	1

Overview

Light pollution is excessive or obtrusive artificial light, causing adverse effects such as sky glow, glare, light trespass, light clutter, decreased visibility at night and energy waste. Like any forms of pollution (such as water, air, and noise pollution) light pollution also causes damage to the environment. It affects human health and psychology, disrupts ecosystems and impinges on astronomical observation.

Approach & Implementation

Both options:

Implement automatic lighting shutoff strategies (using scheduling, photosensors or occupancy sensors) to switch off exterior lighting fixtures and interior lighting fixtures with a direct line of sight to any openings in the envelope during the non-operational period.

Exceptions: The following shall not require an automatic control device:

- Lighting intended for 24-hour operation.
- Lighting in spaces where patient care is rendered.
- Lighting in spaces where an automatic shutoff would endanger the safety or security of the room or building occupant(s).

Option A: Light trespass

Light trespass occurs when unwanted light enters property from a light source outside the property, for instance, a light shining over a neighbor's fence (Figure SE.4). Light trespass reduction is achieved with a combination of the following factors: fixture shielding, directional control designed into the fixture, fixture location, fixture height, fixture aim.

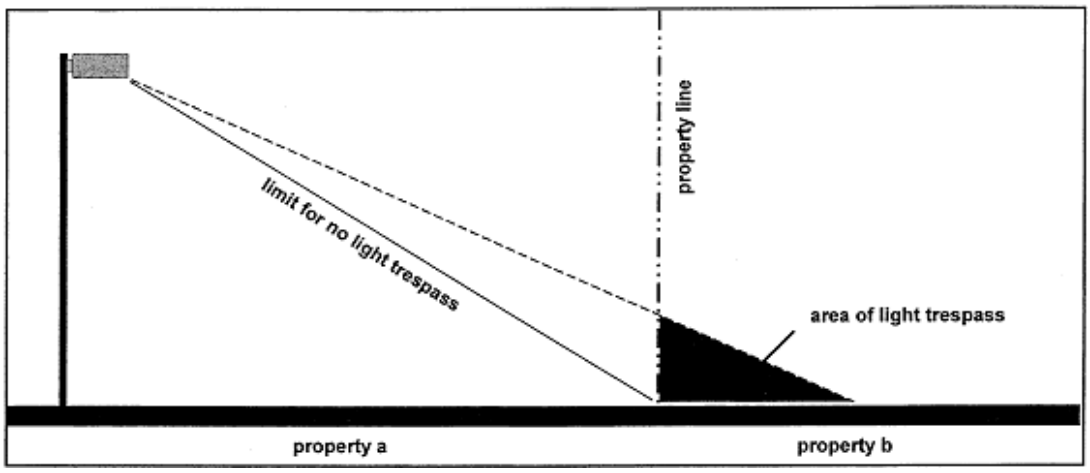

Figure SE.4: Example of light trespass

Option B: Fully shielded fixtures

Exterior lighting fixtures must all be fully shielded.

Shielding is used to block the lamp's rays from traveling upward (causing sky glow) or sideways (and off your property potentially causing a nuisance to your neighbor).
Fully shielded luminaires emit no direct uplight (no light emitted above horizontal) but have no limitation on the intensity in the region between 80° and 90° unlike the full cutoff classification.

If possible, photometric distribution of luminaires should be used to justify that they are fully shielded (i.e. no light emitted above horizontal). Else, the following guidance should be used to select acceptable exterior lighting fixtures.

Figure SE.5 provides a visual guide to understand the differences between unshielded and poorly shielded light fixtures (not compliant with the credit) and the fully shielded fixtures (compliant with the credit) that minimize skyglow, glare and light trespass.

Fully shielded fixtures are not limited to the compliant fixtures illustrated on Figure SE.5.

In general, fully shielded fixtures are luminaires in which the light bulb is placed inside a shield that light cannot pass through. Unacceptable fixtures contain features like sag lens and refractors that extend the light source outside of the fixture shield resulting in light that projects outward, upward, and downward.

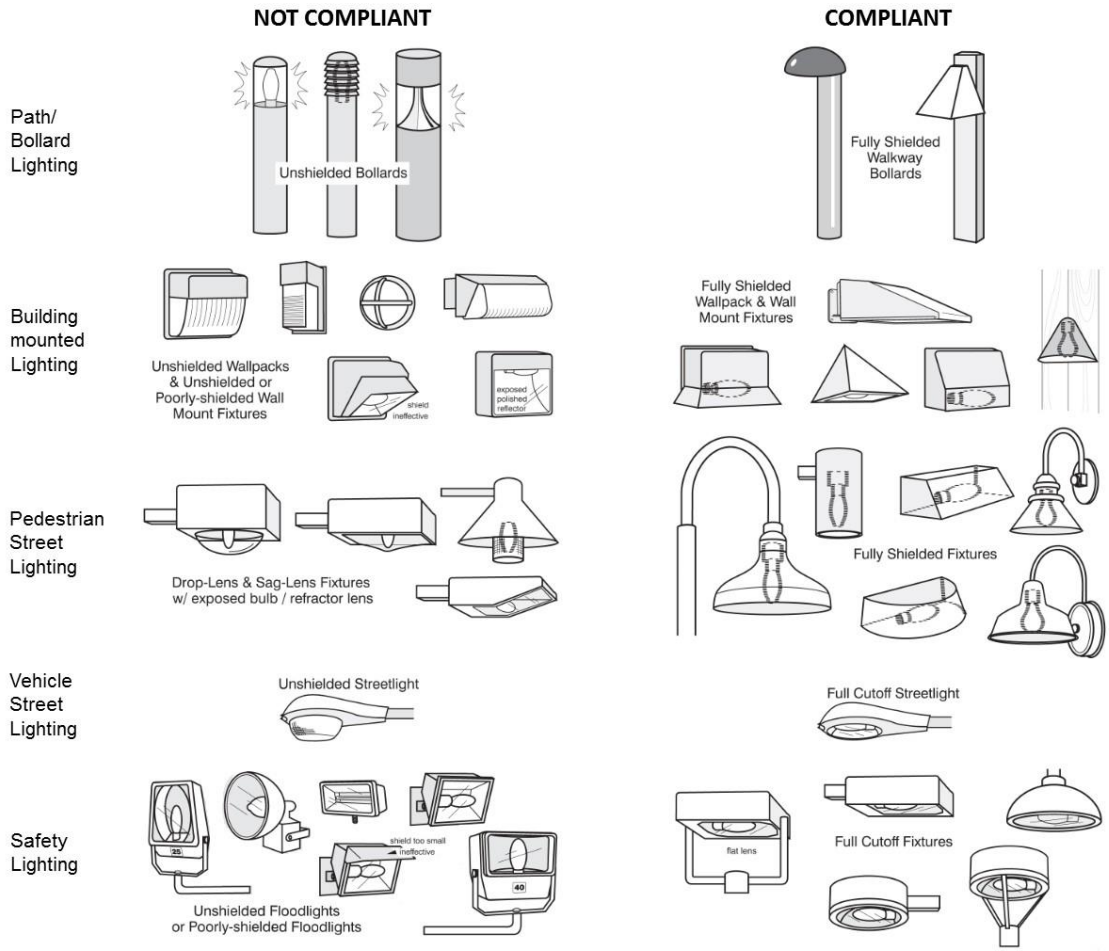

Figure SE.5: Illustrations of unshielded, poorly shielded and fully-shielded exterior lighting fixtures

Calculation

Option A: Light trespass

Calculations must be undertaken for each exterior lighting fixture and interior lighting fixture with a direct line of sight to any openings in the envelope.

First, it is needed to classify the project under one of the environmental zones listed in Table SE.8, as recommended by IDA (International Dark-Sky Association).

Table SE.8: Environmental zones

Zone	Lighting Environment	Description
LZ0	No ambient lighting	Areas where the natural environment will be seriously and adversely affected by lighting
LZ1	Low ambient lighting	Areas where lighting might adversely affect flora and fauna or disturb the character of the area.
LZ2	Moderate ambient lighting	Areas of human activity where the vision of human residents and users is adapted to moderate light levels.
LZ3	Moderately high ambient lighting	Areas of human activity where the vision of human residents and users is adapted to moderately high light levels.
LZ4	High ambient lighting	Areas of human activity where the vision of human residents and users is adapted to high light levels.

During night-time hours (i.e. between 9 p.m. and 9 a.m.), it is required to limit the horizontal and vertical illuminance (E_H and E_V) at the side boundary to comply with Table SE.9:

Table SE.9: Obtrusive light limitations

Zone	Horizontal and Vertical illuminance
LZ0	0 lux
LZ1	1 lux
LZ2	4 luxes
LZ3	5 luxes
LZ4	6 luxes

The point of measurement shall be located at 1 meter above the surface, and at 1.5 meters inside an adjacent residential parcel or public right-of-way, and 3 meters inside an adjacent commercial or industrial parcel or a public roadway.

Horizontal and Vertical illuminances must be calculated with the following formulas:

$$E_H = \frac{I}{D^2}\cos(\alpha)$$

$$E_V = \frac{I}{D^2}\cos(\beta)$$

Where:

E_H and E_V = Horizontal and Vertical illuminance (lx).

I = Intensity towards the point (cd); this information is given in manufacturer's photometric data (candlepower distribution curve*).

D = Direct distance (meters) between the lamp and the closest point located 1.5 or 3 meters beyond the site boundary.

α and β = Angles of incidence (°), as shown below in figure SE.6

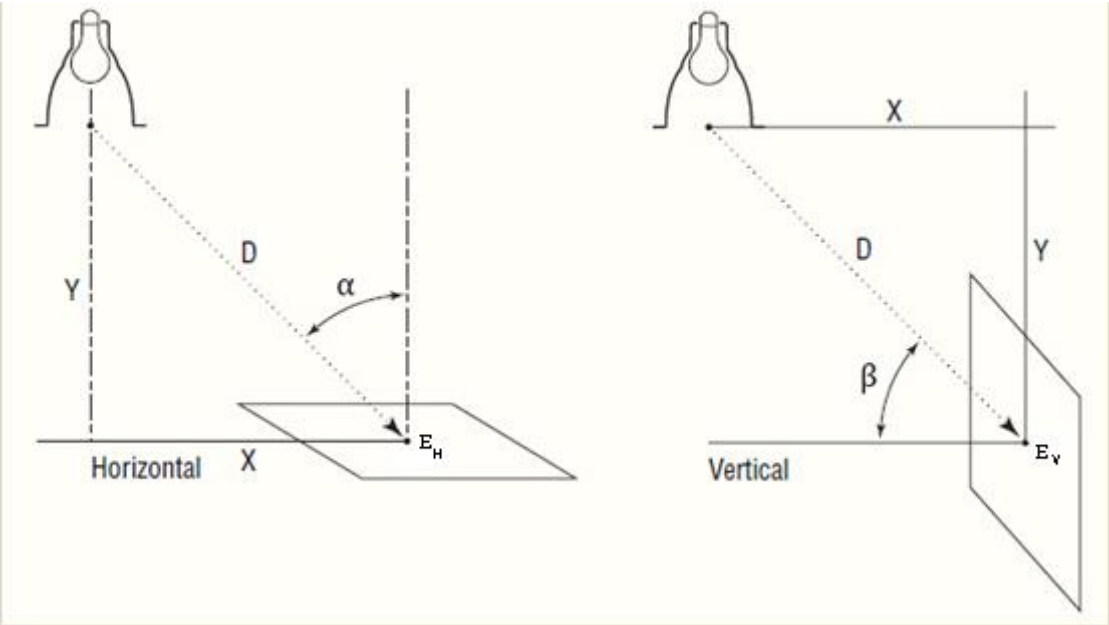

Figure SE.6: Angles of incidence

*The candlepower distribution curve is a cross-sectional “map” of intensity (candelas) measured at many different vertical angles. It is a two-dimensional representation and therefore shows data for one plane only. If the distribution of the unit is symmetric, the curve in one plane is sufficient for all calculations. If asymmetric, such as with street lighting and fluorescent units, three or more planes are required. In general, incandescent and HID reflector units are described by a single vertical plane of photometry. Fluorescent luminaires require a minimum of one plane along the lamp axis, one across the lamp axis and one at a 45° angle. The greater the departure from symmetry, the more planes needed for accurate calculations.

Submissions

Provisional Certification Stage	Option A	Option B
• Tender stage lighting drawings outlining the lighting fixtures concerned by lighting schedule	✓	✓
• Tender schedule of all the installed lighting schedule controls	✓	✓
• Master plan of the project showing neighboring areas with their types	✓	
• Calculations of E_H and E_V values at the side boundary	✓	
• Tender specification extracts -OR- Manufacturer´s published data of all the proposed exterior lighting fixtures indicating the fully shielded classification.		✓

Full Certification Stage	Option A	Option B
• As-built lighting drawings outlining the lighting fixtures concerned by lighting schedule	✓	✓
• As-built schedule of all the installed lighting schedule controls	✓	✓
• Evidence showing the lighting schedule controls installed such as photographs, invoices, receipts, commissioning report, etc.	✓	✓
• Evidence showing the exterior lighting fixtures installed such as photographs, invoices, receipts, commissioning report, etc.	✓	✓
• As-built master plan of the project showing neighboring areas	✓	
• Measurements of E_H and E_V values at the side boundary	✓	
• Manufacturer´s published data of all the installed exterior lighting fixtures indicating the fully shielded classification.		✓

SE-9 Green Transportation

Scope

SE-9 credit applies to NR and Residential projects.

Intent

To raise awareness of the different collective transport means available to occupants of the building and implement policies to encourage occupants to use green transportation.

Requirements

NR & Residential (1-3 points)

Criteria	Points
Strategy A: Bicycle Friendly	
NR Provide covered and secured bicycle parking spaces for 5% of occupants (at peak period) and shower facilities for 0.5% of full-time occupants.	1
Residential Provide covered and secured bicycle parking spaces for 15% of residents	
Strategy B: Public Transportation	
Situate the building within a 500 m walking distance from 2 different public transportation routes	1
Strategy C: Electric Vehicles	
NR Install electric vehicle charging stations for 3% of the total vehicle parking capacity of the site	1
Residential Install electric vehicle charging stations for 5% of the total vehicle parking capacity of the site	
Strategy D: Green transportation program	
Set up a green transportation program	1

Overview

Green transport refers to modes of transport that have a low impact on the environment. The most common forms of green transport include walking, cycling and catching public transport. It is important to promote green transport alternatives as motor vehicles in general, and private motor vehicles (cars and motor bikes) in particular, are responsible for many forms of pollution.

Exhaust fumes emitted when motor vehicles burn fuel cause local air pollution in cities and contribute to global warming. In addition, a significant amount of energy is required to build vehicles and their supporting infrastructure such as roads and car parks.

Approach & Implementation

Strategy A: Bicycle Friendly

NR Projects

Provide covered and secured bicycle parking spaces for 5% of occupants (at peak period) and shower facilities for 0.5% of full-time occupants.

Exceptions: Patients in hospitals and pupils in kindergarten and primary schools should be excluded from the number of full-time occupants for bicycle storage and shower calculations.

Residential Projects

Provide covered and secured bicycle parking spaces for 15% of residents.

Mixed-use Residential/NR projects

Provide covered and secured bicycle parking spaces for 15% of residents and for 5% of other occupants (at peak period). Also, provide shower facilities for 0.5% of full-time occupants.

Strategy B: Public Transportation

The building should be situated within a 500 meters walking distance from 2 existing or planned public transportation route.

The walking distance should be measured from a main building entrance.

- AND -

The project should provide public transportation information including routes and schedules in an obvious and accessible location for occupants. This service must be regularly maintained.

Mixed-use Residential/NR projects

Public transportation information should be displayed in obvious and accessible locations in the Residential components and the NR components of the project.

Strategy C: Electric Vehicles

NR projects

Install electric vehicle charging stations for 3% of the total vehicle parking capacity of the site.

Residential projects

Install electric vehicle charging stations for 5% of the total vehicle parking capacity of the site.

Mixed-use Residential/NR projects

The minimum number of electric vehicle charging stations to be installed should be calculated based on the GFA of NR and Residential components (See Calculations section).

Strategy D: Green transportation program

Set up a green transportation program. In association with any of the above strategies, provide at least 2 other services/incentives to encourage occupants to use a green mode of transport. Such services and incentives include (but are not limited to): organizing a vehicle sharing program, providing staff shuttle busses, covering taxi fares in exceptional circumstances, providing rides to occupants, providing electric vehicles for employee business use, etc.

Information on the green transportation program should be accessible to all building occupants.

Mixed-use Residential/NR projects

Services/incentives provided to residents may differ from services/incentives provided to the other building occupants, but the green transportation program should provide at least 2 types of services/incentives both for residents and for other building occupants.

Information should be made accessible to the residents and to the other building occupants.

Calculations

Note: Non-integer values shall be rounded up. The minimum number of parking spots, shower facilities and electric vehicle charging stations to be eligible to obtain points is 1.

Strategy A: Bicycle Friendly

NR projects

Calculation of the required number of bicycle parking spaces is based on number of occupants at peak period. Capacity of bicycle parking spaces shall be calculated as follows:

- Quantify number of building occupants at peak period
- Calculate minimum capacity of bicycle parking spaces with the following formula:

$$\text{Number of bicycle parking spots} = N_P \times 0.05$$

N_P =Number of building occupants at peak period

Calculation of the required number of shower facilities is based on number of full-time occupants. Full-time occupants are employees/staff in the building and their number should be calculated based on a daily occupancy of 8 hours. Part-time occupants should be given an equivalent 'full-time occupants' value based on the number of hours they spend in the building per day divided by 8.

Capacity of showering facilities shall be calculated as follows:

- Quantify number of building full-time occupants
- Calculate minimum capacity of showering facilities with the following formula:

$$\text{Number of showers} = N_{FT} \times 0.005$$

N_{FT} =Number of full-time occupants

Residential projects

Calculation of the required number of bicycle parking spaces is based on number of residents. Capacity of bicycle parking spaces shall be calculated as follows:

- Quantify number of building residents
- Calculate minimum capacity of bicycle parking spaces with the following formula:

$$\text{Number of bicycle parking spots} = N_R \times 0.15$$

N_R =Number of building residents

Mixed-use Residential/NR projects

The project should provide bicycle parking spots with a minimum capacity equal to the sum of the number of bicycle parking spots required for the Residential components of the project and the number of bicycle parking spots required for the NR components of the project.

Also, the project should provide showering facilities with a minimum capacity equal to the number of showers required for the NR components of the project.

Strategy C: Electric vehicles

Calculation of the required number of electric vehicle charging stations is based on the total number of parking spaces. It shall be calculated with the following formulae:

NR projects

$$\text{Number of electric vehicle charging stations} = T \times 0.03$$

Residential projects

$$\text{Number of electric vehicle charging stations} = T \times 0.05$$

T = Total vehicle parking capacity (total number of parking spaces for cars and motorbikes)

Mixed-use Residential/NR projects

$$\text{Number of electric vehicle charging stations} = \%\ GFA_{NR} \times \text{T} \times 0.03 + \%\ GFA_{R} \times \text{T} \times 0.05$$

% GFA_{NR} = Total GFA of NR components over total project GFA (%)

% GFA_{R} = Total GFA of Residential components over total project GFA (%)

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that the requirements set in the 4 Strategies of the credit have been met.

Submissions

Provisional Certification Stage
Strategy A: Bicycle Friendly
• Plans indicating location, size and capacity of parking and showering facilities • Calculations demonstrating compliance with the requirements
Strategy B: Public Transportation
• Plans or maps indicating location of public transport stops within a 500 meters walking distance of the site • Documentation indicating the number of public transport routes by which the stops are serviced
Strategy C: Electric vehicles
• Plans indicating location of the electric vehicle charging stations • Calculations demonstrating compliance with the requirements
Strategy D: Green transportation program
• Report describing the green transportation program with the different services and incentives planned to be implemented and how these services and incentives will encourage the building occupants to favor green mode of transports over motorized private transports.

Full Certification Stage
Strategy A: Bicycle Friendly
• As-built plans indicating location, size and capacity of bicycle parking and showering facilities • Photographs of the bicycle parking and showering facilities
If not already approved at Provisional Certification or if there is any change: • Final as-built calculations demonstrating compliance with the requirements

Strategy B: Public Transportation
• Photographs showing that information on public transportation is displayed
If not already approved at Provisional Certification or if there is any change: • Final plans or maps indicating location of public transport stops within a 500 meters walking distance of the site. • Final documentation indicating the number public transport routes by which the stops are serviced
Strategy C: Electric vehicles
• As-built plans indicating location of the electric vehicle charging stations • Photographs of the electric vehicle charging stations in the parking
If not already approved at Provisional Certification or if there is any change: • Final as-built calculations demonstrating compliance with the requirements
Strategy D: Green transportation program
• Evidence showing the implementation of a collective transportation program, such as photographs, building policies, receipts, etc.
If not already approved at Provisional Certification or if there is any change: • Final report describing the green transportation program with the different services and incentives implemented and how these services and incentives succeeded to make building occupants use green mode of transports over motorized private transports.

SE-10 Community Connectivity

Scope

SE-10 credit applies to NR and Residential projects.

Intent

To encourage developments to access existing amenities, infrastructure and services.

Requirements

NR & Residential (1 point)

Criteria	Points
Locate the building within a 500 meters walking distance from 10 basic services	1

Overview

A new building will connect with the community more readily if it is situated close to local amenities sufficient to provide for basic needs of the users of the building. Nearby basic services are not only convenient for the building occupants but also lessen the need for motorized transportation to and from the building.

Approach & Implementation

Locate the building within a 500 meters walking distance from 10 different basic services.

Exception: Due to their location in industrial parks, if bicycles are made available for at least 5% of the staff to use (i.e. 5 bicycles for each 100 staff), factories are allowed to consider a 1 km walking distance from the building to the basic services.

The walking distance should be measured from a main building entrance.

Basic services include but are not limited to those listed in Table SE.10. Other types of basic services will be subject to VGBC approval.

Only one service per type of basic service can be counted to meet the requirements of the credit.

Table SE.10: Types of basic services

1. Bank	10. Library	19. School
2. Beauty / Hairdresser	11. Hospital / Clinic / Dental	20. Senior care facility
3. Laundry / Cleaners	12. Museum	21. Supermarket
4. Community center	13. Playground/Park	22. Art / Entertainment center
5. Convenience grocery	14. Pharmacy	23. Repair Shops
6. Day care	15. Place of worship	24. Police station
7. Fitness center / Sport center / Swimming pool	16. Post Office	25. Bookstore
8. Fire station	17. ATM	26. Wet market
9. Petrol Station	18. Restaurant / Coffee shop	

Submissions

Provisional Certification Stage

- List of at least 10 basic services located within a 500m walking distance of the building
- Map or plan indicating position of at least 10 basic services located within a 500m walking distance of the building

Full Certification Stage

If not already approved at Provisional Certification or if there is any change:

- List of at least 10 basic services located within a 500m walking distance of the building
- Map or plan indicating position of at least 10 basic services located within a 500m walking distance of the building

SE-11 Outdoor Communal Space and Facilities

Scope

SE-11 credit applies to NR and Residential projects.

Intent

To encourage projects to set aside a portion of the space and provide facilities for use and enjoyment by the occupants and community.

Requirements

NR (1-2 points)

Only Strategy A can be pursued.

Exception: For buildings where, for safety and security concerns, public cannot be allowed to come on site (such as: factories, schools, embassies, etc.), Strategy B can be followed instead of Strategy A.

Residential (1-2 points)

Both Strategy A and Strategy B can be pursued with a maximum of 2 points available.

Criteria	Points
Strategy A: Public Space	
5% of the site area is a public space with social and recreational value	1
10% of the site area is a public space with social and recreational value	2
Strategy B: Outdoor communal facilities	
Provide 2 outdoor communal facilities for occupants	1
Provide 4 outdoor communal facilities for occupants	2

Overview

A public space is an open space that is freely accessible to people, not limited to building occupants. Public spaces play an important role in improving neighborhood quality of life and increasing connectivity between the building and the community. As public spaces are especially scarce in Vietnamese cities it is important that buildings offer a portion of their site for the public to enjoy. Outdoor communal facilities can also help to improve the quality of life, increase the social interactions among residents and provide recreational activities.

Approach & Implementation

Strategy A: Public Space

To be eligible for this strategy, the areas of public spaces shall be larger than 100 m^2.

Provide public spaces with high value by considering the aspects of sociability, recreation, comfort and access.

As social value of the public spaces should improve naturally along with the other aspects, to meet requirements of this strategy, the project should achieve at least one feature in the 3 key attributes of recreation, comfort and access. The below list of features is non-exhaustive.

- Recreation:
  - Diverse regular activities are conducted (e.g. sports, dance, games, concerts, etc.)
  - Recreational facilities are installed (e.g. playground, outdoor gym, etc.)
- Access:
  - Good connection between the public spaces and the adjacent areas, so that people can easily walk to the public spaces (e.g. no walls surrounding the public spaces, sidewalks leading to the public spaces, etc.)
  - People can use a variety of transportation options to reach the place (e.g. bus, car, bicycle, etc.)
- Comfort:
  - Seating are provided in sufficient numbers
  - The public spaces are regularly cleaned and maintained free of litter
  - The public spaces are well-landscaped with a variety of flowers, shrubs and trees

Strategy B: Outdoor communal facilities

Provide the following types of outdoor communal facilities for occupants:

- Playground areas: Includes such items as climbing apparatuses, balance beams, ropes, swings, etc. Playground areas are to be exclusively for play and must be fenced off.
- Open landscaped areas for active play: Includes open areas for group and/or individual play such as areas for running, jumping, chasing, ball games, sporting activities, and areas for wheeled toys such as bike pathways.
- Outdoor Gym with at least three separate facilities for exercise
- Seating in quiet areas and sun-shaded areas
- Composting facilities
- Vegetable gardens

Calculation

Strategy A: Public Space

Percentage of public space area should be calculated using following formula:

$$\text{Public Space } [\%] = \frac{A_{pub}}{A_{tot}} \times 100$$

A_{pub} = Area of public space [m^2]

A_{tot} = Total site area [m^2]

Exceptional Performance

One point in EP-1 can be awarded if the project demonstrates through Strategy A that more than 15% of the site area is a public space with social and recreational value.

- AND -

Residential Projects

One point in EP-1 can be awarded if the project demonstrates that at least 3 points can be achieved under the 2 Strategies of the credit.

Submissions

Provisional Certification Stage
Strategy A: Public Space
• Report/description indicating the nature of public spaces and indicating the features to be implemented to improve the quality of the public spaces • Tender stage site plan indicating public spaces and highlighting the features to be implemented to improve the quality of the public spaces • Calculations indicating the percentage of public space area
Strategy B: Outdoor communal facilities
• List of all the outdoor communal facilities to be provided • Tender stage site plans showing the location of the facilities

Full Certification Stage
Strategy A: Public Space
• As-built site plan • Photographs showing the public spaces and the features improving their quality

If not already approved at Provisional Certification or if there is any change: • Report/description indicating the nature of public spaces and indicating the features implemented to improve the quality of the public spaces • As-built site plan indicating public spaces and highlighting the features implemented to improve the quality of the public spaces • Final as-built calculations indicating the percentage of public space area
Strategy B: Outdoor communal facilities
• As-built stage plans showing the location of the facilities • Photographs showing the facilities provided
If not already approved at Provisional Certification or if there is any change: • Final list of all the outdoor communal facilities provided

Management

The execution of an environmentally sustainable construction project involves a number of parties from various backgrounds, with a wide range of specialization. To attain the standards expected of a LOTUS NC certified building, high levels of communication and coordination between all parties involved is vital. It is extremely important that the entire project team works together towards adopting all appropriate environmental principals at the project's inception. It is also vital that this information is passed on to buildings users and managers so that the building's design features are understood and used, ensuring the intended performance goals are met throughout the life of the building.

During the construction phase, it is necessary to implement a complete and systematic management scheme to ensure the construction phase is carried out without discrepancies. LOTUS encourages the use of an internationally recognized project management scheme during this phase to ensure this is realized. LOTUS also encourages the training of contractors on the green aspects of the building to ensure that the design intent flows down to all teams that are working on the building and construction progresses smoothly.

Commissioning is a critical operation to ensure building performance meets design specification. Recognizing the vital importance of a properly employed commissioning program, LOTUS NC will award points to ensure the step is executed effectively. In order to benefit fully from the commissioning stage, it is necessary to implement targeted and continuous preventative maintenance programs to ensure optimized performance of all equipment. This will decrease the risk of breakdown and increase the building's life span.

Credit	Title	NR	Residential
Man-1	Effective Design Process	1 point	1 point
Man-2	Construction Stage	1 point	1 point
Man-3	Commissioning	4 points	4 points
Man-PR-1	Maintenance	Prerequisite	Prerequisite
Man-4	Maintenance	1 point	1 point
Man-PR-2	Green Awareness	Prerequisite	Prerequisite
Man-5	Green Awareness	1 point	1 point
	Total of points available	8 points	8 points

Man-1 Effective Design Process

Scope

Man-1 credit applies to NR and Residential projects.

Intent

To encourage projects to follow effective design processes in order to reach high performance.

Requirements

NR & Residential (1 point)

Criteria	Points
Strategy A: Integrated Design Process	
Follow an integrated design process	1
Strategy B: Building Information Modelling	
Use a coordinated BIM model to design the building	1
Strategy C: Cost-effective Design	
Demonstrate that the design is cost-effective	1

Overview

Integrated design process, which rely upon every member of the project team working collaboratively to implement sustainability goals, can ensure a lot of benefits compared to the conventional design process which often leads to problems within the process and inefficiencies within the building's systems due to the lack of coordination between team members.

Building information modelling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of a building. Using a BIM methodology improves collaboration and ensures a new level of control over projects.

Projects with cost-effective designs can reach high sustainable performance while not (or moderately) increasing investment cost. As the most common misconception about green buildings is that they are expensive, it is important that projects targeting green building certification are economically efficient to encourage other projects to follow the trend.

Approach & Implementation

Strategy A: Integrated Design Process

The design of the project should follow an integrated process including the following steps:

- Establish a multidisciplinary project team with all the relevant consultants at early design
- Appoint a team leader / facilitator who will manage the integrated design process, ensure an effective collaboration between team members and ensure the sustainability goals are followed.
- Perform an Eco-Charrette with the entire project team. The Eco-Charrette is an interactive team-building exercise that explores the key green building and green development aspects of a project before any design decisions are made.
- Identify the responsibilities of the different team members
- Analyze opportunities and challenges, explore synergies between disciplines, assess performance of design alternatives
- Organize meetings at key stages of design (pre-design, schematic design, design development, tender documents preparation) to update and review the sustainability targets and progress.

It is encouraged to follow the integrated process further than design and keep a collaborative approach through bidding, construction and commissioning.

Strategy B: Building Information Modelling

The project design team, including at least the architect, the structural engineer and the MEP (Mechanical, electrical and plumbing) engineer, should use a coordinated BIM model to design the building.

A BIM Execution Plan (BEP) should be developed to define the BIM process and ensure that everyone in the design team is on the same page, cooperating and collaborating.

The BEP should contain the following:

- Project information;
- BIM goal & uses;
- Each project member's roles, staffing and competency;
- BIM process and strategy;
- BIM exchange protocol and submittal format;
- BIM data requirement;
- Collaboration procedures and method to handle shared models;
- Quality control; and
- Technology infrastructure & software

More information on the BEP can be found in the 'BIM Essential Guide For BIM Execution Plan' developed by the Centre for Construction IT on behalf of BCA Singapore and the BIM Steering Committee.

Strategy C: Cost-effective Design

A quantity surveyor's report should be prepared to demonstrate the cost-effectiveness of the project.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that at least 2 points are achieved under the different Strategies of the credit.

Submissions

Provisional Certification Stage
Strategy A: Integrated Design Process
• Minutes of meeting of the Eco-Charrette • Pathways with sustainable goals and targets at various design stages • Roles and responsibilities matrix at various design stages • Reports and documents showing the process of design optimization • Minutes of different project team meetings organized during design
Strategy B: Building Information Modelling
• BIM Execution Plan • Coordinated BIM models
Strategy C: Cost-effective Design
• Quantity surveyor's report • Narrative describing the solutions implemented to reduce the cost of the project

Full Certification Stage
Strategy A: Integrated Design Process
If not already approved at Provisional Certification: • Minutes of meeting of the Eco-Charrette • Pathways with sustainable goals and targets at various design stages • Roles and responsibilities matrix at various design stages • Reports and documents showing the process of design optimization • Minutes of different project team meetings organized during design

Strategy B: Building Information Modelling
If not already approved at Provisional Certification: • BIM Execution Plan • Coordinated BIM models
Strategy C: Cost-effective Design
If not already approved at Provisional Certification: • Updated quantity surveyor's report • Narrative describing the solutions implemented to reduce the cost of the project

Man-2 Construction Stage

Scope

Man-2 credit applies to NR and Residential projects.

Intent

To encourage the development of a recognized Project Management framework for a smooth construction process and to encourage the education and training of contractors regarding the green requirements of the project.

Requirements

NR & Residential (1 point)

Criteria	Points
Strategy A: Project management	
Project management is performed in accordance with an internationally recognized system	1
Strategy B: Trades training	
Conduct trades training on the green aspects of the building design	1

Overview

Strategy A: Project management

In order to construct a large, multi-discipline project with defined objectives and targets, it is essential that a clear and transparent process of staged project management is undertaken. Through such endeavors, the resources within a project can remain in scope while being managed and monitored more efficiently. This credit aims at encouraging the implementation of internationally recognized project management tools and procedures to ensure effectiveness and efficiency during construction works.

Strategy B: Trades training

This strategy encourages projects to conduct a trades training workshop in order to educate the contractors about the green attributes, performance requirements and targets of the building. Through the trades training workshop, contractors will be introduced to the unique green aspects of the building so they can identify any project specific requirements that their trade will be expected to adhere to as well as unify the goals of the whole project team. It must occur before construction begins, but after the trades have been hired.

Approach & Implementation

Strategy A: Project management

Project Management frameworks include and are not limited to the following recognized systems:

- FIDIC
- ISO 10006
- PMBOK (Project Management Body of Knowledge)
- PRINCE2

Other recognized international Project Management systems may be considered, subject to VGBC approval. Project Management shall be undertaken by any experienced and competent internal or external individuals through a recognized framework.

Strategy B: Trades training

At the trades training workshop, all prerequisites and any other requirements that the contractors will be expected to meet shall be explained. As a minimum the following contractors are to be included:

- Mechanical and Electrical (M&E)
- Civil Works

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that 2 points can be achieved under the 2 Strategies of the credit.

Submissions

Provisional Certification Stage
Strategy A: Project management
• Report indicating the project management standard to be used -OR- Tender stage specification extracts indicating the proposed project management standard to be used
Strategy B: Trades training
• Trades training workshop program

Full Certification Stage
Strategy A: Project management
• System and related procedures or software outputs • Evidence of competence (certification with project management standard)
If not already approved at Provisional Certification or if there is any change: • Report indicating the project management standard used
Strategy B: Trades training
• Trades training workshop program • Signatures of contractors in attendance at the trades training workshop

Man-3 Commissioning

Scope

Man-3 credit applies to NR and Residential projects.

Intent

To ensure the building systems are installed, calibrated and performing up to the design intent and end-user satisfaction.

Requirements

NR & Residential (2-4 points)

Requirements for 3 and 4 points are only available at Full Certification.

Criteria	Points
Ensure that building systems are well-installed and are performing as intended	2
Ensure a proper handover to the owner O&M staff and end users	3
Conduct commissioning activities during the operations of the building	4

Overview

In practice, due to poor commissioning practice, many buildings do not operate as intended by the owner and by the design specifications.

Building commissioning (Cx) is a planned and systematic form of quality control that ensures that all building services systems are installed, tested, understood and perform well. Buildings that are properly commissioned typically have fewer change orders, tend to be more energy efficient, and have lower operation and maintenance cost.

Approach & Implementation

The systems to be commissioned shall encompass systems related to energy, water and indoor environmental quality:

- Heating, ventilating, air conditioning and refrigeration (HVAC&R) equipment and controls
- Artificial lighting fixtures and lighting controls
- Metering systems
- Plumbing systems (including the domestic hot water systems and pumping systems)
- Renewable energy systems

Ensure that building systems are well-installed and are performing as intended:

For 2 points, it is advised that the commissioning process follows the 17 steps described below. At a minimum, steps 1, 2, 3, 4, 5, 7, 12, 13, 14, 15, 16 and 17 (shown with a *) should be followed and evidence should be provided to demonstrate that these steps were followed.

1. * Identify Commissioning Team (Cx team)
    - Owner designates a party to act as their project representative for commissioning related activities.
    - Owner selects/designates a Commissioning Agent (CxA) for the project. The CxA should be an objective, independent advocate for the owner and should have engineering knowledge and field experience regarding building systems start-up, balancing, functional testing and troubleshooting.

      The CxA will direct the overall commissioning process and will be responsible for:
        - Directing the Cx team
        - Coordinating, performing and overseeing all commissioning activities
        - Reviewing results from the commissioning processes
    - Architects and MEP designers designate a party to act as their project representative for commissioning related activities.

2. * Define Owner's project requirements (OPR) for the project

   The owner should provide a clear outline of the project requirements:
    - User requirements, including building use, occupancy, future expansion, etc.
    - Environmental, energy and efficiency goals
    - Indoor environmental quality requirements
    - Systems and equipment expectations, including lifespan, automation and maintenance requirements
    - Operation and maintenance personnel

3. * Develop a basis for design (BOD)

   The design team should develop a BOD including the following:
    - Primary assumptions, including space use, design conditions and occupancy
    - Standards, codes, guidelines and regulations to which the design must adhere
    - Performance criteria of equipment including: HVAC, lighting, hot water and power systems

4. Review the of OPR and BOD

   The CxA reviews the OPR and BOD and ensures that the basis for design meets the requirements of the owner.

5. * Develop a preliminary Commissioning Plan (Cx plan)

   Each project should be commissioned in accordance with a written Cx plan that is updated as the project progresses. The CxA should develop the Cx plan which should contain, as a minimum, the following components:

   - Overview and scope of the Cx process
   - Roles, responsibilities and lines of communications for each member of the Cx team
   - List of all equipment, systems and assemblies to be commissioned
   - Estimated Cx schedule

6. Develop the Issues Log

   The Issues Log is developed to facilitate the documenting, tracking and resolution of commissioning related issues. Issues Log typically contains at a minimum a detailed description of the issue, date identified, party responsible for corrections, issuing party and completion status.

7. * Develop Cx specifications to include in the construction documents

   The design team should incorporate Cx specifications into the construction documents. The Cx specifications are used to describe the contractor's responsibility pertaining to commissioning. The following, as a minimum, shall be incorporated into the construction documents:

   - Contractor's responsibilities regarding the Cx processes
   - Requirements for submittals and submittal review
   - Requirements for operation and maintenance documentation
   - Required site meetings
   - Construction verification process
   - Start-up and implementation of systems and equipment
   - Performance testing of equipment
   - Acceptance and closeout
   - Operation and maintenance staff training

8. Review of the construction documents

   The CxA reviews the construction documents to ensure continued adherence of the design to the owner's requirements.

9. Review of the contractor's submittals

   The CxA reviews all submittals provided by the contractor relating to systems and equipment which are included in the Cx plan. This review shall happen concurrently with the review conducted by the design team and owner.

10. Update the OPR, BOD and Cx Plan

    If necessary, the OPR, BOD and Cx Plan should be updated to reflect changes made to the project.

11. Conduct construction phase commissioning kick-off meeting

    The kick-off meeting is most effectively held when the contractors have mobilized to the site. The Cx plan is reviewed, along with roles and responsibilities, schedule, and deliverables.

12. * Develop installation verification checklists

    The CxA should prepare installation verification checklists utilizing the approved construction submittals and installation manuals of the installed equipment.

13. * Conduct installation verification

    The contractor should thoroughly execute the installation verification checklists and other required startup and checkout documentation and submit to the CxA and other required parties in a timely manner so they can be used in developing performance test procedures and to aid confirming test readiness.

14. * Develop performance testing scripts

    Also called functional testing, performance testing aims to ensure that systems operate correctly and as expected. Testing should include every process in the sequence of operation for each system, such as start-up, shut-down, capacity modulation, emergency mode, failure mode and interlocks to other system. Performance testing scripts should be developed by the CxA together with the design team and/or contractor.

15. * Conduct performance testing

    The performance testing should take place after the systems and equipment to be commissioned have been installed, energized, balanced and otherwise made ready for use. The contractor should perform the testing under supervision of the CxA.

16. * Evaluate results

    The CxA should evaluate results to ensure systems performed according to specification.

17. * Prepare the commissioning report (Cx report)

    The CxA should write a Cx report after installation verification and performance testing have been conducted. The Cx report should include:

    - An executive summary
    - An evaluation of the operating condition of the systems at the time of performance testing completion

- A list of issues/deficiencies that were discovered and the measures taken to correct them, and a list of uncorrected operational issues/deficiencies
- Completed installation verification checklists
- Performance testing procedures and results
- Final versions of the OPR, BOD and Cx plan

Ensure a proper handover to the owner O&M staff and end users:

To earn 3 points, after conducting the above commissioning activities, the project should ensure a proper handover to the owner O&M staff and end users by following the 2 next steps:

18. Verify training of the owner O&M staff and end users.

    Verify that the training for the owner's operating staff is conducted in accordance with the owner's requirements for all commissioned equipment.

    The key objective of the owner's operating staff training is to convey knowledge and skills required to effectively and efficiently operate the building. This includes an understanding of the OPR and BOD as well as training on the purpose and use of the Systems Manual.

    The CxA should review the contractor's submittals of the training content, materials, and instructor qualifications. Also, the CxA should participate in key training sessions, including usage of the Systems Manual.

19. Deliver post-construction documents

    The CxA should complete and deliver to the owner a package of post-construction documents needed to understand and properly operate the building.

    The package of post-construction documents should include as a minimum:

    - Completed Cx report
    - Documentation of operating staff training
    - A Systems Manual that should provide the information needed to understand and properly operate the building systems. It should be understandable to people unfamiliar with the project. The Systems Manual documentation is compiled by the CxA and includes documents from the owner, designers, and contractors.

      For each commissioned system, the following information should be included:

        - General description with the locations of equipment
        - System operating instructions
        - Final versions of the OPR and BOD
        - Important as-built drawings including, at a minimum, single-line diagrams and control drawings

- Sequences of operations (For HVAC systems, sequences of operations should include setpoints, schedules, energy efficiency features and seasonal changeover procedures).
- Recommended schedule for recommissioning

Conduct commissioning activities during the operations of the building:

To earn 4 points, the project should also conduct commissioning activities during the operations of the building by following the 3 next steps:

20. Perform fine-tuning (if needed)

    Fine-tuning of the commissioned systems may still be needed even if they are meeting the requirements of the specification. The building's occupants judge comfort levels, not the design or installation. Most fine-tuning activities will involve tweaking setpoints, or adjusting ventilation grilles, dampers and controls.

21. Perform seasonal testing (if needed)

    Seasonal testing involves re-commissioning heating systems in winter and mechanical cooling systems in summer.

22. Develop an ongoing commissioning plan

    Ongoing commissioning is the process of providing continuous improvement in the operating systems of a building for lower energy use, lower water use and improved Indoor Environmental Quality. Also, under the ongoing commissioning plan, systems may be re-commissioned or adjusted if performance isn't meeting requirements.

    The CxA should develop an ongoing commissioning plan that includes the following:

    - roles and responsibilities of the management and operators
    - energy and water use baselines
    - measurement and verification (M&V) procedures with measurement requirements and the review process that will be used to analyze data and validate performance
    - post-occupancy analysis plan

    Post-occupancy analysis should be completed within 9 to 12 months from the completion of the building to assess and improve performance in terms of end-user satisfaction and operational effectiveness. It should include:

        - measurement and physical monitoring of physical systems such as light levels, noise levels, CO_2 levels, air flow rates, etc.

- interviews and/or surveys of the building occupants regarding the building performance and end-user satisfaction on the following elements: thermal comfort, indoor air quality, lighting quality, and acoustic comfort.

Summary:

Table Man.1 summarizes all the steps described above and shows the responsible parties. All the steps do not necessarily need to be executed in the same order as presented.

Table Man.1: Summary of commissioning activities and responsible parties

Phase	Commissioning activity	Responsible parties	Required?
Predesign	1. Identify Commissioning Team	Owner, design team	Yes
	2. Define Owner's project requirements (OPR)	Owner	Yes
Design	3. Develop a basis for design (BOD)	Design team	Yes
	4. Review of the OPR and BOD	CxA	Advised
	5. Develop a preliminary Commissioning Plan	CxA	Yes
	6. Develop the Issues Log	CxA	Advised
Construction documents	7. Develop Cx specifications	Design team	Yes
	8. Review of the construction documents	CxA	Advised
Construction	9. Review contractor's submittals	CxA, owner, design team	Advised
	10. Update the OPR, BOD and Cx Plan	CxA, owner, design team	Yes, if needed
	11. Conduct commissioning kick-off meeting	CxA, contractor	Advised
	12. Develop installation verification checklists	CxA	Yes
	13. Conduct installation verification	Contractor	Yes
	14. Develop performance testing scripts	CxA	Yes
	15. Execute performance testing	Contractor	Yes
	16. Evaluate Results	CxA	Yes
	17. Prepare Cx report	CxA	Yes
Post-construction	18. Verify training	CxA	Yes
	19. Deliver post-construction documents	CxA	Yes
Occupancy and Operations	20. Perform fine-tuning	CxA, building operators	Yes, if needed
	21. Perform seasonal testing	CxA, building operators	Yes, if needed
	22. Develop an ongoing commissioning plan	CxA, building operators	Yes

Submissions

Provisional Certification Stage
Ensure that building systems are well-installed and are performing as intended:
• OPR and BOD • Preliminary commissioning plan • If available, commissioning specifications included in the construction documents
Ensure a proper handover to the owner O&M staff and end users:
This Strategy is not available at Provisional Certification Stage and no submissions are required.
Conduct commissioning activities during the operations of the building:
This Strategy is not available at Provisional Certification Stage and no submissions are required.

Full Certification Stage
Ensure that building systems are well-installed and are performing as intended:
• Complete commissioning report
Ensure a proper handover to the owner O&M staff and end users:
• Contractor's submittals of the training content, materials, and instructor qualifications. • Minutes of meetings showing that the training sessions have taken place • Evidence showing the Systems Manual which can be either: - photographs or scans showing front cover, table of contents, and at least 3 key sheets of the Systems Manual - or, if available, electronic version of the Systems Manual.
Conduct commissioning activities during the operations of the building:
• Copy of the ongoing commissioning plan signed and stamped by the owner • Evidence of the fine-tuning and seasonal testing activities performed (if any) such as log books, testing results, etc.

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Man-PR-1 & Man-4 Maintenance

Scope

Man-PR-1 prerequisite and Man-4 credit apply to NR and Residential projects.

Intent

To encourage the development of a preventative maintenance plan to ensure that the building's systems and equipment are achieving optimum performance.

Requirements

NR & Residential (Prerequisite)

Criteria	PR
Provide a Building Operation & Maintenance Manual	Man Prerequisite 1

NR & Residential (1 point)

This credit is only available at Full Certification.

Criteria	Points
Produce a preventative maintenance plan	1

Overview

The primary goal of maintenance is to prevent the failure before it occurs and thus mitigate the damage to the building and its occupants. It includes preserving and restoring equipment reliability to maximize the life of equipment and services.

Preventive maintenance activities include systematic inspection, partial or complete overhauls at specified periods, oil changes, lubrication, cleaning, etc. In addition, maintenance workers record equipment deterioration so parts can be repaired or replaced before they cause system failure. This will require a dedicated in-house team or qualified maintenance contractors. Ideally the dedicated in-house team will be hired before the construction is complete so that this team will be able to attend and participate in the installation and the commissioning of all equipment and will be in charge to operate and maintain later on. Training can be provided by a member of the Cx team that has a complete understanding of the building's operational and maintenance requirements.

Approach & Implementation

Management Prerequisite 1

The building operation and maintenance manual (O&M manual) includes the necessary information for the operation and maintenance of the building. The building operation and maintenance manual should include:

- A description of the main design principles
- As-built drawings and specifications
- Instructions for building operation and maintenance (including health and safety information, general instructions for efficient operation and periodical maintenance)
- Schedule of all equipment
- Commissioning and testing results (if any)

Management Credit 4

Produce a preventative maintenance plan for the building's major services and equipment which shall encompass energy intensive and water systems:

- Heating, ventilating, air conditioning and refrigeration (HVAC & R) systems
- Artificial lighting systems
- Hot water systems
- Metering and monitoring systems
- Control systems
- Hydraulic systems
- Renewable energy systems (for instance, wind, solar)

The preventative maintenance plan shall include, as a minimum, the following information:

- List of all equipment requiring maintenance
- List of all maintenance operations needed for each equipment
- Timeline for maintenance for all listed equipment and maintenance operations
- Schedule indicating when each maintenance operation should be conducted

Submissions

Provisional Certification Stage
Management Prerequisite 1
• Tender stage specification extracts -AND/OR- signed letter from the owner/developer that a building operation and maintenance manual will be produced.
Management Credit 4
This Credit is not available at Provisional Certification Stage and no submissions are required.

Full Certification Stage
Management Prerequisite 1
• Evidence showing the building operation and maintenance manual which can be either: - photographs or scans showing front cover, table of contents, and at least 3 key sheets of the building operation and maintenance manual, - and/or, if available, full electronic version of the manual.
Management Credit 4
• Copy of the Preventative Maintenance Plan signed and stamped by the owner

Man-PR-2 & Man-5 Green Awareness

Scope

Man-PR-2 prerequisite and Man-5 credit apply to NR and Residential projects.

Intent

To promote awareness and knowledge about sustainability issues in the community.

Requirements

NR & Residential (Prerequisite)

Criteria	PR
Provide a Building User's Guide for occupants	Man Prerequisite 2

NR & Residential (1 point)

This credit is only available at Full Certification.

Criteria	Points
Implement 2 of the following strategies to raise awareness on sustainability: - Provide signs and/or displays to demonstrate the project's green features - Provide sustainable practice guides to building occupants - Organize regular Green activities and events	1

Overview

Awareness of climate change and other environmental concerns is still relatively low in Vietnam and there is still a lot of work to be done to increase public awareness and environmentally friendly behavior. Green buildings should not only implement sustainable design and construction practices but also should help to educate community members and encourage them to change their behaviors.

Approach & Implementation

Management Prerequisite 2

Produce a building user's guide which should be a non-technical, easy to understand guide with information for users about:

- Design specifications of the project and how these affect its operation
- The building's standard of performance
- Sustainable features of the project

- Correct operation of HVAC and lighting systems
- Access, security and safety systems
- Evacuation/disaster response plan
- Methods for reporting problems
- Information on parking, public transportation, car sharing schemes, etc.
- Waste recycling procedures

NR

The Building User's Guide should be made readily accessible so that users can refer to it and learn about the building easily. Ideally it should be made accessible online.

Residential

The Building User's Guide should be made available to every dwelling-units.

Management Credit 5

Implement at least 2 of the following strategies to raise awareness on sustainability:

- Educational signage:

  Provide educational materials or signs to explain the project's green building features to building occupants and visitors.

  For projects with renewable energy generation, provide an educational display about the system in a publicly visible area.

- Sustainable practice guides

  A sustainable practice guide must be an illustrated document that:

  - Gives a list of sustainable practices on energy efficiency, water efficiency, waste management and sustainable purchasing.
  - Provides a clear description of the sustainable practices in order to help building occupants implement them.

Mixed-use Residential/NR Projects

Different sustainable practice guides should be provided for the occupants of the non-residential components and for the building residents.

- Green activities:

  Organize regular activities and events to educate and raise awareness of the community:

  - Provide building tours on a regular basis (biweekly or monthly when the project first opens and at longer intervals depending on the community interest).

- Organize activities or events for children to raise their awareness on the topics of environmental protection, climate change, sustainable use of resources, etc.
- Set up an organic community gardening project
- Other activities/events shall be subject to VGBC approval

Submissions

Provisional Certification Stage
Management Prerequisite 2
• Tender stage specification extracts -AND/OR- signed letter from the owner/developer that a building user's guide will be produced.
Management Credit 5
This Credit is not available at Provisional Certification Stage and no submissions are required.

Full Certification Stage
Management Prerequisite 2
• Copy of the building user's guide which can be either: - photographs or scans showing front cover, table of contents, and at least 3 key sheets of the building user's guide, - or, if available in an electronic version, submit full building user's guide document.
Management Credit 5
For the Educational signage strategy: • Photographs showing signs and/or displays installed in different locations of the project For the Sustainable practice guides strategy: • Copies of the sustainable practice guides • Evidence showing that the sustainable practice guides are handed to tenants and residents For the Green activities strategy: • Report describing the Green activities and events planned and already carried out • Evidence showing that the activities occurred, such as photographs, announcements, etc.

Exceptional Performance

The purpose of this category is to reward innovative techniques/initiatives, as well as exceptional performance enhancement.

There are up to 8 points available over the 2 credits, but these points are not specifically assessed to one or the other credit.

Credit	Title	NR	Residential
EP-1	Enhanced Performance	8 points	8 points
EP-2	Innovative Solutions		
	Total of points available	8 points	8 points

EP-1 Enhanced Performance

Scope

EP-1 credit applies to NR and Residential projects.

Intent

To encourage exceptional performance and recognize projects that achieves environmental benefits in excess of the current LOTUS rating system benchmarks.

Requirements

NR & Residential (1-8 points)

Criteria	Points
Exceed significantly the credit requirements of LOTUS NC credits	1-8

Overview

The weightings and benchmarks in LOTUS have been set to reflect what is perceived as possible in the current market. However, if any innovative idea allows the design team to exceed significantly the requirements of the highest threshold, points will be rewarded. The applicant must describe what innovative strategies/initiatives have been implemented in order to achieve the Exceptional Performance Enhancement Credit. The VGBC reserves the right to not award points where the performance improvement is not demonstrated to be achieved by innovative measures or where required evidence is not adequately provided.

Approach & Implementation

Projects can target up to 8 points in this credit with 1 point for each Enhanced Performance of a LOTUS NC credit.

There are two different cases where points can be awarded for Enhanced Performance:

Case 1:

In a credit with two or more performance increments, the building performance exceeds the maximum credit requirement by an additional increment.

All the requirements that need to be met to achieve points in credit EP-1 through Case 1 are listed in Table EP.1.

Table EP.1: Building performance to reach in the different credits for one point in EP-1

Credit	Building performance to reach for one point in EP-1
E-2 Total Building Energy Use	Demonstrate a 47.5% reduction of the total building energy use compared to the baseline
E-3 Building Envelope - Option B	Building's average OTTV surpasses QCVN 09:2017/BXD requirements by 60%
E-5 Artificial Lighting - Strategy A	**NR** Installed LPD surpasses QCVN 09:2017/BXD requirements by 80% **Residential** Installed LPD surpasses QCVN 09:2017/BXD requirements by 60%
E-8 Renewable Energy	4% of the total energy used in the building is produced from renewable sources
W-1 Water Efficient Fixtures	Reduce building domestic water consumption through fixtures by 50% in comparison to a baseline model
W-4 Sustainable Water Solutions - Strategy A	Recycled water, reused water or harvested rainwater contributes 60% of the building's total water consumption
MR-2 Sustainable Materials	35% of the total value of the materials in the project is from sustainable materials.
MR-4 Demolition and construction waste	90% of the demolition and construction waste has been reused, salvaged and/or recycled
H-4 Daylighting - Option B	Achieve a spatial daylight autonomy$_{300/50\%}$ (sDA$_{300/50\%}$) of more than 95% of the net occupied area while controlling solar glare
SE-3 Vegetation	Provide greenery to achieve a Greenery Index higher than 3.0
SE-4 Stormwater Management - Option A	Average perviousness of the site is at least 70%
SE-5 Heat Island Effect	70% of the paved and roof area limits heat island effect
SE-6 Refrigerants - Option B	Average Refrigerant Atmospheric Impact of all the air-conditioning systems installed in the building is below 8
SE-11 Outdoor Communal Space and Facilities - Strategy A	15% of the site area is a public space with social and recreational value

Case 2:

In a credit with different strategies available, the building performance reaches a higher number of points than what is available in the credit.

Example: Credit H-5 External Views (2 points available)

- Strategy A – The building has more than 90% of the net occupied area that achieves a direct line of sight to the outdoor environment and 2 points can be earned.
- Strategy B – The building also has more than 70% of the net occupied area that has quality views and 1 point can be earned.
- This building is awarded 2 points in Credit H-5 External Views and 1 point in credit EP-1.

All the credits where points can be awarded in EP-1 through case 2 are listed in Table EP.2.

Table EP.2: Credits where one point in EP-1 can be awarded for achieving different strategies

Credit	Requirements to be awarded one point in EP-1
E-4 Building Cooling	At least 7 points can be achieved under the 2 strategies of the credit
E-5 Artificial Lighting	**NR** 4 points can be achieved under the 2 strategies of the credit
W-4 Sustainable Water Solutions	At least 6 points can be achieved under the 2 strategies of the credit
MR-1 Reduced Concrete Use	The 3 strategies of the credit are achieved
H-2 Low Emission Products	**NR** 3 out the 4 strategies of the credit are achieved **Residential** The 4 strategies of the credit are achieved
H-5 External Views	3 points can be achieved under the 2 strategies of the credit
SE-3 Vegetation	5 points can be achieved under the 2 strategies of the credit
SE-9 Green Transportation	The 4 strategies of the credit are achieved
SE-11 Outdoor Communal Space and Facilities	At least 3 points can be achieved under the 2 strategies of the credit
Man-1 Effective Design Process	2 out of the 3 strategies of the credit are achieved
Man-2 Construction Stage	The 2 strategies of the credit are achieved

Submissions

Provisional Certification Stage
For each performance enhancement of a credit:
• Submissions as per initial credit requirements • Report indicating what measures are taken to surpass the initial credit requirement.

Full Certification Stage
For each performance enhancement of a credit:
• Submissions as per initial credit requirements If not already approved at Provisional Certification or if there is any change: • Final report indicating what measures were taken to surpass the initial credit requirement

EP-2 Innovative Solutions

Scope

EP-2 credit applies to NR and Residential projects.

Intent

To promote innovative solutions that are not considered in LOTUS NC.

Requirements

NR & Residential (1-8 points)

Criteria	Points
Implement innovative solutions that are outside the scope of LOTUS NC	1-8

Overview

LOTUS NC covers a broad range of credits for measuring the environmental performance of a building. However, through this credit, it is also recognized that there may be an innovative strategy or practice in the building that is not addressed by any LOTUS NC credits.

Approach & Implementation

An EP-2 submission must be a concise report that clearly articulates the nature and magnitude of the environmental benefit achieved by the proposed innovative solution.

The innovative solutions proposed by projects will be considered on a case by case basis. The VGBC reserves the right to not award points where adequate justification for the innovative nature of the strategy, environmental benefit and achieved performance cannot be provided. For this reason, it is advisable to confirm the proposed innovation credit nature, thresholds and submittal requirements with the VGBC at any time prior to submittal.

Submissions

Provisional Certification Stage
For each Innovative solution targeted:
• Report outlining the proposed innovative strategy and the expected performance • Supporting evidence verifying the expected performance such as manufacturer's data, calculations, etc.

Full Certification Stage
For each Innovative solution targeted:
• Supporting evidence demonstrating that the construction or installation has been done according to the description given in the report.
If not already approved at Provisional Certification or if there is any change: • Final report outlining the innovative strategy and the expected/achieved performance • Supporting evidence verifying the expected performance such as manufacturer's data, calculations, etc.

Glossary

Specific LOTUS Terms

Applicant - The person / organization applying for LOTUS Certification of a project.

Applicant Representative - The Applicant Representative is responsible for all elements of the certification and submission process within LOTUS Rating Systems. The Applicant Representative will directly liaise with the Assessment Organization Representative throughout all stages of LOTUS Certification.

Application Form - The Application Form is the first step in registering a project. Once completed, the Assessment Organization will check to see that all relevant information is present and correct, register the project and request the payment of a Registration Fee and the signing of the Certification Agreement.

Assessment Fee - The Assessment Fee, value dependent on the size of the project, is a one-off charge for the total administration process of LOTUS Certification and is bound by the Certification Agreement.

Assessment Organization - The organization that performs the assessment of the projects applying for LOTUS Certification.

Assessment Organization Representative - The Assessment Organization Representative is nominated within the Registration Process and will be the Assessment Organization primary representative that liaises with the Applicant Representative throughout the project.

Category - A Category is a grouping of Credits that have a similar area of focus and perceived environmental impact.

Certification Agreement - The Certification Agreement is the legally binding contract signed between the Applicant and the Assessment Organization upon registration.

Credit - Each Credit has a specific intent that, if followed and achieved, allows the user to gain points within a LOTUS Rating System.

LOTUS Accredited Professional - The LOTUS Accredited Professional or LOTUS AP has undergone training and successfully passed the LOTUS Rating System examination. Upon Accreditation, the LOTUS AP is then deemed qualified to work either as an internal or external resource within a LOTUS project.

LOTUS Certified Rating - The LOTUS Certified Rating is the result obtained after Submission has been assessed at Full Certification stage by the Assessment Organization. A project can achieve 4 levels of certification, LOTUS Certified, LOTUS Silver, LOTUS Gold or LOTUS Platinum.

LOTUS Technical Manual - The LOTUS Technical Manual is a user's guide to attaining a LOTUS Certification. It provides technical guidance for all LOTUS Credits in order for users to understand intents, requirements, approaches and implementations, calculations and submissions.

Notification Form - The Notification Form is submitted by the Applicant Representative to notify the Assessment Organization that the Applicant is ready to provide ALL submissions in order to be assessed for LOTUS Certification. The Notification Form must be submitted a minimum of 2 weeks prior to the main Submissions in order for the Assessment Organization to organize the period in which the project will be assessed.

Prerequisite - Indicates the minimum requirements in a LOTUS rating system. There are stand-alone prerequisites as well as credit-involved prerequisites, but regardless of types, buildings that apply for LOTUS certification are obliged to fulfil all prerequisites in every category. Each prerequisite is organized in a standard format, similar to credit format. A list of all prerequisites is provided at the beginning of the LOTUS Technical Manual.

Project Assessment Committee (PAC) - The committee led by the Assessment Organization project manager that consists of experts drawn from within the Assessment Organization and externally from the private sector, academia, institutes and public departments that are responsible for the independent assessments of projects submitted for LOTUS Certification.

Project Identification Number (PIN) - The Project Identification Number (PIN) is a unique reference number issued at the Registration Confirmation. This reference number must be protected and is for the use of the Applicant Representative when providing submissions to the Assessment Organization.

Registration Fee - The Registration Fee is a one-off charge for the administration process of registration to a LOTUS Rating System and is bound by the Certification Agreement.

Submission - The Submission is the process where all documents are provided to the Assessment Organization Representative for assessment.

Submission Section - In each Credit, the Submission Section details all requirements that will be assessed for LOTUS Certification.

LOTUS Submission Terms

Bill of Quantity (BOQ) - A document drawn up by a quantity surveyor providing details of the prices, dimensions, etc., of the materials required to build a project. A BOQ is a document used in tendering in the construction industry in which materials, parts, and labor and their costs are itemized. It may also detail the terms and conditions of the construction or repair contract and itemize all work to enable a contractor to price the work for which he or she is bidding.

Calculations - The mathematical interpretation and computation of numbers and quantities. Calculations are generally required for many LOTUS credits to prove that a building is qualified for LOTUS certification.

Commissioning Records - Documents that record the activities and results of the Commissioning Process, including inspection reports, testing reports, etc.

Contract - A binding legal agreement of an exchange of promises between two or more parties. Contracts are documents that ensure the safety of parties who sign it by making personal and business agreements official and binding. Contracts help all parties involved as well as any contractor administering the contract to understand the terms of the agreement and the individual rights and obligations.

Detail drawings - Detail drawings show a small part of the construction at a larger scale, to show how the component parts fit together.

Drawings - Two dimensional technical diagrams of a place or object.

Elevation - An elevation is a view of a building seen from one side, a 2D drawing of one facade of the building.

Invoice/Receipt - A proof of purchase given from a supplier to a consumer.

Landscape design drawing/plans - Scaled maps illustrating all features and relevant properties of a building landscape.

Minutes - A written account of actions decided upon during a meeting.

Plan - A floor plan is the most fundamental architectural diagram, a view from above showing the arrangement of spaces in building in the same way as a map but showing the arrangement at a particular level of a building. Technically it is a horizontal section cut though a building (conventionally at three feet/one meter above floor level), showing walls, window and door openings and other features at that level.

Reports - A written document usually required for LOTUS certification submission that describes how a structure or system of a building satisfies the requirements of a certain LOTUS credit.

Schematics - A diagram that represents the elements of a system using symbols.

Site Plans - An accurate drawing or picture of a planned or completed development site, which has a scale of size for reference (to determine relative sizes and distances). Site plans often show, but are not limited to, boundaries, building locations, landscaping, topography, vegetation, drainage, floodplains, zoning, routes/streets, sidewalks and other site features.

Specification - A detailed statement describing the requirements for construction, installation or manufactured elements, in particular the materials, dimensions, quality of work and required performance and/or adherence to standards and codes.

System Description - A document that describes the function of interacting elements designed to work as a whole.

Tender Stage Documentation - Documents provided to potential tenderers when they are invited to tender and which form the basis on which tenders are submitted, including instructions to tenderers, contract conditions, specifications and drawings, pricing documents, form of tender and tenderers' responses. The stage occurs upon completion of the majority of the design work and the documents are what is used (but not limited to) cost a proposal.

Master Plan Terms

Building footprint - The area of the building in plan on the ground floor or ground plane that is enclosed by exterior walls and adjoining structures sharing the same foundation as the building such as decks, porches and garages.

Hardscaping -The practice of landscaping that refers to paved areas like streets & sidewalks, large business complexes & housing developments and other industrial areas.

Development Footprint - The area of a site that is directly impacted by development activity including: building structures, hardscaping, access roads, car parking and non-building facilities.

Non-Building area - The site area minus the building footprint. Includes Open space as well as hardscaping, access roads, car parking and non-building facilities.

Site Area - The total area of the building site, the area of the lot(s) on which have been/are to be developed. (Figure G1)

Vegetated Area - Any areas on the building site that are not paved and have plant cover.

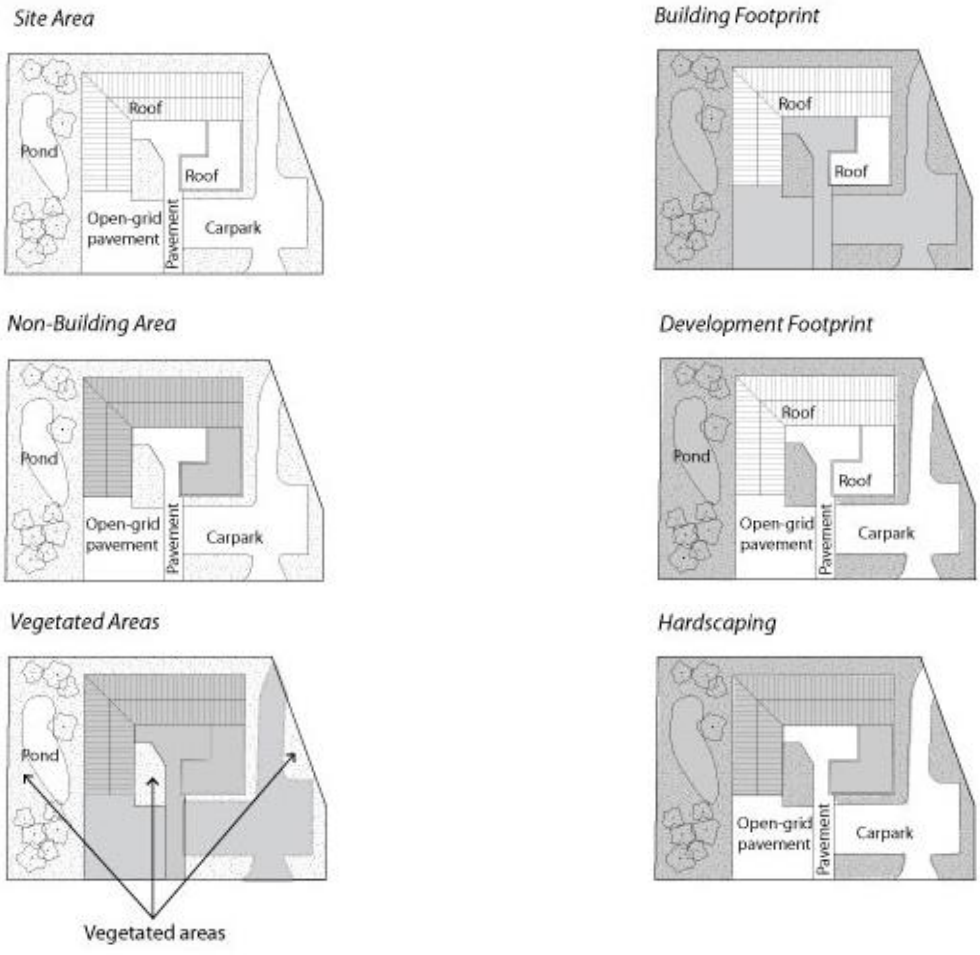

Figure G.1: Site area illustrations

Technical Terms

Additions - Construction work on an existing building resulting in an increased floor area.

Alterations - Improvement work not related to the primary structural components, exterior shell or roof of the building. Specifically, renovation work that may result in changes to the building envelope or floor plan, such as removing/erecting interior walls, removing/installing new windows. This does not include minor changes such as the installation of new water fixtures, replacement of electrical equipment, replacement of windows etc.

ASHRAE - The American Society of Heating, Refrigerating and Air Conditioning Engineers is an international technical society for all individuals and organizations interested in heating, ventilation, air-conditioning, and refrigeration. The society publications include handbook, journal as well as series of HVAC relating standards and guidelines. These standards are often referenced in green building assessment reference guide/technical manual and are considered useful guide for consulting engineers, mechanical contractors, architects, and government agencies.

Baseline model - A baseline model of building X would inherit all design and orientation characteristics of building X (e.g. orientation, GFA, number of occupants, number of floors, shape, local weather conditions, number of operational days, etc.). However, the materials and equipment used in the baseline model are conventional ones, as opposed to the "Design model", to which green and efficient practices will be applied.

Biodiversity - Or Biological diversity is a term that includes the variety of all life forms (plants, animals, microorganisms, their genes) together with the ecosystems they are a part of. Biodiversity changes constantly due to processes such as evolution, extinction, habitat degradation, etc.

Black water - Wastewater which contains wastes from toilets, kitchen taps or industrial waste and requires treatment before reuse.

Building envelope - The elements of a building that enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from unconditioned spaces.

Climate change - In modern terms, climate change refers to the changes of the Earth climate mainly due to the uncharacteristic increase of greenhouse gases concentration in the atmosphere, resulting from human activities.

Coefficient of performance (COP) - The ratio of the rate of heat removal to the rate of energy input in consistent units, for a complete cooling system or factory assembled equipment, as

tested under a nationally recognized standard or designated operating conditions. COP for air-cooled electrically driven air conditioners includes compressor, evaporator, and condenser. COP for water chilling packages does not include chilled water or condenser water pumps or cooling tower fans.

Cooling Seasonal Performance Factor (CSPF) - As defined in ISO 5151, CSPF is the ratio of the total annual amount of heat that the equipment can remove from the indoor air when operated for cooling in active mode to the total annual amount of energy consumed by the equipment during the same period. Unlike COP that represents the efficiency of an equipment at given conditions, CSPF represents the efficiency over a full year of operation.

Common Areas - Those areas within a building or tenancy not leased to a particular tenant, but which are available for the use of all tenants and usually of members of the public.

Completion of construction - Defined as building commissioning, building practical completion or beginning of building operation, whichever occurs first.

Computational Fluid Dynamic (CFD) Analysis - A modelling technique that can be used to calculate fluid properties such as temperature, heat flow, wind velocity and air flow of a building.

Conditioned space - An enclosed space within a building which is a cooled space, heated space, or indirectly conditioned space.

Daylight Factor - The daylight factor is the ratio of the interior illuminance to the global horizontal illuminance under CIE standard overcast sky conditions.

Daylighting - Technologies or design strategies used to provide lighting to buildings without power consumption. Although maximizing natural lighting will minimize electricity consumption used for lighting, too much solar irradiation will heat up the building and increase cooling load.

Design Model - Design Model refers to the case of the proposed project. It carries with it the assumption that it will have a calculable improvement in green performance as compared to what is deemed standard practice for a building of equivalent size, location and use - Baseline model.

Domestic Water - Treated water supplied to the building from municipal water supply systems for domestic uses and meets the quality requirement as stated in QCVN 02:2009/BYT National technical regulation on domestic water quality. LOTUS considers both municipal water and groundwater as domestic water.

Dwelling-unit - Also called housing unit. It is a space that is intended to be used as living quarters. For a room or apartment to be defined as a dwelling-unit, it must be distinctly separated from other living spaces within the building.

Eco-Charrette - A crucial pre-design step, during which a minimum of the developer, the architect and the engineers, together define a strategy and a performance level for the project. This process ensures a complete commitment from the whole design team, before the design work has started, allowing for a full understanding of the aims throughout every step of the design.

Eco-value - Or ecological value of a piece of land is its ability to support native life as a part of the natural ecosystem. Land is often of high ecological value when it is in its most natural state supporting the existing population.

Environmental Product Declaration (EPD) - It is a standardized way of quantifying the environmental impact of a product or system. Declarations include information on the environmental impact of raw material acquisition, energy use and efficiency, content of materials and chemical substances, emissions to air, soil and water and waste generation. Product and company information is also included.

Fenestration - Any light-transmitting component in a building wall or roof. The fenestration includes glazing material (which may be glass or plastic), framing (mullions, muntins, and dividers) external shading devices, internal shading devices, and integral (between-glass) shading devices.

Forest Stewardship Council (FSC) - FSC was established to promote the responsible management of the world's forests. FSC promote responsible forest management. Products carrying the FSC label are independently certified to assure consumers that they come from forests that are managed to meet the social, economic and ecological needs of present and future generations.

Full-time occupants - Full-time occupants are employees/staff in the building and their number should be calculated based on a daily occupancy of 8 hours. Part-time occupants should be given an equivalent 'full-time occupants' value based on the number of hours they spend in the building per day divided by 8

Global Warming Potential (GWP_{100}) - A value assigned to a refrigerant based on scientific measurements showing how much that refrigerant will contribute to global warming if released into the atmosphere. The reference datum is based on the effect of CO_2 in the atmosphere, which is assigned a GWP of 1. GWP is usually measure over a 100-year period and the lower the GWP of a refrigerant is the better or less harmful the refrigerant is for the environment.

Gray water - Waste water recovered from households or buildings and has not come to contact with food or human/animal waste.

Greenhouse gases (GHG) - Gases in the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. (As defined in the IPCC AR4 SYR Appendix Glossary).

Green roof - Green roof refers to a building roof that is partially or completely covered with vegetation and soil, or a growing medium, planted over a waterproofing membrane along with appropriate additional layers such as a root barrier and drainage and irrigation systems. The term does not refer to roofs which are merely colored/painted green, as with green roof shingles, or decorated with pot plants.

Gross Floor Area (GFA) - The sum of the fully enclosed covered floor area of a building at all floor levels. Parking areas and non-enclosed roofed-over areas (such as exterior covered walkways, porches, terraces or steps, roof overhangs, and similar features) are not to be included as GFA.

Habitable spaces - In a residential building, habitable spaces include kitchen, living room, dining room, bedroom and study but exclude bathrooms, storage, and utility spaces. All habitable spaces are considered occupied spaces.

Habitat - The natural environment in which one organism exists.

HVAC (Heating, Ventilating and Air Conditioning) - The equipment, distribution network, and terminals that provides either collectively or individually the processes of heating, ventilating, or air conditioning to a building.

Illuminance - The density of the luminous flux incident on a surface. It is measured in lux or lm/m^2 and is equal to the luminous flux (lumen) divided by the area (m^2) of the surface when the latter is uniformly illuminated.

ISO Standard - Standards set by the International Organization for Standardization. Although ISO is a non-governmental organization, its standards often become law through either treaties or referencing by national standards and are usually integrated in green building assessment tools.

Landscaping - All activities that modify the visible features of the non-building area.

LPD (Lighting Power Density) – The ratio of electric lighting output to the illuminated area, measured in W/m^2.

Lighting Ballast - A device used to obtain the necessary circuit conditions (voltage, current, and wave form) for starting and operating an electric-discharge lamp. Ballast factor (BF) is the ratio of commercial ballast lamp lumens to a reference ballast lamp lumens, used to correct the lamp lumen output from rated to actual.

Line of sight - An imaginary line/path from occupant eyes to perceived objects. A direct line of sight refers to an unobstructed path from a building occupant eyes to the external view.

Lumen (Lm) - SI unit of luminous flux. Radio-metrically, it is determined from the radiant power. Photo-metrically, it is the luminous flux emitted within a unit solid angle (one steradian) by a point source having a uniform luminous intensity of one candela.

Major building refurbishment - A project is considered a major refurbishment when any of the following eligibility requirements is complied with:

- An alteration affects more than 50% of the Gross Floor Area (GFA) of the building at any one time
- An alteration disrupts the operations or relocates more than 50% of the building occupants
- An addition increases the GFA of the building by more than 30%

Mixed-use building - Building accommodating two or more different usage types (residential, office, retail, hotel, etc.).

Mixed-use Residential/NR building - Building accommodating both residential and NR commercial spaces (office, retail, hotel, etc.). A multi-family residential building featuring non-residential components such as an office for building management or amenity spaces (gym, swimming pool, etc.) reserved for residents is not a mixed-use building.

Modelling Simulation - A visual representation of how something that is designed will perform, using a software program to show interactions and the results of multiple variables.

Natural ventilation - Technologies or design features used to ventilate buildings without power consumption. Natural ventilation, unlike fan-forced ventilation, uses the natural forces of wind and buoyancy to deliver fresh air into buildings.

Net Occupied Area - The sum of the areas of all the occupied spaces of the project.

Non-baked materials - Also called Non-fired materials. They are building materials that solidify and meet all required physical properties (compressive strength, bending strength, water absorption, etc.) without undergoing the firing process. With the Circular No.

13/2017/TT-BXD of December 8, 2017, the Ministry of Construction supports the development of non-baked materials to replace traditionally baked bricks, a main cause of pollution and energy waste.

Occupied spaces - Enclosed spaces that can accommodate human activities. They include work spaces (offices, meeting rooms, laboratories, etc.), event spaces (halls, sales areas, libraries, gyms, etc.), common areas (receptions, waiting rooms, lounges, lobbies, etc.), and learning spaces (classrooms). They exclude corridors, staircases, storage areas, toilets, changing facilities, IT equipment rooms and mechanical rooms.

Overall Thermal Transfer Value (OTTV) - OTTV is a measure of the average heat gain into a building through its envelope. It is measured in W/m^2. A building with a higher OTTV will impose a greater cooling load on the air-conditioning system, which would have to expend more electrical energy in removing it. The aim of low OTTV is to ensure adequately designed building envelopes which cut down external heat gains and hence reduce the cooling load of air-conditioning systems.

Ozone Depletion Potential (ODP) - A value assigned to a refrigerant based on scientific measurements that show how destructive a refrigerant is to the ozone layer if released into the atmosphere. The reference datum is based on the effect of refrigerant R11, which is assigned an ODP of 1. The lower the value of ODP the better or less harmful the refrigerant is for the ozone layer and therefore the environment.

Passive Design Analysis - An account of the decisions made and steps taken to implement a design that reduces energy consumption of a building by taking advantage of natural heating, cooling and lighting.

Permeable hardscape - All areas of a building landscape that are paved with construction materials allowing water to pass through to the soil underneath.

Project Design Team - The Project Design Team are the core team of experts involved in the design of a project that must integrate the principles of sustainability into the design process in order to gain points for certification.

Public space - Any space which is open to the public, not limited to building occupants. There might be certain rules applied to the space, but no fee must be paid to access.

Quy chuẩn xây dựng Việt Nam (Vietnam Construction Regulation/Building Code) - All mandatory regulations applied in building activities, which are issued by governmental authorities on building.

QCVN 09:2017/BXD - The National Technical Regulation on Energy Efficiency Buildings is issued by the Ministry of Construction and is mandatory in Vietnam in order to help meet energy saving goals.

R-value - Measure of how well an object resists conductive flow of heat: the greater the R-value, the greater the resistance, and so the better the thermal insulating properties of the object. The SI (metric) unit of R-value is square-meter kelvin per watt (m2·K/W).

Rapidly renewable materials - A rapidly renewable material is a source that can regenerate what has once been harvested within 10 years or less.

Reflectance - The ratio of light reflected by a surface to the light incident upon it.

Refrigerant - A refrigerant is a compound used in a heat cycle that reversibly undergoes a phase change from a gas to a liquid in a process of converting thermal energy to mechanical output.

Recycling - A process in which materials that have been once processed into products are collected, processed again and returned to the market as raw materials or as finished goods.

Renewable energy - Energy generated from sources (sunlight, wind, rain, tides, and geothermal heat) that are replenished naturally and continually.

Reuse - A process in which processed materials are collected and returned to the market without reprocessing to change form or characteristics.

$SCOP_C$ (Seasonal Coefficient Of Performance for cooling) - The total cooling output of an air-conditioner during its normal annual usage period for cooling divided by the total electric energy input during the same period in consistent SI units.

SHGC (Solar Heat Gain Coefficient) - The SHGC of a glass is the percent of solar energy incident on the glass that is transferred indoors both directly and indirectly through the glass.

Stormwater - Stormwater is the water that originates during precipitation events.

SRI (Solar Reflectance Index) - It is a measure of a surface's ability to reject solar heat and to stay cool. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100.

TCVN (Vietnam standard) - All technical documents describing principles, guidelines or properties/results of activities issued by authorized agencies to help maximizing effectiveness in certain conditions (25/2001 QD-BXD issued on 4/9/2001). Application of most TCVN is on voluntary basis except for standards relating to life safety, fire and explosion protection, environment sanitation and environmental conditions recording. The

Vietnam Directorate for Standards, Metrology and Quality is mainly responsible for issuing Vietnamese standards.

TCXD/TCXDVN (Vietnam Construction Standard) - All Vietnamese standards which are applicable to construction and building but are not mandatory as opposed to the Vietnam Construction Regulation or building code. (TCXDVN definition at item 19 and 20, Article 3, Building Code - 26/2003/L-CTN issued on 10/12/2003)

Thermal Comfort - A term describing conditions in which building occupants are comfortable with the surrounding thermal environment. Conditions include air temperature, radiant temperature, humidity, draught, clothing and activity rates.

Thermal Mass - Materials with mass heat capacity and surface area capable of affecting building loads by storing and releasing heat as the interior and/or exterior temperature and radiant conditions fluctuate.

Thermal Zone - A thermal zone is a space or collection of spaces having similar space-conditioning requirements, the same heating and cooling setpoint, and is the basic thermal unit (or zone) used in modeling the building.

Unmet load hour - An unmet load hour is defined as an hour in which one or more thermal zones is outside of the thermostat setpoint plus or minus one half of the temperature control throttling range. The temperature control throttling range is the number of degrees that room temperature must change in order to go from full cooling to no cooling. In LOTUS, an unmet load hour is an hour in which one or more thermal zones is outside of the thermostat setpoint plus or minus 1.1°C (= 2°F).

VAV (variable air volume) - Type of HVAC system which has the ability to vary the airflow of cooled supply air (maintained at a constant temperature) to the different air-conditioned spaces in order to meet precisely the thermal setpoint.

Ventilation - The process of supplying fresh air and removing vitiated air by natural or mechanical means to and from a space. Such air may or may not have been conditioned.

Volatile Organic Compound (VOC) - An organic chemical compound that enters gaseous phase under normal room conditions due to its high vapor pressures. Some VOCs have negative effects on human health when concentrated in poorly ventilated indoor spaces.

VRV/VRF (variable refrigerant volume/flow) - Type of direct (one refrigerant only) air-conditioning system with variable speed compressors, several air handlers (indoor units) on the same refrigerant loop/circuit.

VSD (variable-speed drive) - Equipment used to control the speed of a pump or fan to adjust to the demand.

Water efficient fixture - Water-based fixture that requires less amount of water to complete a designed task than most average fixtures.

Xeriscaping - Landscaping that minimizes the need for supplemented watering. Xeriscaping is particularly encouraged in areas where freshwater accessibility is limited.

Annex 1: Applicability and procedures for C&S projects

Table A.1: Applicability and procedures to follow for all credits and prerequisites for C&S projects

PR/Credit	Requirements	Applicability	Procedure
E-PR-1	Requirements on R-values and SHGC values	Whole building	Follow all the requirements of the prerequisite.
	Requirements on efficiency of HVAC systems	All the HVAC systems installed by the developer	Follow all the requirements of the prerequisite in the scope of applicability and include guidance on the selection of HVAC systems in the green fit-out guidelines.
	Requirements on Lighting power density	All the spaces where lighting is fully installed by the developer	Follow all the requirements of the prerequisite in the scope of applicability and include guidance on the selection of lighting fixtures in the green fit-out guidelines.
E-PR-2 & E-1	Whole credit/PR	Whole building	Follow all the requirements of the prerequisite/credit.
E-PR-3 & E-2	Whole credit/PR	Whole building	Follow all the requirements outlined in the prerequisite/credit. For all items under tenants or residents' control, the proposed and baseline buildings should be modelled identically. Exception: If more than 50% (based on GFA) of tenants and/or residents have followed green fit-out guidelines and have installed energy-efficient equipment, it is possible to model the proposed building with the equipment installed by the tenants and/or residents. As evidence, inspection records or spot check reports showing the equipment installed by the tenants and/or residents will have to be provided.
E-3	Whole credit	Whole building	Follow all the requirements of the credit.
E-4	Strategy A: Natural Ventilation	Whole building	Follow all the requirements of the credit.
	Strategy B: Air-conditioning	All the HVAC systems installed by the developer	Follow all the requirements of the credit in the scope of applicability and include guidance on the selection of HVAC systems in the green fit-out guidelines. Exception: If more than 50% (based on GFA) of tenants and/or residents have followed green fit-out guidelines and have installed energy-efficient air-conditioning systems, it is possible to include these systems in the calculations for Strategy B1. As evidence, inspection records or spot check reports showing the equipment installed by the tenants and/or residents will have to be provided.

E-5	Artificial Lighting	All the spaces where lighting is fully installed by the developer	Follow all the requirements of the credit in the scope of applicability and include guidance on the selection of lighting systems in the green fit-out guidelines. Exception: If more than 50% (based on GFA) of tenants and/or residents have followed green fit-out guidelines and have installed an energy-efficient lighting system, it is possible to include these systems in the calculations for Strategy A. As evidence, inspection records or spot check reports showing the lighting system installed by the tenants and/or residents will have to be provided.
E-6	Requirements on PMS and BMS	All the equipment and systems installed by the developer	Follow all the requirements of the credit in the scope of applicability and include guidance on the energy monitoring in the green fit-out guidelines. Also, separate tenancies should be individually metered (but not necessarily connected to the PMS/BMS system).
	Requirements on Energy Monitors	Whole building	Follow all the requirements of the credit.
E-7	Whole credit/PR	Whole building	Follow all the requirements of the credit.
E-8	Whole credit/PR	Whole building	Follow all the requirements of the credit.
W-PR-1 & W-1	Whole credit/PR	All the water fixtures installed by the developer	Follow all the requirements of the prerequisite/credit in the scope of applicability and include guidance on the selection of water fixtures in the green fit-out guidelines. Exception: If more than 50% (based on GFA) of tenants and/or residents have followed green fit-out guidelines and have installed water-efficient fixtures, it is possible to include these systems in the calculations. As evidence, inspection records or spot check reports showing the fixtures installed by the tenants and/or residents will have to be provided.
W-2	Whole credit	Whole building	Follow all the requirements of the credit.
W-3	Whole credit	Whole building	Follow all the requirements of the credit.
W-4	Whole credit	Whole building	Follow all the requirements of the credit.
MR-1	Whole credit	Whole building	Follow all the requirements of the credit.
MR-2	Whole credit	All the materials installed by the developer	Follow all the requirements of the credit in the scope of applicability and include guidance on the selection of sustainable materials in the green fit-out guidelines.
MR-3	Whole credit	All the non-structural walls installed by the developer	Follow all the requirements of the credit in the scope of applicability and include guidance on the selection of non-baked materials in the green fit-out guidelines.

MR-PR-1 & MR-4	Whole credit/PR	All the construction works realized by the developer	Follow all the requirements of the prerequisite/credit in the scope of applicability and include guidance on the management of construction waste in the green fit-out guidelines.
MR-5	Whole credit	Whole building	Follow all the requirements of the credit.
H-PR-1	Whole PR	Whole building	Follow all the requirements of the prerequisite.
H-1	Strategy A Requirements on mechanically and mixed-mode ventilated spaces	All the HVAC systems installed by the developer	Follow all the requirements of the credit in the scope of applicability: • fresh air supply requirements should be met for the completed occupied spaces • for the tenant and/or resident areas served by HVAC systems installed by the developer, the requirements on fresh air supply should be met for the total area of incomplete spaces based on expected occupancy type. • for the tenant and/or resident areas not served by HVAC systems installed by the developer, guidance on fresh air supply should be included in the green fit-out guidelines.
	Strategy B	All the HVAC systems installed by the developer	Follow all the requirements of the credit in the scope of applicability: • air filtration should be installed on all the fresh air intakes installed by the developer • for the tenant and/or resident areas not served by HVAC systems installed by the developer, include guidance on air filtration in the green fit-out guidelines.
	Strategy C	All the HVAC systems installed by the developer	Follow all the requirements of the credit in the scope of applicability: • CO_2-based demand-controlled ventilation system should regulate the fresh air ventilation rate in all the completed high-density occupied spaces • for the incomplete spaces, guidance on CO_2-based demand control ventilation should be included in the green fit-out guidelines.
	Strategy D	Whole building	Follow all the requirements of the strategy.
H-PR-2 & H-2	Whole credit	All the construction works realized by the developer	Follow all the requirements of the prerequisite and credit in the scope of applicability and include guidance on the selection of low-emission products in the green fit-out guidelines.
H-3	Whole credit	Whole building	Follow all the requirements of the credit.
H-4	Whole credit	Whole building	Follow all the requirements of the credit for the whole building: • requirements of the credit should be met for the completed occupied spaces • requirements should be met for the incomplete spaces that should be considered as occupied spaces. Recommended reflectance values should be used and spaces should be considered as they are (i.e. without interior layout completed). Guidance on the provision of daylight should be included in the green fit-out guidelines.

H-5	Strategy A	Whole building	Follow all the requirements of the credit for the whole building: • requirements of the credit should be met for the completed occupied spaces • requirements should be met for the incomplete spaces that should be considered as occupied spaces and as they are (i.e. without interior layout completed). Guidance on the provision of external views should be included in the green fit-out guidelines.
H-6	Requirements for air-conditioned spaces	All the HVAC systems installed by the developer	Follow all the requirements of the credit in the scope of applicability: • thermal comfort requirements should be met for the completed occupied spaces • for the tenant and/or resident areas served by HVAC systems installed by the developer, the requirements on thermal comfort should be met for the total area of incomplete spaces based on expected occupancy type. • for the tenant and/or resident areas not served by HVAC systems installed by the developer, guidance on thermal comfort should be included in the green fit-out guidelines.
	Requirements for non-air-conditioned spaces	Whole building	Follow all the requirements of the credit
H-7	Requirements for non-residential projects	Not applicable	This pathway is not available to C&S projects.
	Requirements for residential projects	Whole building	Follow all the requirements of the credit.
SE-1	Whole credit	Whole building	Follow all the requirements of the credit.
SE-2	Whole credit	Whole building	Follow all the requirements of the credit.
SE-3	Whole credit	Whole building	Follow all the requirements of the credit.
SE-4	Both options	Whole building	Follow all the requirements of the credit.
SE-5	Whole credit	Whole building	Follow all the requirements of the credit.
SE-6	Option A	Whole building	Follow all the requirements of the credit and include guidance on natural ventilation in the green fit-out guidelines. Exception: If more than 50% (based on GFA) of tenants and/or residents have followed green fit-out guidelines and have installed air-conditioning systems with low refrigerant atmospheric impact, it is possible to include these systems in the calculations. As evidence, inspection records or spot check reports showing the equipment installed by the tenants and/or residents will have to be provided.

SE-6	Option B and C	All the HVAC systems installed by the developer	Follow all the requirements of the credit in the scope of applicability and include guidance on the selection of HVAC systems in the green fit-out guidelines.
SE-7	Whole credit	All the construction works realized by the developer	Follow all the requirements of the credit.
SE-8	Requirements on automatic lighting shutoff strategies	All the spaces managed by the building management team	Follow all the requirements of the credit in the scope of applicability and include guidance on lighting shutoff strategies in the green fit-out guidelines.
	Other requirements in both options	Whole building	Follow all the requirements of the credit.
SE-9	Whole credit	Whole building	Follow all the requirements of the credit.
SE-10	Whole credit	Whole building	Follow all the requirements of the credit.
SE-11	Whole credit	Whole building	Follow all the requirements of the credit.
Man-1	Whole credit	All the construction works realized by the developer	Follow all the requirements of the credit.
Man-2	Whole credit	All the construction works realized by the developer	Follow all the requirements of the credit.
Man-3	Whole credit	All the systems and equipment installed by the developer	Follow all the requirements of the credit in the scope of applicability and include guidance on commissioning in the green fit-out guidelines.
Man-PR-1 & Man-4	Maintenance	All the systems and equipment installed by the developer and managed by the building management team	Follow all the requirements of the prerequisite and credit in the scope of applicability and include guidance on maintenance in the green fit-out guidelines.
Man-PR-2	Whole PR	Whole project	Different building user's guides should be produced for residents and for different types of tenants (office, retail…).
Man-5	Whole credit	All the construction works realized by the developer	Follow all the requirements of the credit.
Inn-1	Enhanced Performance	Based on the credit	Based on the credit
Inn-2	Innovative Solutions	Depending on the solution	Depending on the solution

Addenda: Full list of changes from the first published version of the Technical Manual

All the projects are required to adhere to the changes published before their registration date.

The changes published after project's registration are optional, but strongly encouraged.

Page	Credit	Section	Modification	Date
17	/	LOTUS NC Updates	A new section is included with the following content: *LOTUS NC V3 will be regularly updated with changes aiming to improve the system (e.g. to fix mistakes, to provide clearer explanations, to set more relevant requirements, etc.).* *Whenever a change is made, a new version of the Technical Manual including the change will be published. Also, the complete list of all changes brought to the Technical Manual since the first published version, that can be found in the Addenda at the end of the manual, will be updated.* *Projects will only be required to adhere to all the changes made prior to their registration date*.	24/04/2019
30	/	Submission Process	Add the following for the Approach and Implementation section in Category Submission Forms: *In the case there is any change from previous round of submissions (e.g. different solutions implemented, different equipment/products/systems/materials selected, modified floor layout, etc.), a description of all the changes should be included.*	30/12/2019
33	/	Projects with incomplete spaces	For the incomplete spaces that are intended to be finished by the owner, change the requirements for prerequisites and credits using baselines to calculate performance (E-PR-3 & E-2 Total Building Energy Use and W-PR-1 & W-1 Water Efficient Fixtures) as follows: *The design model should be set equal to the baseline model for all the systems, equipment, appliances that have not been installed in the incomplete spaces. All the systems, equipment, appliances serving the incomplete spaces that have been installed should be modelled as-installed.*	04/06/2019
62	E-4 Building Cooling	Approach & Implementation	Add the following note: *VRV/VRF systems should be considered as air-cooled air-conditioners and their efficiency should be compared to values in Table E.5.*	30/12/2019

66	E-4 Building Cooling	Calculations	Add the following exception: *For VRV/VRF systems, if available from manufacturer's data, projects should use SCOP/COP values calculated at standard rating conditions under AHRI 1230. Else, projects should calculate COP by hand using the net cooling capacity of the systems and including the power of the fans in the indoor units to calculate the total power input. The net cooling capacity should be calculated by subtracting the heat from indoor fans to the rated cooling capacity of the outdoor unit (cooling capacity at standard rating conditions under AHRI 340/360 or, if not available, at the following conditions: indoor air at 27 °Cdb / 19 °Cwb and outdoor air at 35 °Cdb).*	30/12/2019
77	E-6 Energy Monitoring and Management	Approach & Implementation	For the strategy on Power Monitoring System, add the following details on the energy uses that must be monitored individually: • *HVAC equipment such as chillers, air-conditioners, air handling units and pumps* • *Interior artificial lighting*	04/06/2019
89	W-PR-1 & W-1 Water Efficient Fixtures	Calculations	A new assumption has been included: *Outpatients in health care facilities should be considered as visitors.*	30/12/2019
99	W-3 Water Metering	Approach & Implementation	Modify the paragraph on virtual meters as follows: *Where a water flow can be determined as the difference between a main meter (e.g. measuring the total domestic water use) and a number of other sub water meters, projects do not need to install a water meter for this water flow.*	30/12/2019
115	MR-1 Reduced Concrete Use	Approach & Implementation	Add the following details on the types of compliant non-structural exterior walls: • *Curtain walls (with glass, spandrel glass, stone veneer, aluminium, etc.)* • *Sandwich wall panels*	04/06/2019
119	MR-2 Sustainable Materials	Calculations	Add the following details on calculations: *Calculation is based on cost of materials excluding labor and equipment but including delivery and taxes. When the actual cost of materials is not available, a default cost equal to 45% of the total construction costs should be used.*	04/06/2019
127	MR-PR-1 & MR-4 Demolition and Construction Waste	Calculation	A table with weight-to-volume conversion factors for different types of waste has been included.	30/12/2019

139	H-1 Ventilation for indoor air quality	Approach & Implementation	In Strategy C: CO2-based demand-controlled ventilation, delete the sentence: *This strategy can only be followed by projects with 95% of the total net occupied area meeting the requirements for mechanically ventilated spaces set in Strategy A.* And, replace with: *This strategy can only be followed by projects with all the high density occupied areas meeting the requirements for mechanically ventilated spaces set in Strategy A.*	30/12/2019
140	H-1 Ventilation for indoor air quality	Approach & Implementation	In Strategy D: Ventilation in Wet Areas, add the following requirements for Intermittent Local Ventilation Exhaust of kitchens: *If the airflow of the local exhaust system represents less than 5 kitchen air changes per hour, a vented range hood should be installed*.	24/04/2019
146 - 147	H-PR-2 & H-2 Low-Emission Products	Approach & Implementation	Add the following notes: • *In this prerequisite and credit, only interior products should be considered.* • *Also, are considered as low-VOC/low-formaldehyde emission products, the products which:* - *are salvaged and reused with more than one year old at the time of use, provided that the finishing products (paints, coatings, adhesives, and sealants) used, if any, are low-VOC emission products.* - *are compliant with CDPH Standard Method Version V1.1 - 2010 or CDPH/EHLB Standard Method V1.2 - 2017 using the applicable exposure scenario* • *Composite wood floorings should be considered under Strategy C: Composite wood.*	10/05/2019
147	H-PR-2 & H-2 Low-Emission Products	Approach & Implementation	Add the following note: *Epoxy floor coatings should be considered in Strategy B.*	30/12/2019
149 - 150	H-3 Biophilic Design	Approach & Implementation	Add the following to the requirements for outdoor spaces: *If an outdoor space includes a water body (such as: pond, pool, fountain, etc.), the area of the water body can be counted as part of the total area of outdoor spaces. But, when calculating the Green Plot Ratio of the outdoor space, the area of the water body can be excluded from the area of the outdoor space.*	30/12/2019
150	H-3 Biophilic Design	Approach & Implementation	For compliance with requirements on indoor water features, it is now possible to: *provide few indoor water features of at least 1.8 m in height or 2 m² in area.*	04/06/2019

165	H-6 Thermal Comfort	Calculations	Modify the paragraph for Air-conditioned spaces and mixed-mode ventilated spaces as follows: *The building energy simulation performed in the scope of the Prerequisite E-PR-3 and Credit E-2 shall be used to demonstrate that the selected indoor conditions can be maintained consistently throughout the occupied cooling period.* *All the thermal zones modelled in the simulation that are including occupied spaces should be considered in calculations. For an occupied space to comply with the requirements of the credit, it should be located in a thermal zone that has a number of unmet load hours during the occupied cooling period that does not exceed 2% of the occupied hours. For this credit, an unmet load hour is defined as an hour in which a thermal zone is outside of the thermostat setpoint plus or minus 1.1°C (= 2°F).*	30/12/2019
187	SE-3 Vegetation	Approach & Implementation	One more sustainable planting strategy is added: • *Grow plants that attract biodiversity (birds, bees, butterflies, etc.)*	30/12/2019
197	SE-5 Heat Island Effect	Approach & Implementation	An exception has been added: • *Concrete pavements, due to weathering and accumulation of dust, darken over time. As a result, typical gray concrete pavements that have an SRI at around 35 when new will rapidly have an SRI lower than 29. As concrete is a good alternative to asphalt to reduce the heat island effect, gray concrete can still qualify as compliant but a factor of 0.5 will have to be considered in calculations. As for white concrete pavements, they are still accepted as fully compliant as they can maintain an SRI above 29. In case the whiteness or SRI values of the concrete are not known, all the concrete mixtures using slag cement or white cement can be considered as white concrete* And, water bodies (pond, pool, fountain) can now be considered as limiting heat island effect.	30/12/2019
198	SE-5 Heat Island Effect	Calculations	The formula in calculations has been modified: • *The area of gray concrete pavement is now weighted with a coefficient of 0.5.* And, the following has been added: • *For open-grid pavements, if they are more than 50% unbound, the total area covered should be considered. Else, only the total unbound area can be considered.*	30/12/2019

203	SE-6 Refrigerants	Calculations	To describe the Refrigerant Charge (Rc), the following sentence has been added: *For VRV/VRF systems, the total refrigerant charge including the initial refrigerant quantity charged into the unit at the factory and the additional refrigerant charge for piping should be considered.*	30/12/2019