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

LOTUS Homes C&S Pilot

Technical Manual

Official version – Released on March 6th, 2024

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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 rating 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.

The LOTUS Rating Systems currently include:

- LOTUS New Construction (LOTUS NC)
- LOTUS Building in Operation (LOTUS BIO)
- LOTUS Homes
- LOTUS Small Buildings (LOTUS SB)
- LOTUS Interiors
- LOTUS Small Interiors (LOTUS SI)
- LOTUS Homes Core & Shell (LOTUS Homes C&S)

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 Certification System philosophy, structure and practical application within the lifecycle of a building project. LOTUS APs are listed on the VGBC website.

LOTUS Homes C&S Rating System

Scope

LOTUS Homes Core & Shell (LOTUS Homes C&S) is to be used for the following types of single-family dwellings:

- Villas: detached villa, semi-detached villa, deluxe villa and resort villa
- Terraced houses (a series of houses connected by common sidewalls and forming a continuous group), including terraced houses sharing a common basement for parking.

LOTUS Homes C&S only applies to Core and Shell single-family dwellings (C&S Homes) within urban development projects. C&S Homes are buildings built by developers where some internal finishes and services are left out, for provision by the home buyers.
LOTUS Homes C&S doesn't assess the development project, but only the C&S Homes.

Eligibility

1. Group of Homes

For a project to be eligible for LOTUS Homes C&S assessment, it must be a group of C&S Homes within a new urban development project (referred to as khu đô thị mới in Vietnamese).

C&S Homes shouldn't individually follow LOTUS Homes C&S Certification but should be certified as groups. To compose a group, all the C&S Homes should be:

- under the same construction contract,
- constructed at the same time (in the same phase of development)
- constructed within the same development project

Development projects with different types of Homes can choose to separately certify each type of Homes or certify all the different types of Homes together. In the second case, the project (that is a group composed of different types of Homes) should follow the requirements provided in Annex 1.

2. Core and Shell Homes

Only C&S Homes are eligible for assessment under LOTUS Homes C&S.
Projects that install 2 or more of the following cannot be considered as C&S Homes and will be required to follow LOTUS Homes instead of LOTUS Homes C&S:

- Air-conditioning system
- Artificial lighting system (electric source)
- Sanitaryware fixtures
- Water heating system
- Flooring, ceilings & partitions

Categories

LOTUS Homes C&S is composed of 7 Categories, each containing a varying number of Credits. Against each credit, specific criteria have been set carrying individual scoring points.

Energy (E) - To reduce the energy consumption of the house through passive design and effective building envelope, and to build a home that is solar-ready and net-zero ready.

Water (W) - To reduce the water consumption of a building through rainwater harvesting.

Materials & Resources (MR) - To minimize the environmental impacts of materials and minimize waste.

Health and Comfort (H) - To ensure high indoor environmental quality, through the optimization of indoor air quality, daylighting, and acoustic comfort.

Site and Environment (SE) - To protect the ecology of the site of the building and surrounding area and to integrate adaptation and mitigation strategies.

Management (Man) - To ensure that, throughout the project, all targets set up are competently and effectively managed.

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

Prerequisites

LOTUS Homes C&S includes one prerequisite Man-PR-1 Home Buyer Guidance that must be carried out as a minimum requirement for all projects. As some finishes and equipment will be left for home buyers to complete in the dwelling-units, it is necessary for the developer to guide home buyers and explain to them how to select products and equipment to have as green a home as possible.

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).

Weighting

The current weighting of categories within LOTUS Homes C&S (Table 1) 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 1: LOTUS Homes C&S Weighting

Categories	Points	Weight
Energy	25	32%
Water	2	3%
Materials & Resources	15	19%
Health & Comfort	8	10%
Site & Environment	16	21%
Management	4	5%
Exceptional Performance	8	10%
Total	78	100%

Certification Levels

The first certification level for LOTUS has been benchmarked at 40% (LOTUS Certified) of the total number of points excluding the 8 “bonus” points from the Exceptional Performance Category.
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.

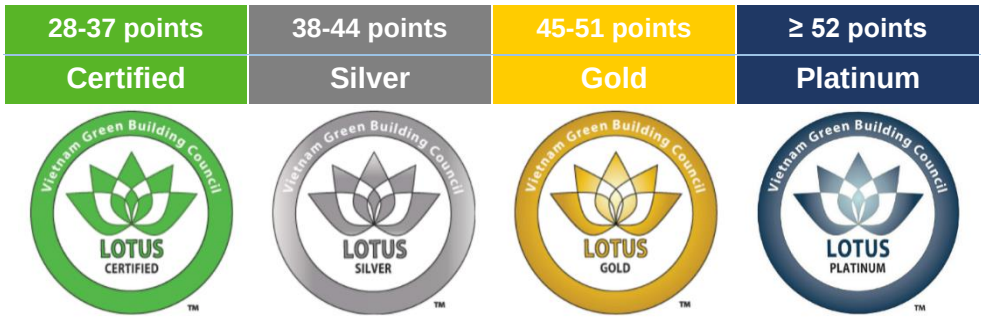


Figure 1: Certification System & Performance levels

LOTUS Homes C&S 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 are provided to the Assessment Organization 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 will improve the project´s overall performance and help to achieve a better LOTUS Certification level.

LOTUS Homes C&S certification happens in maximum 2 steps:

- LOTUS Provisional Certification and/or
- 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). However, in case of project is pending for a certain reason, a letter to explain the situation can be accepted to maintain the Provisional Certification within 12 months .

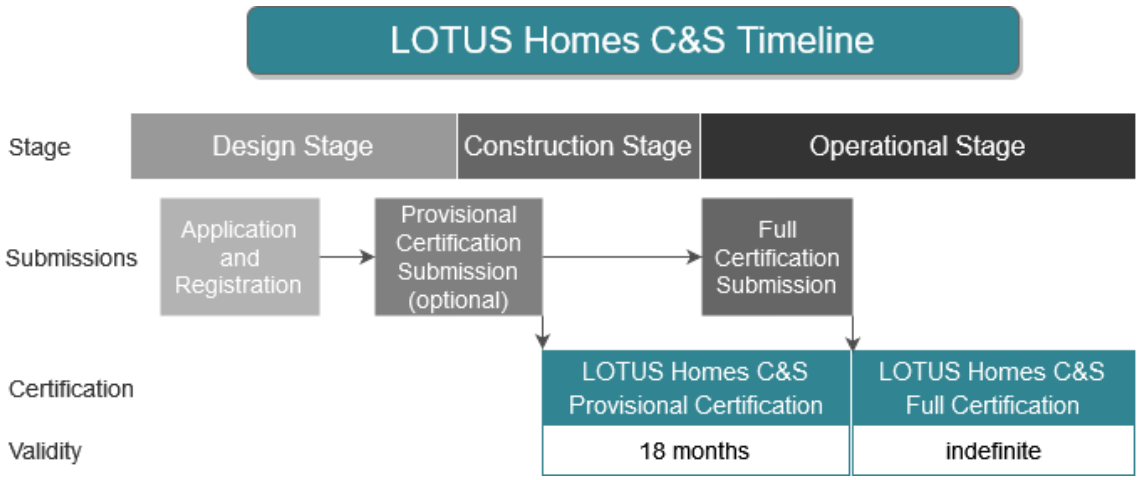
LOTUS Full Certification assesses the performance of the as-built building. LOTUS Full Certification can be applied for as soon as handover is completed and should be completed before 18 months of the completion of construction. It demonstrates that all green building strategies and attributes defined 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 has an indefinite validity. The Full Certificate will clearly mention that the core & shell of the building was designed and built following green building standards and the developer will have to market the project as such.

LOTUS Timeline

The following sections outline the timeline to attain LOTUS Homes C&S certification:

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



(with possible extension)

Figure 2: LOTUS Homes C&S Timeline

Application and Registration

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

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.

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.

LOTUS Provisional Certification Stage

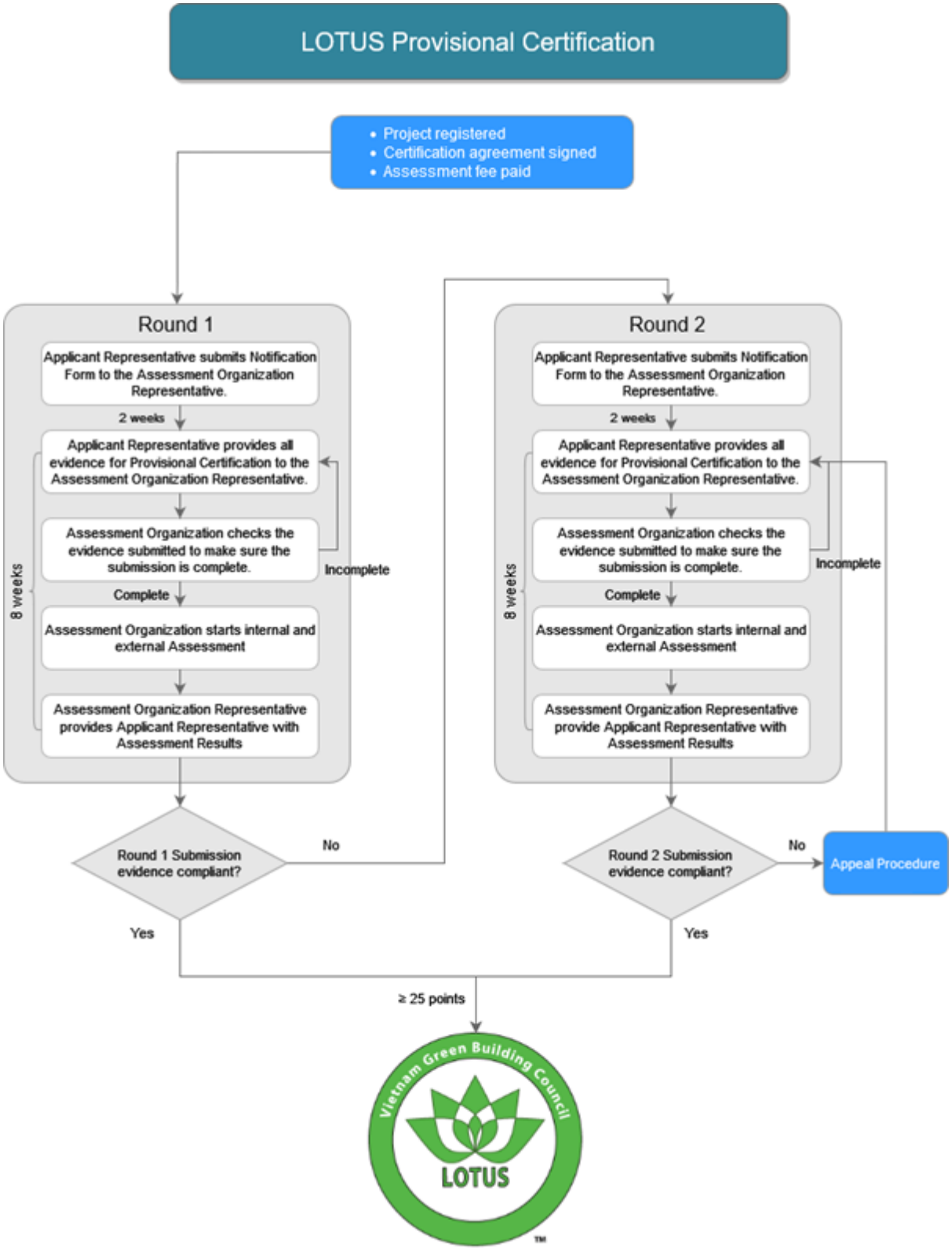


Figure 3: LOTUS Homes C&S Provisional Certification

Following registration, the project design team must prepare all of the evidence required by LOTUS Homes C&S Pilot 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, Credits MR-3 Sustainable Materials, MR-5 Demolition and Construction Waste, MR-6 Operation Waste Management and Man-3 Home Buyer Guidance are not available as it is not possible for projects to provide satisfying evidence of compliance in the design stage.

Projects only need to achieve a total of 25 points to obtain Provisional Certification.

Round 1

Round 1 of submissions should follow the steps below:

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.

2. Submissions

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.

3. Scan of the submissions

The data supplied to the Assessment Organization Representative will be checked to make sure it is complete, based on the list of submitted documents in the Category Submission Forms. In case documentation is missing, the Assessment Organization Representative will request the Applicant Representative to promptly provide the missing data.

4. 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.

5. 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. Also, a Submission Form for the next round of submissions will be prepared and provided to the Applicant Representative.

6. Queries on assessment results

Within 30 calendar days after receiving the assessment report, the Applicant Representative has the possibility to send queries on the assessment results. Queries should be questions to clarify the requirements that need to be met by the project. All queries should be submitted in the document ‘LOTUS Template - Queries on Assessment Results’. Within 2 weeks after the

reception of the queries, the Assessment Organization Representative will schedule a call with the Applicant Representative to answer all the queries. After the call, the Assessment Organization Representative will complete the document to provide final answers to the queries.

Round 2

If Round 1 of submissions 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.

The same 6 steps as described for Round 1 should be followed for Round 2.

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 Appeal should be submitted in writing to the Assessment Organization within 30 calendar days after receiving the assessment report from Round 2.

The same 6 steps as described for Round 1 should be followed for the Appeal Round.

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 25 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

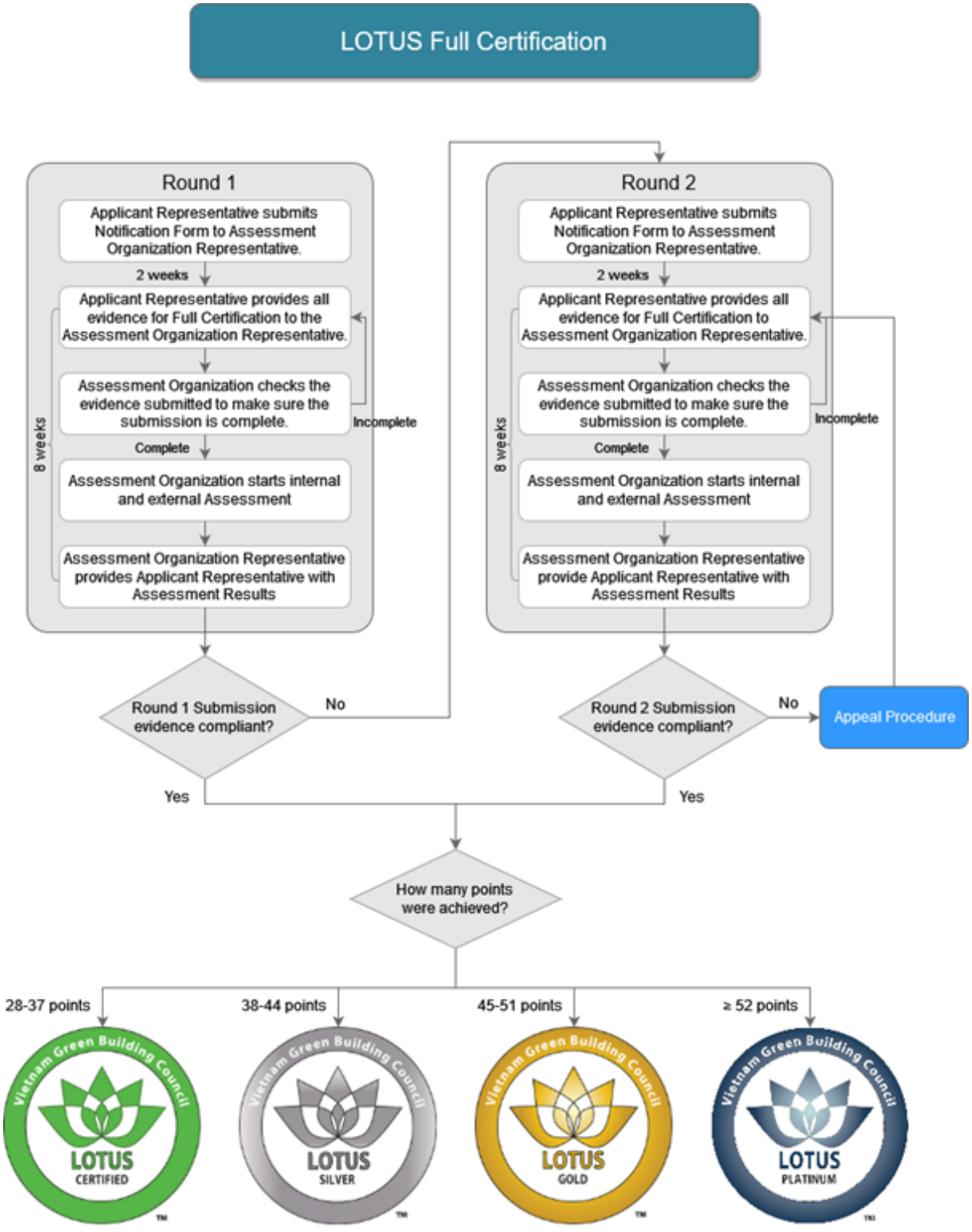


Figure 4: LOTUS Homes C&S Full Certification Process

The assessment process for the LOTUS Full Certificate is the same as for 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.

Full Certificate

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

LOTUS Homes C&S Full Certificate is issued with an unlimited validity period. The Certificate will clearly mention that the core & shell of the homes was designed and built following green building standards and the developer will have to market the project as such.

LOTUS Homes C&S Submissions

Types of Submissions

There are maximum 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.

To be complete, at each round, submissions should include all the following:

- Completed Submission Forms
- Updated general project information
- Complete set of documents in the Credit folders of all prerequisite and targeted credits

Package of documentation for LOTUS Homes C&S Pilot projects

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 C&S Home Categories and one General Information Folder.

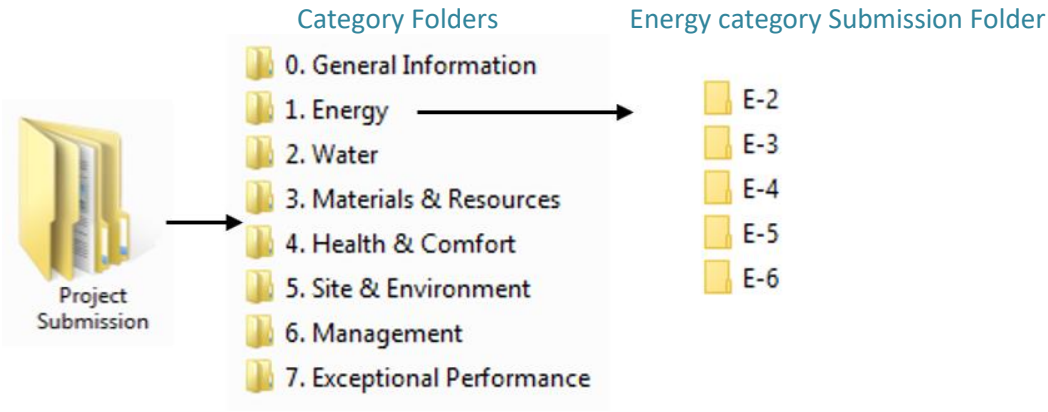


Figure 5: Project Submission Folder

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 Homes C&S Pilot 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. At Provisional Certification, it should include design drawings and specifications (where available) for all architectural, civil, structural, mechanical, electrical and hydraulic works. At Full Certification, it should include as-built architectural, mechanical, electrical and hydraulic drawings.

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 Round 1 of Provisional Certification and one for Round 1 of 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 the Project Submission Folder, only forms for Round 1 of Provisional Certification and Round 1 of Full Certification are included. These forms should be completed by the Applicant and included in the submissions.

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
- Status of submittals:
  At Provisional Certification, indicate whether the submissions are:
  - complete (i.e. the design of the project is complete and all design/tender documents are available to demonstrate compliance at Provisional Certification stage), or
  - in a draft version (i.e. some aspects of the design have still not been decided and/or documents demonstrating compliance are not available).

At Full Certification, indicate whether credits are:
  - fully re-submitted (i.e. there are some major changes from Provisional Certification). In this case, all submittals need to be re-submitted.
  - partly re-submitted (i.e. there are some small changes that do not affect compliance accepted at Provisional Certification stage). In this case, a description of the changes showing that they do not affect compliance along with as-built documentation need to be provided.
  - not re-submitted (i.e. there are no changes from Provisional Certification). In this case, only as-built documentation needs to be provided.
- 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.
- 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 Homes C&S Pilot 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 that can be used for all the credits requiring calculations. Calculators are pre-formatted excel files automatically performing calculations following calculation methods included in the Technical Manual.
- Reference guidelines providing additional information and guidance, such as:
  - LOTUS Guidelines - Air layers and U-value calculation
  - LOTUS Homes C&S Pilot Guidelines - Building energy simulation.
  - LOTUS Technical Queries Guidelines

Submission Forms for additional rounds of submissions

Submission Forms for additional rounds of submissions (Round 2 and Appeal Round) will be provided by the Assessment Organization Representative together with the Assessment Report of previous round. These forms should be completed by the Applicant with the number of points targeted at the present round of submissions, a description of the changes made to fix all the issues reported in the Assessment Report of previous round and the list of new documents submitted.

Requirements on submission documentation

All documentation submitted should respect the following requirements:

- Documents should be in English where possible; however, it is acceptable to submit some documents in Vietnamese.
- For all credits, a narrative including the performance achieved, the method of compliance and any relevant information to facilitate the review process should be provided.
- All steps of calculations should be clearly developed and explained. Results standing alone will not be accepted.
- All calculations should be made in SI units.
- All documentation provided for the assessment must be inserted in the electronic submission folder provided after registration. Each document should be inserted in the corresponding credit folder.
- The key information that demonstrates compliance with requirements should be highlighted in the submitted documents.
- All calculations should be provided in an unlocked excel file.
- All document titles should be consistent and show the content of the document, the revision number, the date and/or the round of submissions (e.g. Daylight Simulation Report – rev 2 - 30.04.2023 - Round 2 PC)

Requirements on as-built evidence

As-built evidence is required to be submitted at Full Certification stage to demonstrate that the project was actually built in accordance with LOTUS requirements. To qualify as acceptable evidence, the as-built evidence submitted by the project should be relevant, complete, reliable and legible.

Relevant evidence

- The evidence submitted should show relevant information (i.e. information related to the LOTUS Credit or Prerequisite targeted and contributing to show compliance with the requirements.)
- The evidence submitted should be relevant to the project being assessed. The pieces of evidence submitted to demonstrate that materials, products, equipment or systems were installed on the project, or that strategies, measures or plans were implemented by the project should be relevant to the project being assessed. For this, they should indicate the name of the project and/or the address of the project.

Complete evidence

The evidence submitted should show complete information necessary to demonstrate compliance with the requirements of the LOTUS credit or prerequisite.
Complete information should include all the following:

- information on all the materials, products, equipment or systems installed, and on all the strategies, measures or plans implemented relevant to the LOTUS credit or prerequisite targeted.
- complete information (i.e. all the relevant information) on each of the materials, products, equipment or systems installed, and on each of the strategies, measures or plans implemented relevant to the LOTUS credit or prerequisite targeted.

Reliable evidence

The evidence submitted should be reliable.
For this, all the following types of evidence must be signed and stamped:

- as-built drawings (signed and stamped by the contractor and the project owner)
- commissioning records (signed and stamped by the contractor, the project owner and by the Commissioning Agent, if any)
- contracts (signed and stamped by the 2 parties in the contract)
- delivery notes, receipts/invoices (signed and stamped by the supplier and, at least, signed by the contractor and/or the project owner)
- letters (signed and stamped by the organization that wrote the letter)
- material approval requests (signed and stamped by contractor and the project owner)

And, the following types of evidence may only be signed:

- minutes (signed by the participants)

Legible evidence

The evidence submitted should be legible (i.e. readable, clear and easy to understand).
Where necessary, documents should be annotated to highlight the relevant information.

Specific requirements for photographs

Photographs may be used as evidence to show that a strategy has been implemented, a piece of equipment has been installed, etc. But, in general, photographs should be used as additional evidence, in support of a main piece of evidence. For example, for MR-4 Non-baked Materials, photographs showing installed non-baked materials can be provided in addition to signed/stamped as-built drawings already showing the location of all the non-structural walls made from non-baked materials).

There are 2 types of exceptions in which case photographs can be provided as main evidence:

- for credits where photographs are required to be submitted (e.g. for SE-4 Stormwater runoff: where photographs showing the different landscaped and paved areas)
- for credits where other types of evidence are lacking and cannot be submitted. In this case, the following requirements must be met:
  - Photographs should be dated
  - Photographs should not be blurry or distorted
  - Several photographs (at varying levels of proximity) should be taken for each feature (product, material, equipment, strategy, etc.) that needs to be shown in evidence. In this manner, both the general location and the specifics (e.g. model name, rated power input, etc.) of the feature photographed can be observed. Ideally, the photographs should include metadata showing the latitude and longitude coordinates for the location where they were taken.
  - Photographs should show complete evidence as required above.

LOTUS Homes C&S Credit/Prerequisite list

Credit / Prerequisite	Title	Points
ENERGY		25 points
Pathway 1: Net-Zero Energy-Ready Home path		25 points
E-1	Net-Zero Energy-Ready Home	25
Pathway 2: Prescriptive path		20 points
E-2	Passive Design	6
E-3	Building Envelope	7
E-4	Natural Home Cooling	3
E-5	Renewable Energy	3
E-6	Solar Hot Water-Ready Home	1
WATER		2 points
W-1	Rainwater Harvesting	2
MATERIALS & RESOURCES		15 points
MR-1	Environmental Impact of Construction Materials	4
MR-2	Reduced Concrete Use	2
MR-3	Sustainable Materials	4
MR-4	Non-baked Materials	2
MR-5	Demolition and Construction Waste	2
MR-6	Operation Waste Management	1
HEALTH & COMFORT		8 points
H-1	Ventilation for Indoor Air Quality	4
H-2	Daylighting	3
H-3	Acoustic Comfort	1

SITE & ENVIRONMENT		16 points
SE-1	Site Selection	1
SE-2	Disaster Resilience	2
SE-3	Development Footprint	2
SE-4	Stormwater Runoff	2
SE-5	Heat Island Effect	2
SE-6	Construction Activity Pollution Control	2
SE-7	Green Transportation	2
SE-8	Greenery & Biophilia	2
SE-9	Outdoor Communal Facilities	2
MANAGEMENT		4 points
Man-1	Effective Design Process	1
Man-2	Construction Stage	1
Man-PR-1	Home Buyer Guidance	Prerequisite
Man-3	Home Buyer Guidance	1
Man-4	Green Awareness	1
EXCEPTIONAL PERFORMANCE		8 bonus points
EP-1	Exceptional Performance Enhancement	8
EP-2	Innovative Solutions	

Energy

As urbanization is speeding up all over the world, buildings have been described as a hidden culprit, responsible for 20% to 40% of global energy consumption and more than 30% of global greenhouse gas emission.

In Vietnam, while fast economic growth and urbanization rates are improving living conditions, they are also leading to an increasing energy demand. It is expected that between 2010 and 2025 there will be a 10% increase in energy demand each year and that by 2025 the demand will be triple the current demand and that 8 times the amount of electricity will be required to cope with the fast urbanization and construction rate. Moreover, as Vietnam's energy is mainly generated from non-renewable fossil fuels which are the main sources of greenhouse gas emissions, increased energy demand also means worsening global warming. However, since buildings, especially in urban areas, consume the majority of the energy produced annually in Vietnam, there is potential for mitigating climate change and energy insecurity through integrating energy efficiency measures into buildings. With energy efficient designs, buildings can potentially become net-zero energy. With this target in mind, LOTUS Homes C&S rewards efforts taken to reduce the building energy consumption through passive design, optimized thermal performance and incorporation of natural ventilation, as well as utilizing sustainable energy sources.

For LOTUS Home C&S, some parts of QCVN 09-2017/BXD are considered to apply as the requirements for credits until new Vietnam standard for residences comes.
Under the Energy Category, projects should follow either Pathway 1 or Pathway 2.

Credit	Title	Points
Pathway 1: Net-Zero Energy-Ready Home path		25 points
E-1	Net-Zero Energy-Ready Home	25 points
Pathway 2: Prescriptive path		20 points
E-2	Passive Design	6 points
E-3	Building Envelope	7 points
E-4	Natural Home Cooling	3 points
E-5	Renewable Energy	3 points
E-6	Solar Hot Water-Ready Home	1 point
	Total of points available	25 points

E-1 Net-Zero Energy-Ready Home

Intent

To design and build homes that can become net-zero energy homes in the future.

Requirements

Criteria	25 points
Design and build net-zero energy-ready homes that are solar PV-ready	20
Design and build net-zero energy-ready homes with a renewable energy generation system already installed	25

Overview

Net-zero energy homes are homes that produce as much clean energy as they consume. Net-zero energy ready homes are homes that have been designed and built to a level of performance such that they could, with the addition of a renewable energy system (i.e., solar panels), achieve net-zero energy performance. In the case of C&S Homes, as developers do not install the active systems (air-conditioning, artificial lighting, household appliances, etc.), net-zero energy ready C&S Homes can be defined as homes that have been designed and built to a level of performance such that they could, with the addition of standard-efficiency active systems and with a renewable energy generation system already installed or the future addition of a renewable energy system (i.e. solar panels), achieve net-zero energy performance.

Approach & Implementation

For solar PV-ready homes to qualify as net-zero energy ready, the project should show that the potential installation of a solar system on the roof could balance the future energy use of the C&S Home.

For C&S Homes with a renewable energy generation system already installed to qualify as net-zero energy ready, the project should show that the energy to be produced by the renewable energy generation system can balance the future energy use of the C&S Home.

For this, the following methodology should be used:

- An energy simulation should be performed to estimate the future total annual energy use of the C&S Home. The energy simulation must follow the Guidelines for building energy simulation in LOTUS Homes C&S Pilot.

For solar PV-ready homes:

- The project should meet all requirements in Option A: Solar PV-Ready Home of credit E-5 Renewable Energy.
- Simulation should be performed to estimate the solar photovoltaic energy that could be produced by installing solar panels where appropriate (roof and/or carport) on the C&S Home.

For C&S Homes with a renewable energy generation system already installed:

- Simulation should be performed to estimate the energy to be produced by the renewable energy generation system already installed.

Note: For buildings not able to send renewable energy produced onsite to the grid, only energy that can be consumed (or stored and then consumed) on site should be counted.

Submissions

Provisional Certification Stage
● Input and output report(s) generated by the energy simulation software. ● Screenshots showing all the information listed in Guidelines for building energy simulation in LOTUS Homes C&S Pilot missing in the report(s) generated by the energy simulation software. ● Back-up calculations, manufacturer's data and drawings to support all data inputs and assumptions taken ● Calculations showing estimated annual renewable energy production along with a description of simulation methodology/software used ● For solar PV-ready homes, all submittals required in in Option A of credit E-5 Renewable Energy ● For C&S Homes with a renewable energy generation system already installed, all submittals required in in Option B of credit E-5 Renewable Energy

Full Certification Stage
● As-built evidence support all data inputs in the energy simulation
If not already approved at Provisional Certification or if there is any change: ● Input and output report(s) generated by the energy simulation software. ● Screenshots showing all the information listed in Guidelines for building energy simulation in LOTUS Homes C&S Pilot missing in the report(s) generated by the energy simulation software. ● Back-up calculations, manufacturer's data and drawings to support all data inputs and assumptions taken ● Calculations showing estimated annual renewable energy production along with a description of simulation methodology/software used ● For solar PV-ready homes, all submittals required in in Option A of credit E-5 Renewable Energy ● For C&S Homes with a renewable energy generation system already installed, all submittals required in in Option B of credit E-5 Renewable Energy

E-2 Passive Design

Intent

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

Requirements

Criteria	6 points
Strategy A: East and west facades	
East and west facades area is lower than 40% of the total facade area	1
East and west facades area is lower than 20% of the total facade area	2
Strategy B: Window-to-wall ratio (WWR)	
WWR of the east and west facades is lower than 30%	1
WWR of the east and west facades is lower than 15%	2
Strategy C: Shading devices	
1 point for meeting each of the following requirements: - Install appropriate shading devices on 90% of the glazing area on the north and south facades - Install appropriate shading devices on 90% of the glazing area on the east and west facades	2

Overview

A well-positioned building can deliver significant environmental benefits. Appropriate orientation, glazing distribution and shading will assist passive cooling by minimizing the building's exposure to the sun. With less heat entering the building, this will result in improved comfort and a decreased energy consumption.

Approach & Implementation

Strategy A: East and west facades

The buildings should be oriented in such a way to limit the size of the west and east facing facades.

The west facing facade is defined as the facades oriented within the range of 45 degrees North of West and 45 degrees South of West (in green on figure E.1). East facing facade is defined similarly (in blue on figure E.1).

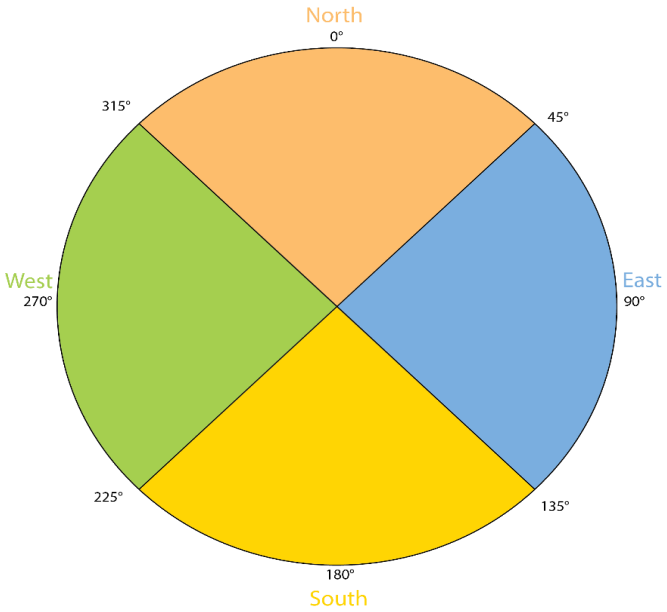


Figure E.1: Definition of the different facing façades

Strategy B: Window-to-wall ratio

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

A good daylighting can be maintained with a reduced glazing area with proper window sizing and arrangement. Windows placed high on the wall provide mode daylight. Oppositely, floor-level windows only add very little daylight while allowing heat to penetrate the building.

Strategy C: Shading devices

For north and south facades, appropriate shading devices can be:

- horizontal overhangs that achieve a value of A coefficient higher than 1.3 (according to Table E.1).
- full-height louvered screen (with horizontal or vertical fins)
- vegetation covering the whole glazing area

If the building has no glazing areas on north and south orientations, no point can be earned.

For east and west facades, appropriate shading devices can be:

- full-height louvered screen (with horizontal or vertical fins) or
- vegetation covering the whole glazing area.

If the building has no glazing areas on east and west orientations, no point can be earned.

Table E.1: A coefficient for horizontal sunshades placed on or above the upper window edge (*Source: Table 2.2a of QCVN 09:2017/BXD*)

Projection factor PF = b / H	North	South	Other orientations
0.10	1.23	1.20	1.09
0.20	1.43	1.39	1.19
0.30	1.56	1.39	1.3
0.40	1.64	1.39	1.41
0.50	1.69	1.39	1.54
0.60	1.75	1.39	1.64
0.70	1.79	1.39	1.82
0.80	1.82	1.39	1.89
0.90	1.85	1.39	2
1.00	1.85	1.39	2.08

Notes on Table E.1:

- b, d and H share the same dimension for length with:
  b – reach of sunshade;
  H – window height;
  d – clearance from upper window edge to lower sunshade contact
- Table E.1 is applicable for consistent horizontal sunshades placed above the upper window edge by a clearance d, with d/H ≤ 0.1 – tolerance of less than 10%.

<u>All strategies</u>:

In the case where a building has no east nor west oriented facades (e.g. terraced houses), the building will be awarded 2 points under Strategy A and 2 points under Strategy B. In Strategy C, only the requirements on north and south facades will be available.

Calculations

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

A building has a 500 m^2 total building facade area, a 60 m^2 west-facing facade (with no fenestration) and a 50 m^2 east-facing façade with 20 m^2 of fenestration shaded with full-height louvered screens.

- Strategy A: Calculate the percentage of west and east-facing facades

$$\%\ of\ east\ and\ west\ facades\ area\ = \frac{60\ m^2 + 50\ m^2}{500\ m^2} = 22\ \%$$

The percentage of east and west facades area is under 40%, so 1 point can be granted.

- Strategy B: Calculate the WWR of the west and east-facing facades

$$WWR\ of\ east\ and\ west\ facing\ facade\ = \frac{20\ m^2}{60 + 50\ m^2} = 18\ \%$$

The WWR of the east and west-facing facades is lower 30%, so 1 point can be granted.

- Strategy C: Full-height louvered screens have been installed on all the glazing areas of the east orientation; but no shading devices were installed on the north and south facades. The project can only be awarded 1 point under Strategy C.

Conclusion: This project can be awarded a total of 3 points under the credit E-2.

Submissions

Provisional Certification Stage
Strategy A: East and west facades
● Tender elevation drawings annotated to show the size of the facades
Strategy B: Window-to-wall ratio
● Tender elevation drawings showing the glazing areas and their size
Strategy C: Shading devices
● Tender plans and elevation drawings showing the shading devices and their size

Full Certification Stage
Strategy A: East and west facades
● As-built elevation drawings ● Photographs of the facades
Strategy B: Window-to-wall ratio
● As-built elevation drawings showing the glazing areas and their size ● Photographs of the facades showing the glazing areas
Strategy C: Shading devices
● As-built plans and elevations showing the shading devices and their size ● Photographs of the facades showing the shading devices

E-3 Building Envelope

Intent

To ensure proper application of materials and techniques to the construction of the building envelope to optimize the thermal performance of the building.

Requirements

Criteria	7 points
Strategy A: R-value of walls	
Average R-value of the walls is 20% higher than QCVN 09:2017/BXD requirements.	1
Average R-value of the walls is 40% higher than QCVN 09:2017/BXD requirements.	2
Strategy B: R-value of roofs	
Average R-value of the roofs is 20% higher than QCVN 09:2017/BXD requirements.	1
Average R-value of the roofs is 40% higher than QCVN 09:2017/BXD requirements.	2
Strategy C: SHGC values of glazing	
SHGC values of glazing are 10% lower than QCVN 09:2017/BXD requirements.	1
SHGC values of glazing are 20% lower than QCVN 09:2017/BXD requirements.	2
Strategy D: Solar radiation on opaque surfaces	
Implement strategies to reduce the solar radiation absorbed by opaque surfaces	1

Overview

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

For air-conditioned buildings, where indoor climate is controlled by HVAC systems, it is essential to maintain a proper thermal insulation between the interior and the exterior of the building to limit the heat transfer due to the indoor-outdoor temperature difference.

For naturally ventilated buildings, insulation is of 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 through optimized orientation, proper fenestration layout, the use of external shadings and the use of materials with high solar reflectance.

Approach & Implementation

Strategy A: R-value of walls

QCVN 09:2017/BXD requires R-value of external walls to be higher than 0.56 m^2.K/W

To decrease the heat transfer through the walls, the following strategies may be used:

- Select materials with a low thermal conductivity (λ, in W/(m.K)) such as insulation or lightweight materials
- Increase thickness of the wall assemblies
- Add air layers (ventilated or unventilated)

Strategy B: R-value of roofs

QCVN 09:2017/BXD requires R-value of external roofs to be higher than 1 m^2.K/W.

To decrease the heat transfer through the roofs, the same strategies as for walls can be used.

Strategy C: SHGC values of glazing

Select glazing materials with SHGC values lower than the values in Table E.2 and/or install shading devices to prevent heat to enter the building through fenestrations.

If sunshades are installed on glazing area, projects should follow section 2.1.5 of QCVN 09:2017/BXD where allowances (A coefficient) on maximum SHGC values are given based on the geometry of the sunshades installed.

For glazing areas shaded by vegetation or by complex shading devices, in order to calculate the A coefficient, estimate how many percent of solar energy will not strike the glazing area thanks to the vegetation, this will be subject to VGBC approval.

Table E.2: Maximum SHGC values of glazing for different WWR and orientations
(*Source: Table 2.3 of QCVN 09:2017/BXD*)

WWR (%)	$SHGC_{max}$ on 8 main orientations		
	North	South	Other orientations
≤ 20	0.90	0.90	0.80
30	0.64	0.70	0.58
40	0.50	0.56	0.46
50	0.40	0.45	0.38
60	0.33	0.39	0.32
70	0.27	0.33	0.27
80	0.23	0.28	0.23
90	0.20	0.25	0.20
100	0.17	0.22	0.17

Strategy D: Solar radiation on opaque surfaces

To limit solar radiation on opaque roof AND walls of the building, LOTUS requires that:

95% of the opaque roof surface meet any or any combination of the following:

- Have a Roof solar reflectivity > 0.7
- Be a green roof
- Have external shadings. PV panels and solar collectors can be considered external shadings for opaque roofs.

AND

95% of the opaque walls surface should meet any or any combination of the following:

- Have a solar reflectivity > 0.4
- Be green walls
- Have external shadings

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates through Strategy A that average R-value of the walls is more than 60% higher than QCVN 09:2017/BXD requirements.

- AND -

One point in Credit EP-1 can be awarded if the project demonstrates through Strategy B that average R-value of the roofs is more than 60% higher than QCVN 09:2017/BXD requirements.

AND -

One point in Credit EP-1 can be awarded if the project demonstrates through Strategy C that SHGC values of glazing are more than 30% lower than QCVN 09:2017/BXD requirements.

Submissions

Provisional Certification Stage
Strategy A: R-value of walls
● Tender drawings showing details of all the external wall assemblies ● Tender specifications -OR- Manufacturer's data indicating the thermal conductivity of the materials used for external walls ● Details of R-values calculations
Strategy B: R-value of roofs
● Tender drawings showing details of all the roof assemblies ● Tender specifications -OR- Manufacturer's data indicating the thermal conductivity of the materials used for roofs ● Details of R-values calculations

Strategy C: SHGC values of glazing
● Tender specifications -OR- Manufacturer's data indicating SHGC values of glazing to be installed ● Fully completed LOTUS Homes C&S Pilot Calculator - E-3 - SHGC requirements
Strategy D: Solar radiation on solid surfaces
● Tender plans and elevations indicating the types of solid surfaces ● For surfaces with high solar reflectivity, tender specification extracts -OR- Manufacturer's data indicating the solar reflectivity coefficients of the materials -OR- Justification for any values used solar reflectivity coefficients (when tender specifications or manufacturer's data is not available)

Full Certification Stage
Strategy A: R-value of walls
● As-built drawings showing details of all the external wall assemblies ● Evidence showing the materials used for the external walls, 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 ● Details of R-values calculations
Strategy B: R-value of roofs
● As-built drawings showing details of all the roof assemblies ● Evidence showing the materials used for the roofs, 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 roof ● Details of R-values calculations
Strategy C: 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 ● Fully completed LOTUS Homes C&S Pilot Calculator - E-3 - SHGC requirements
Strategy D: Solar radiation on solid surfaces
● As-built plans and elevations indicating the types of solid surfaces
If not already approved at Provisional Certification or if there is any change: ● For surfaces with high solar reflectivity, Manufacturer's data indicating the solar reflectivity coefficients of the materials -OR- Justification for any values used solar reflectivity coefficients (when tender specifications or manufacturer's data is not available)

E-4 Natural Home Cooling

Intent

To reduce the need for HVAC systems and increase natural air flow.

Requirements

Criteria	3 points
Strategy A: Stack Ventilation	
Install a vent column or an effective rooftop turbine vent to create stack ventilation	1
Strategy B: Cross Ventilation	
1 point for every 25% of the area in living rooms and bedrooms which are designed with effective cross ventilation (up to 75%)	3

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 building orientation to provide a supply of fresh air to occupants. This practice reduces the energy consumption of HVAC systems, while increasing Indoor Air Quality (IAQ).

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 and providing thermal comfort. This method involves proper building orientation, as well as the correct design of size, number and placement of wall and roof opening.

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, this buoyancy causes the warm air to rise and leave the building via openings positioned at high elevations. This generates a pressure difference between the interior of the building and the exterior, which causes cooler, denser air to enter at lower elevations.

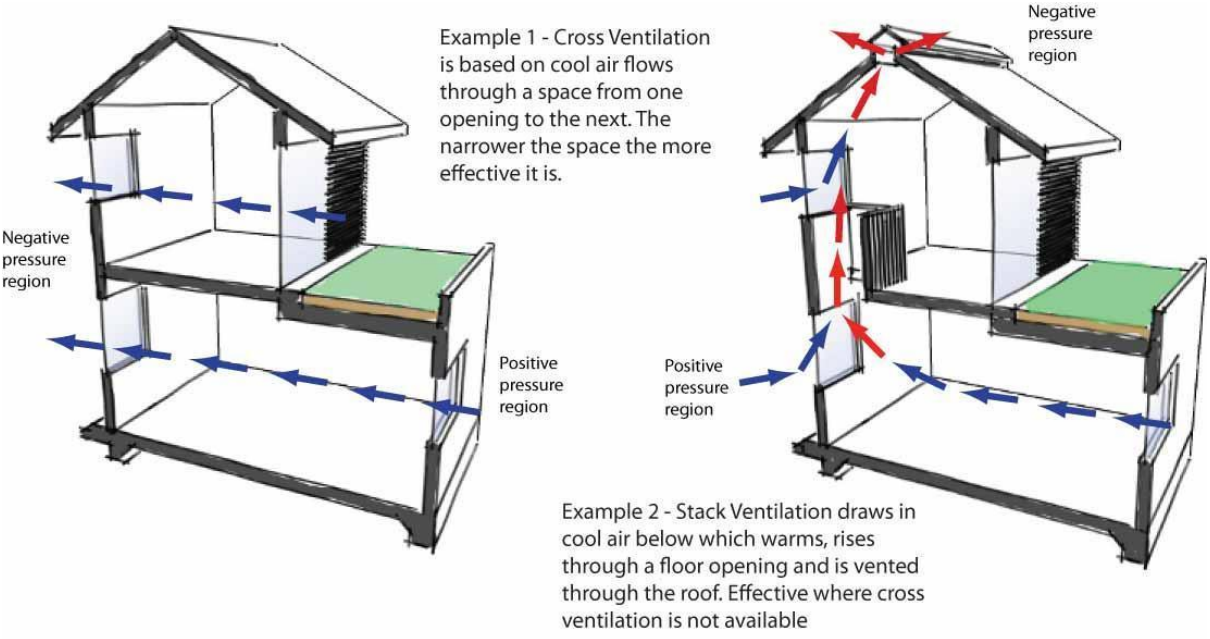


Figure E.2: Natural ventilation can be provided in a building through two methods: wind driven ventilation and stack ventilation

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 efficient cooling system along with reductions in HVAC loads can result in energy and financial savings over the life of a building. Selecting energy efficient equipment will help to save a lot of energy. Changing filters, cleaning evaporators and condensers and having them checked on a regular basis will reduce HVAC maintenance and even replacement costs.

Approach & Implementation

Strategy A: Stack Ventilation

Create effective stack ventilation in the house by:

- Installing a weatherproof vent column on the roof above a central shaft (atrium, staircase, etc.). The vent column should be higher than 50 cm and should have a throat diameter of at least 20 cm; OR
- Installing a wind-driven turbine vent (also known as a rotary ventilator or rooftop turbine vent) on the roof above a central shaft (atrium, staircase, etc.). The roof turbine vent should have a curved vane (not a straight vane) and should be mounted on top of a pyramid skylight.

Strategy B: Cross ventilation

Living rooms and bedrooms should be designed to achieve effective cross ventilation.

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 the openings are 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 ventilation openings
- Window openings have an openable area of at least 1 m^2.

The main entrance of the house should be assumed to be closed and all the windows and internal doors should be 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 house, the door can be considered as a window opening.

Calculations

Strategy B: Cross ventilation

The total area in living rooms and bedrooms which are designed with effective cross ventilation is calculated using the following formula:

$$Living\ rooms\ and\ bedrooms\ with\ effective\ cross\ ventilation\ [\%] = \frac{\Sigma_i A_i}{A_T} \times 100$$

A_i = Area of the living room or bedroom i designed with effective cross ventilation [m^2]

A_T = Total combined area of all the living rooms and bedrooms in the house [m^2]

Submissions

Provisional Certification Stage
Strategy A: Stack ventilation
● Plans showing the vent column or the rooftop turbine vent with the dimensions
Strategy B: Cross ventilation
● Tender elevations and plans marking all wall and roof openings ● Tender window schedule indicating the number, location, type and size of all wall and roof openings - OR - ● Room data sheets that indicate floor area and specifications of all wall and roof openings (number, location, type and size). ● Calculations of the percentage of living rooms and bedrooms which are designed with effective cross ventilation

Full Certification Stage
Strategy A: Stack ventilation
● As-built plans showing the vent column or the rooftop turbine vent with the dimensions ● Photographs showing the vent column or the rooftop turbine vent
Strategy B: Cross ventilation
● As-built plans, elevations and sections marking all wall and roof openings ● As-built window schedule indicating the number, location, type 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 of the percentage of living rooms and bedrooms which are designed with effective cross ventilation

E-5 Renewable Energy

Intent

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

Requirements

Criteria	3 points
Option A: Solar PV-Ready Home	
Design and build solar PV-ready homes	1
Option B: Renewable energy generation system	
Install a renewable energy generation system with a power output of more than 1 kW per dwelling-unit	1
Install a renewable energy generation system with a power output of more than 2 kW per dwelling-unit	2
Install a renewable energy generation system with a power output of more than 3 kW per dwelling-unit	3

Overview

A solar PV-ready home is one that has been designed and prepared for the installation of a solar power system to occur in the future. This will make the installation of the solar power system easier, faster and cheaper. Also, this can help to improve the performance of the system.

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 help to reduce the environmental impacts and CO_2 emissions of buildings, but the application of renewable energy strategies in buildings are still uncommon in Vietnam and should be promoted in the interest of sustainable development.

Approach & Implementation

Option A: Solar PV-Ready Home

For multi-family residential projects, only projects for which the homeowners will have control of the roof and have the right to install solar panels are eligible to follow this option.

To design solar PV-ready homes, the following requirements should be met:

- Ensure roof structure can withstand the extra weight that the solar panels will create.
- Design roof areas for solar placement. Large rectangular unobstructed areas should be available on the roof for installing solar PV panels. Rooftop equipment, vents and any other obstructions should be placed in a way to maximize the available space for installing solar panels. If sloped roofs are designed, when possible, the project should orientate the roof to the south and increase the slope of the roof in order to produce the most energy throughout the year.
- Install an electrical conduit from the primary electrical panel location to the roof
- Reserve space near the electrical panel for installing a solar inverter that will convert solar energy into electrical energy and for routing cabling. An area of about 60 cm x 90 cm should be sufficient.
- Properly size the electrical panel so it is able to accommodate the solar power system

It is also possible to plan for the installation of solar panels onto a carport.

Option B: Renewable energy generation system

Produce energy with a renewable electricity generation system installed on-site. Renewable energy sources that can be used include solar photovoltaic (PV) and wind energy.
When the renewable electricity generation system is a solar photovoltaic system, the number of kWp installed should be considered instead of the power output.

Submissions

Provisional Certification Stage
Option A: Solar PV-Ready Home
● Report describing how all requirements to design solar PV-ready homes will be met ● Roof plans showing the space that will be available on the roof for installing solar PV panels ● Electrical drawings showing details of the electric panel
Option B: Renewable energy generation system
● Tender schedule of all the energy production equipment ● Tender electrical schematic drawings showing the energy production system ● Tender specifications -OR- Manufacturer´s published technical data of all the energy production equipment

Full Certification Stage
Option A: Solar PV-Ready Home
● Photographs showing the space available on the roof for installing solar PV panels ● Photographs showing the space available near the electrical panel for installing a solar inverter and for routing cabling ● Evidence showing that an electrical conduit from the primary electrical panel location to the roof was installed. ● As-built electrical drawings showing details of the electric panel ● Evidence showing that information on the installation of a solar hot water system has been handed to all home buyers
If not already approved at Provisional Certification or if there is any change: ● Final report describing how all requirements to design solar PV-ready homes have been met.
Option B: Renewable energy generation system
● Final as-installed schedule of all the energy production equipment ● As-built electrical schematic drawings showing the energy production system ● 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.

E-6 Solar Hot Water-Ready Home

Intent

To design and prepare the building for the future installation of a solar hot water system.

Requirements

Criteria	1 point
Design and build solar hot water-ready homes	1

Overview

A solar hot water-ready home is one that has been designed and prepared for the installation of a solar hot water system to occur in the future. This will make the installation of the solar hot water system easier, faster and cheaper.

Approach & Implementation

For multi-family residential projects, only projects for which the homeowners will have control of the roof and have the right to install solar hot water system are eligible to follow this credit.

To design solar hot water-ready homes, the following requirements based on the Guide to the Province of British Columbia Solar Hot Water Ready Regulation 2013 should be met:

- Design roof areas for solar placement. A rectangular unobstructed area of at least 6 m2 (about the size of 2 typical solar hot water collectors of 160 liters) should be available on the roof for installing solar collectors.
- Ensure roof structure can withstand the extra weight that the solar collectors will create.
- Install one conduit run (i.e. pipe chase, a narrow space between walls through which plumbing is run) going from the kitchen and bathrooms to the roof area designated for installation of solar collectors in order to accommodate the solar hot water tubing
- The conduit run should:
  - be accessible at all ends
  - be capped or sealed at all ends
  - be identified by markings that are permanent, distinct and easily recognized
  - have a minimum inside diameter of 50 mm to run 15 mm or 20 mm pipes plus insulation

- Information to explain all the features that were integrated to the building to prepare for the installation of a solar hot water system in the future should be handed to all home buyers, within the Sustainable Practice Guide (required in Management Prerequisite 1) or as a separate document that home buyers can hand to the contractor that will install the solar water heating system.

Submissions

Provisional Certification Stage
● Report describing how all requirements to design solar hot water-ready homes will be met ● Annotated roof plans showing the roof area designated for installation of solar collectors

Full Certification Stage
● Photographs showing the conduit run installed to accommodate the solar hot water tubing ● As-built roof plans and/or photographs of the roof showing the roof area designated for installation of solar collectors ● Evidence showing that information on the installation of a solar hot water system has been handed to all home buyers
If not already approved at Provisional Certification or if there is any change: ● Final report describing how all requirements to design solar hot water-ready homes have been met.

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.

With C&S Homes projects not installing water fixtures, irrigation system and vegetation, LOTUS Homes C&S is limited to encourage the installation of rainwater collection.

Credit	Title	Points
W-1	Rainwater Harvesting	2 points
	Total of points available	2 points

W-1 Rainwater Harvesting

Intent

To encourage rainwater harvesting to reduce domestic water consumption.

Requirements

Criteria	2 points
Design and build a rainwater harvesting-ready home	1
Install a rainwater harvesting system to catch rainwater falling on the roof	2

Overview

Rainwater harvesting refers to the collection and storage of rain. Collection is usually from rooftops and channeled to storage tanks. Rainwater can be collected to be used for non-potable water usage and at the same time to reduce rainwater runoff and control infrastructure demand.

A rainwater harvesting-ready home is a house that only needs the installation of a rainwater tank and a downspout connector to be able to collect rainwater.

Approach & Implementation

For 1 point, to design a rainwater harvesting-ready home, the requirements on catchment area, gutters/roof drains and protection screening should be met and information on the other requirements should be handed to all home buyers, within the Sustainable Practice Guide (required in Management Prerequisite 1) or as a separate document.

For 2 points, all the following requirements on the installation of a rainwater harvesting system should be met:

- Catchment area:
  - The roof surface should be used as the catchment area.
  - Roofs should either be steep-sloped roofs or flat roofs with a slight gradient which allows rainwater to drain quickly and effectively into the gutters, without collecting in depressions. Steep roofs are advised as rainwater will be collected faster, in bigger quantity and cleaner (less potential for contamination) than with low-slope roofs.
  - Flat roofs shouldn't have gravel or asphalt materials on the surface.

- Gutters/roof drains:

The gutters or the pipes attached to roof drains should be sized so that they adequately move rainwater runoff from storm events. For drainage systems with gutters, downspouts should also be sized properly, a downspout area of 10 cm2 for 15 m2 of roof area is advised.

- Protection screening:

  Gutters and drains should have some debris screens in order to keep large debris from entering. For drainage systems with gutters, it is also possible to install a first flush diverter that collects and separates first flush of roof water runoff (that contains the most amount of debris from the roof surface) from entering the storage tank, but it is not recommended.

- Additional rainwater filtration device:

  Some additional rainwater filtration devices, either a downspout filter and/or a tank screen that is installed on the tank entry point, should be installed by developer.

- Storage:

  A rainwater storage tank where the captured rainwater is diverted to and stored for later use should be installed. The size of the tank will depend on the expected daily rainwater consumption, the duration of the dry season, the catchment area, and the space available at the location where the tank will be located. The rainwater storage tank should be installed upon a solid and flat base.

- Distribution:

  The distribution component of a rainwater harvesting system includes all of the piping, pumps, and other devices that move water from the storage to the point-of-use. Rainwater should be readily available wherever rainwater will be used. For C&S Homes, a simple tap on the rainwater tank to use rainwater for irrigation can be accepted.

Note: To cover the case where homeowners would want to use rainwater for household use, information on after-storage treatment should be included in the Sustainable Practice Guide required in Management Prerequisite 1.

In case rainwater is to be used for household use, treatment of the water after the storage and before use is critical for health of the occupants. The level of treatment will depend of the intended use of the water (drinking, bathing, cooking, etc.) but a multi-barrier approach where more than one method of treatment are used to maximize effectiveness is recommended.

The different types of water treatment available are:

- Filtration: It is similar to screening but on a smaller scale. There are various levels of filtration, and they are measured on a “micron” level. This measures the diameter of a particle that would be blocked by the filter. For example, a 5-micron filter would block particles in the water that are 5 microns or larger (a micron is one-millionth of a meter).

5-micron filters can remove microorganisms, sediment, metals, and other organic matter. If larger sized filters are used, small microorganisms, such as bacteria can pass through, so a disinfection method is needed (explained next). It is important that filters are checked and changed on a regular basis so that they maintain their effectiveness.

- Adsorption. Adsorption uses activated carbon (charcoal filters) to bind harmful contaminants, such as chemicals and organic compounds (including VOCs). They can also remove chlorine from water.
- Disinfection: The goal of disinfection is to destroy the microbiological organisms that have the potential to cause illness or harm. Some of the smaller microorganisms, such as bacteria, may pass through large cartridge filters so they must be targeted with disinfection. Three disinfection methods common to rainwater harvesting systems are chlorination, ultraviolet light (UV), and ozonation.
    - Chlorination uses the chemical of chlorine in either dry, liquid, or gas to kill microorganisms. It is very effective against viruses and bacteria. An advantage to chlorine is that it leaves a residual so that your entire distribution system remains disinfected. However, using chlorine can be dangerous, so it's important to follow manufacturer's guidelines.
    - UV light is a common disinfection method. The device works by sending water through a tube that contains the UV bulb. The light disrupts the DNA of microorganisms so that they can't reproduce. There are Class A and Class B UV light. The Class A light is rated to destroy pathogens and is required to have an alarm to alert users if the device is not working. A Class B light cannot be used as a sole method of disinfection but helps to polish water that has already been treated. An important point to keep in mind is that UV lights are most effective when the water is clear. Any sediment in the water can block the pathogens from the light. This is why having filtration before UV light is critical.
    - Ozonation disinfects by introducing ozone gas to the water. It is usually done at the point where water is used in the distribution system or in the storage tank. It is a colorless gas that disinfects, oxidizes, deodorizes, and decolorizes. Ozone gas is toxic and installation and maintenance of this type of system must be done by a licensed professional.

Submissions

Provisional Certification Stage
For all projects:
● Report describing and detailing how the requirements on catchment area, gutters and gutter protection screening will be met by the project ● Roof plans showing the catchment area for rainwater
For projects that will install a complete rainwater harvesting system:
● Report describing and detailing how the requirements on additional rainwater filtration device, storage and distribution will be met by the project.

Full Certification Stage
For all projects:
● Photographs showing the catchment area, gutters and gutter protection screening
If not already approved at Provisional Certification or if there is any change: ● Report describing and detailing how the requirements on catchment area, gutters/roof drains and protection screening have been met by the project
For projects that will install a complete rainwater harvesting system:
● Photographs showing the different components of the rainwater harvesting system (catchment area, gutters/roof drains, protection screening, additional rainwater filter, storage and distribution)
If not already approved at Provisional Certification or if there is any change: ● Report describing and detailing how the requirements on additional rainwater filtration device, storage and distribution have been met by the project.

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	Points
MR-1	Environmental Impact of Construction Materials	4 points
MR-2	Reduced Concrete Use	2 points
MR-3	Sustainable Materials	4 points
MR-4	Non-baked Materials	2 points
MR-5	Demolition and Construction Waste	2 points
MR-6	Operation Waste Management	1 point
	Total of points available	15 points

MR-1 Environmental Impact of Construction Materials

Intent

To measure the environmental impacts of the construction materials used for the project and optimize the design to reduce these impacts.

Requirements

Criteria	4 Points
Strategy A: Cradle-to-gate Embodied Carbon	
Calculate the cradle-to-gate embodied carbon of the project	1
Reduce the cradle-to-gate embodied carbon of the project by optimizing design	2
Strategy B: Life-cycle Assessment	
Calculate the environmental impacts of the project through life-cycle assessment	1
Reduce the environmental impacts of the project by optimizing design using life-cycle assessment	2

Overview

The use of materials in building construction has a big impact on virgin natural resources, pollution, energy use and carbon emissions. To reduce as much as possible the impacts of the construction activities on the environment, it is necessary to identify, evaluate and monitor these impacts throughout the life-cycle of the building materials that include manufacturing, transportation, installation, maintenance, and disposal of building materials.

Building life-cycle stages are defined by EN 15978 and EN 15804 standards as follows:

- stage A1-A3: Product stage with raw material extraction (A1), transport to the manufacturer (A2) and manufacturing (A3),
- stage A4-A5: Construction stage with transport to the building site (A4) and installation into the building (A5),
- stage B1-B5: Use stage with use or application of the installed product, maintenance, repair, replacement and refurbishment, and
- stage C1-C4: End of life stage with de-construction/demolition, transport to waste processing, waste processing for reuse, recovery and/or recycling, and disposal

Cradle-to-gate embodied carbon refers to the emissions associated with the manufacturing of building materials (stages A1-A3) from raw material extraction to the gate of the manufacturer and it accounts for the vast majority of a building's total embodied carbon.

Building Life-cycle Assessment (LCA) is a scientific methodology used to calculate the environmental impacts of a building through its whole existence, from the extraction of raw materials to the construction phase, use, and finally demolition and disposal. LCA not only assesses carbon footprint (i.e. Global warming potential) but also many more impact categories (or environmental impact indicators), such as ozone depletion potential acidification, fossil fuel depletion, acidification potential (that measures the potential of pollutants to cause the acidification of soil and water), eutrophication potential (that measures the enrichment of the freshwater, marine and terrestrial ecosystems with nutritional elements), etc.

Approach & Implementation

In this credit, all building materials used for the foundations, substructure, structure and enclosure should be considered. Materials for interior finishes and for mechanical, electrical and plumbing equipment should be excluded.

Strategy A: Embodied Carbon

- Carbon reporting:

The first step to address embodied carbon in construction projects is carbon reporting where the embodied carbon of the project is calculated and reported.

Cradle-to-gate embodied carbon (through stages A1 to A3) should be calculated in kilograms of carbon dioxide equivalent per meter squared (kg CO_2e/m^2).

For this, the project should first make the inventory of the types and quantities of materials that are part of the scope of the credit using BOQs and/or BIM model.

Then, the project should use a tool to calculate its cradle-to-gate embodied carbon. Many tools are available on the market, they can be freestanding software, plug-ins for other software (generally BIM software), or web-based tools. But, the project should select a tool which is linked to robust carbon data sets complying with the EN 15804 standard and/or with the ISO 14040/44 standard, such as the Inventory of Carbon and Energy (ICE) database, the RICS Building Carbon Database, etc.

- Carbon comparison:

The second step to address embodied carbon is carbon comparison where different design options for carbon are compared. For compliance, the project should identify and implement the most impactful and cost-efficient carbon reduction measures to achieve at a minimum a 20% reduction of the embodied carbon against a baseline building.

The following strategies for reducing embodied carbon in houses should be considered:

- Design lightweight, efficient structures (See credit MR-2 Reduced Concrete Use)
- Select low-carbon embodied materials:
    - Use EPDs to identify lower-carbon facilities & products
    - Use salvaged materials if/where possible
    - Select timber from sustainable sources and/or rapidly renewable materials
    - Use a maximum of materials with recycled content
- Optimize concrete specification & mix design using performance-based specifications (rather than prescriptive requirements) and replacing portland cement with Type 1L cement, fly ash, slag, and other supplementary cementitious materials.

The baseline and proposed buildings must have similar architecture with only differences due to the change of materials. Also, the proposed building shouldn't have a lower energy performance than the baseline.

Baseline assumptions must be based on standard design and material selection for the project location and building type. In particular, for projects in Vietnam, the following features should be assumed for the baseline:

- Reinforced concrete structure
- In-situ reinforced concrete conventional slab
- Non-structural walls made of clay bricks

Use the same tool and carbon data sets to calculate the cradle-to-gate embodied carbon of both the baseline building and the proposed building. Then, calculate the reduction of the embodied carbon achieved by the project in comparison to the baseline.

<u>Strategy B: Life-cycle Assessment</u>

- LCA reporting:

As a first step in Strategy B, the project should calculate its environmental impacts through LCA analysis considering, at a minimum, stages A1-A5, B2-B4, and C1-C4.

For this, the project should first make the inventory of the types and quantities of materials that are part of the scope of the credit using BOQs and/or BIM model.

Then, the project should use a life-cycle assessment software tool and data sets to evaluate its environmental impacts. Data sets must comply with the EN 15804 standard and/or with the ISO 14040/44 standard, such as the Inventory of Carbon and Energy (ICE) database, the RICS Building Carbon Database, etc.

A reference period of 60 years should be considered, and the quantified environmental impacts of the building should be declared and reported as per EN-15978 using the category indicators (parameters) and units shown in Table MR.1.

Table MR.1: Parameters for describing environmental impacts

Impact Category	Parameter (Category Indicator)	Unit
Global Warming (Climate Change)	Global warming potential, GWP	kg CO_2 eq.
Ozone Depletion	Depletion potential of the stratospheric ozone layer, ODP	kg CFC 11 eq.
Acidification for Soil and Water	Acidification potential of land (soil) and water, AP	kg SO2 eq.
Eutrophication	Eutrophication potential, EP	kg (PO4)3- eq.
Photochemical Ozone Creation	Formation potential of tropospheric ozone photochemical oxidants, POCP	kg C2H4 eq.
Depletion of Abiotic Resources – elements	Abiotic resource depletion potential for elements (non-fossil resources), ADP-elements	kg Sb eq.
Depletion of Abiotic Resources – fossil fuels	Abiotic resource depletion potential of fossil fuels, ADP-fossil fuels	MJ, net calorific value

- LCA comparison:

For a second point in Strategy B to be awarded, the project should achieve a 10% reduction of at least three of the Category Indicators listed in Table MR.1 against a baseline building, while none of the Category Indicators may increase by more than 5% compared with the baseline building.

The baseline and proposed buildings must have similar architecture with only differences due to the change of materials. Also, the proposed building shouldn't have a lower energy performance than the baseline.

The service life of the baseline and proposed buildings must be the same and at least 60 years to fully account for maintenance and replacement.

Baseline assumptions must be based on standard design and material selection for the project location and building type. In particular, for projects in Vietnam, the following features should be assumed for the baseline:

- Reinforced concrete structure
- In-situ reinforced concrete conventional slab
- Non-structural walls made of clay bricks

Use the same life-cycle assessment software tool and carbon data sets to evaluate environmental impacts of both the baseline building and the proposed building.

Then, for each Category Indicator, calculate the percentage of reduction achieved by the project in comparison to the baseline.

Submissions

Provisional Certification Stage
For both strategies:
● BOQ including all building materials used for the foundations, substructure, structure and enclosure
Strategy A: Embodied Carbon
● Embodied carbon report showing the cradle-to-gate embodied carbon in kg CO_2e/m^2, all the materials considered, the tool and data sets used and all the assumptions that were made for embodied carbon calculations of the proposed building and of the baseline building (if 2 points targeted)
Strategy B: Life-cycle Assessment
● LCA analysis report showing results for each Category Indicator (total results and results per life-cycle stage), the life-cycle assessment scope, all the materials considered, the tool and data sets used and all the assumptions that were made for the proposed building and for the baseline building (if 2 points targeted)

Full Certification Stage
For both strategies:
● Final BOQ including all building materials used for the foundations, substructure, structure and enclosure
Strategy A: Embodied Carbon
If not already approved at Provisional Certification or if there is any change: ● Final embodied carbon report showing the cradle-to-gate embodied carbon in kg CO_2e/m^2, all the materials considered, the tool and data sets used and all the assumptions that were made for embodied carbon calculations of the proposed building and of the baseline building (if 2 points targeted)
Strategy B: Life-cycle Assessment
If not already approved at Provisional Certification or if there is any change:
● Final LCA analysis report showing results for each Category Indicator (total results and results per life-cycle stage), the life-cycle assessment scope, all the materials considered, the tool and data sets used and all the assumptions that were made for the proposed building and for the baseline building (if 2 points targeted)

MR-2 Reduced Concrete Use

Intent

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

Requirements

Criteria	2 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 CO2 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, aluminum, 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 (m3) or on area (m2).
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:

$$Compliant\ non-structural\ interior\ walls\ [\%] = \left(\frac{IW_C}{IW_{tot}}\right) \times 100$$

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]

$$Compliant\ non-structural\ exterior\ walls\ [\%] = \left(\frac{EW_C}{EW_{tot}}\right) \times 100$$

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-3 Sustainable Materials

Intent

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

Requirements

This credit is only available at Full Certification.

Criteria	4 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 25%)	4

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 (FSC), Vietnam Forest Certification Scheme (VFCS), Malaysia Timber 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

Projects should perform calculations using ‘LOTUS Homes C&S Pilot Calculator - MR-3 - Sustainable Materials’.

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:

$$Sustainable\ materials\ [\%] = \sum_{i} \frac{C_i \times S_i}{C_{tot}}$$

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:

$$S_i = V_i \times (0.5 + F_i)$$

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 30% 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 installed, indicating location/use
- Bill of quantities (BOQ) detailing the cost of all materials installed in the project and the cost of all sustainable materials. If no final signed/stamped BOQ can be provided, a signed and stamped letter from the project owner should be submitted as additional evidence.
- Fully completed LOTUS Homes C&S Pilot Calculator - MR-3 - Sustainable Materials
- Evidence that the sustainable materials were installed such as photographs, invoices, receipts, commissioning report, etc.

For reused materials and materials with reused components:

- Evidence showing that the materials have been salvaged, refurbished or reused, such as: photographs, receipts, etc.

For materials with recycled content:

- Manufacturer's published data indicating recycled content -OR- signed and stamped letter from the manufacturer indicating recycled content

For timber sustainable from sustainable sources:

- Certificate -OR- Manufacturer's published data indicating that the timber is from a certified sustainable source

For materials third party certified based on whole LCA:

- Certificate indicating that the materials have been third party certified based on whole LCA

For materials from a manufacturer with ISO 14001 certification:

- Certificate indicating that the manufacturing facility is certified under ISO 14001

For materials with self-declared EPD:

- Copy of the self-declared EPD from manufacturer

For materials extracted, harvested and/or manufactured locally:

- Signed and stamped letter from the manufacturer indicating the extraction, harvest and/or manufacturing location of the materials

For materials with third-party verified EPD:

- Copy of the EPD showing that it has been third party verified.

For materials with third-party verified environmental claims:

- Certificate indicating that the environmental claims of the materials have been third party verified

MR-4 Non-baked Materials

Intent

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

Requirements

Criteria	2 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 CO2 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.

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

Calculations

Calculation is based either on volume (m3) or on area (m2).

Percentage of non-baked materials use should 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:

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

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 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-5 Demolition and Construction Waste

Intent

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

Requirements

This credit is only available at Full Certification.

Criteria	2 Points
Strategy A: Waste Diversion	
Implement a Waste Management Plan and reuse, salvage and/or recycle 50% of the demolition and construction waste	1
Implement a Waste Management Plan and reuse, salvage and/or recycle 70% of the demolition and construction waste	2
Strategy B: Reduction of Waste Generation	
Implement a Waste Management Plan and 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

Both strategies:

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.)

Calculations

Strategy A: Waste Diversion

Projects should perform calculations using 'LOTUS Homes C&S Pilot Calculator - MR-5 Demolition and Construction Waste'.

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:

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

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/OR -

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

Full Certification Stage
Both strategies
● 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
● Fully completed LOTUS Homes C&S Pilot Calculator - MR-5 Demolition and Construction Waste
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-6 Operation Waste Management

Intent

To implement waste sorting and facilitate the recycling and reuse of waste.

Requirements

This credit is only available at Full Certification.

Credit	1 point
Provide a storage place with different bins for recyclables, organic wastes and garbage	1

Overview

Houses produce a considerable amount of wastes that should be diverted from landfill for recycling or reuse. Good practice and the provision of separate bins to allow for recycling is a simple way to reduce the amount of waste generated once the building is occupied.

Approach & Implementation

Provide different waste bins for the C&S Homes to separate the following types of waste:

- Recyclables
- Organic wastes
- Garbage

For C&S Homes projects with terraced houses sharing a common basement for parking, the following requirements should be met:

- A common waste storage area located in the basement or at the ground level for convenient access by occupants and collection vehicles should be provided.
- The common waste storage area should include waste bins sufficiently sized based on the number of residents and frequency of recycling pick-up to separate the following types of waste:
  - Recyclables
  - Organic wastes
  - Garbage
- Also, signs should be displayed in the building to indicate the common waste storage area and all the different waste bins should be clearly marked for each type of waste.

Submissions

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

Full Certification Stage
● Photographs showing that different bins for recyclables, organic wastes and garbage are provided in the C&S Homes. And, for C&S Homes projects with terraced houses sharing a common basement for parking: ● 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 waste storage area, the bins reserved for the different types of waste and the signs displayed to show the location of storage areas.

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 urban population will increase by 45% within the next 20 years. 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 occupants' health and comfort is done most effectively by maintaining and increasing the building's IEQ. Improving the IEQ results in reduced cases of asthma, allergies, respiratory disease and other occupant ailments described as "sick building syndrome".

All credits within the Health & Comfort Category of LOTUS Homes C&S target the overall improvement of the indoor environment in buildings. The improvements aim at three different aspects of the indoor environment. First and most important aspect is the quality of indoor air. The building has to ensure fresh, clean air free of toxic chemicals for occupants. Moreover, a healthy indoor environment in a building has to be comfortable visually and acoustically and for the occupants of the building.

Credit	Title	Points
H-1	Ventilation for indoor air quality	4 points
H-2	Daylighting	3 points
H-3	Acoustic Comfort	1 point
	Total of points available	8 points

H-1 Ventilation for Indoor Air Quality

Intent

To maintain good indoor air quality during occupancy.

Requirements

Criteria	4 Points
Strategy A: Fresh Air Supply	
Provide sufficient fresh air supply to a minimum of 90% of the total net habitable area of the building.	2
Strategy B: Air filtration	
Install air filters on fresh air intakes	1
Strategy C: 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. The addition of fresh air into the building improves indoor air quality by diluting indoor air with fresh air and removing indoor pollutants. Increased fresh air supply can help decrease respiratory illnesses. However, with today's polluted air in urban environments, fresh air is rarely free of contaminants and clean filtered air may be necessary to effectively improve the indoor air quality.

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

To protect occupants from combustion byproducts, to achieve points in this credit:

- C&S Homes projects with terraced houses sharing a common basement for parking should install and run exhaust fans continuously in the basement

- C&S Homes with an attached garage should have a solid partition wall and door between the habitable spaces and the car parking area
- C&S Homes with a garage in the basement should have a wall penetration in the basement so that the homeowners can install an exhaust ventilation system. Information on how an exhaust ventilation system can be installed should be included in the Sustainable Practice Guide required in Management Prerequisite 1.

Strategy A: Fresh Air Supply

This strategy applies to all the habitable spaces in the building.

A minimum of 90% of the total net habitable area should be provided with sufficient fresh air supply by meeting the following requirements depending on ventilation type.

- Habitable spaces with supply mechanical ventilation:

Fresh air supply rates must meet or surpass the requirements on ventilation rates of any of the following standards:

- TCVN 5687:2024 - Ventilation - Air Conditioning, Design Standards
- ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (from 2013 or later)
- AS 1668.2-2012 - 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.

- Habitable spaces with natural ventilation:

Naturally ventilated spaces (or mechanically assisted naturally ventilated spaces) must 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 openable area of wall and roof openings (that should be calculated in accordance with the definition in the Glossary of Technical Terms) 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.

- Habitable spaces with mixed-mode ventilation:

Mixed-mode ventilated spaces (combination of natural ventilation from operable openings, and mechanical systems) must meet both the above requirements for spaces with supply ventilation and spaces with natural ventilation.

Strategy B: Air Filtration

This strategy can only be followed by projects with 90% of the total net habitable 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.

Air filters are generally classified under:

- MERV (Minimum efficiency reporting value) rating, which is a measurement scale designed by ASHRAE 52.2-2012 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, M5-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, F9 (EN 779) or E10 (EN 1822).

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/m3 (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: Ventilation in Wet Areas

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, intermittent local ventilation exhaust or openable windows 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
- 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. However, if the exhaust fan flow is less than 5 air changes per hour, the installation of a vented range hood should be recommended to the home buyer in the Sustainable Practice Guide (required in Management Prerequisite 1).

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.

- Openable windows

Toilets and bathrooms should have an operable window area no less than 4% of room floor area nor less than 0.15 m^2.

Calculations

Strategy A: Fresh Air Supply

- Habitable spaces with supply ventilation:

For each of these habitable spaces, calculate minimum ventilation rates (fresh air supply) in accordance with one of the standards listed in Approach & Implementation and demonstrate that designed ventilation rates meet the requirements of the selected standard.

- Habitable spaces with natural ventilation:

For each of these habitable 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.

For each of these habitable spaces, perform calculations of the total area of wall or roof openings to show compliance with the above requirements.

Strategy C: Ventilation in Wet Areas

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
- One air change per hour is equivalent to an exhaust rate of 1 volume of the room per hour
- 5 air changes per hour is equal to a rate of 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.

Submissions

Provisional Certification Stage
Strategy A: Fresh Air Supply
For mechanically ventilated spaces and/or 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 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/or mixed-mode ventilated spaces:

- Tender elevations and plans marking all operable wall and roof openings
- Tender window schedule indicating the number, location, type and size of all wall and roof openings - OR -
- Room data sheets that indicate floor area and specifications of all wall and roof openings (number, location, type and size).

- Calculations showing that naturally ventilated occupied spaces conform to the requirements
- Tender elevations and plans marking all operable wall and roof openings

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: 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 window schedule indicating the number, location, type and size of all wall and roof openings
- Photographs showing the different types of openings installed

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

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 supply air filters installed

Strategy C: 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-2 Daylighting

Intent

To encourage building designs which maximize the use of daylight.

Requirements

Only one of the 2 following options can be pursued.
For projects not installing interior partitions, the habitable spaces of the C&S Homes cannot be defined. These projects should follow Option B and the criteria apply for the net floor area instead of the net habitable area.

Option A: Daylight Factor

Criteria	2 Points
60% of the habitable spaces has an average daylight factor above 1.5%	1
80% of the habitable spaces has an average daylight factor above 1.5%	2

Option B: Daylight Autonomy

Criteria	3 Points
Achieve a spatial daylight autonomy$_{300/50\%}$ (sDA$_{300/50\%}$) of more than 40% of the net habitable area while controlling solar glare	1
1 point for every additional 20% of the net habitable 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

Option A: Daylight Factor

Achieve an average daylight factor (DF) above 1.5% in the habitable 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 habitable area.
The sDA$_{300/50\%}$ results represent the percentage of the net habitable 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 habitable area but also the solar glare should be limited. For this, an annual sunlight exposure of ASE$_{1000,250}$ of no more than 20% of the net occupied area should be achieved. ASE$_{1000,250}$ is the percentage of area that exceeds a direct sunlight illuminance of 1000 lux for 250 hours.

Calculations

Option A: Daylight Factor

The prediction of daylight factor (DF) requires knowledge of the building and its surroundings. DF must be calculated for all habitable spaces.

Calculations for Option A 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 habitable spaces. The sky conditions for daylight factor calculations should be set on the 21st of September at 12:00pm at CIE Standard Overcast Sky. 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:

Projects should perform spreadsheet calculations using the 'LOTUS Homes C&S Pilot Calculator - H-2 - Daylight Factor' in which the average DF for each 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 [%]

A_g = Glazed area of windows in the zone studied (excluding frames or obstructions) [m^2]

A_{total} = Total internal surface area of the 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).

M = Maintenance factor. This factor 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.1)

t = Visible light transmission (Values of Table H.2 can be used if manufacturer's data is not available)

ρ = Average reflectance of surrounding room surfaces (recommended values in Table H.3 can be used)

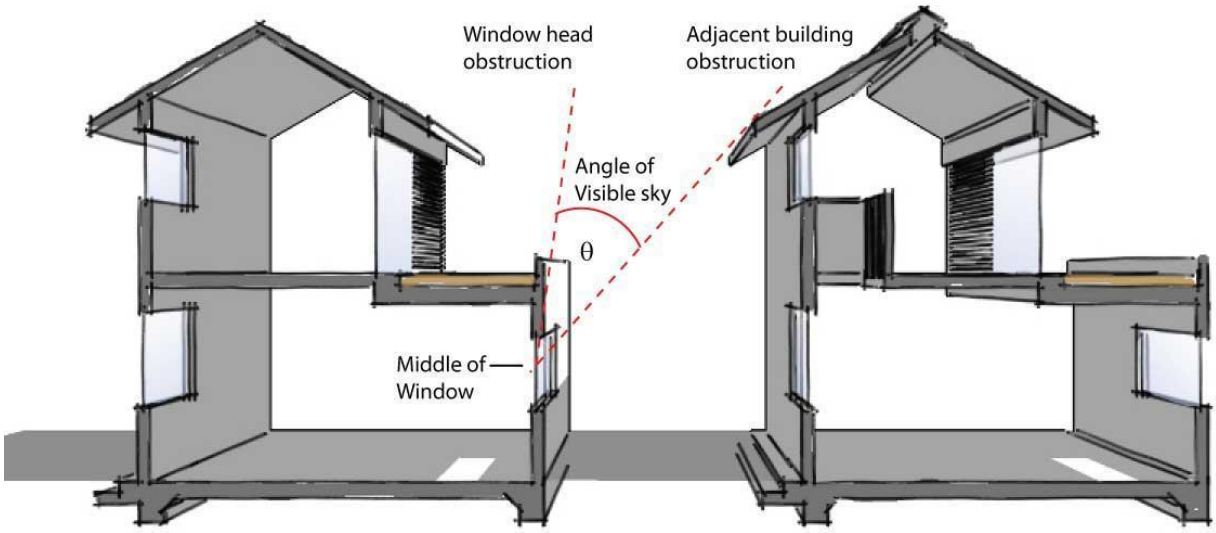


Figure H.1: Angle of visible sky from the mid-point of the window

Table H.1: 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
Dirty Industrial Area	Vertical	0.8	0.7
	Sloping	0.7	0.6
	Horizontal	0.6	0.5

Table H.2: Typical values of 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

Table H.3: Recommended average 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 habitable spaces
- Identify all the habitable spaces that have an average DF value above 1.5%
- All these spaces are considered as compliant for the daylighting credit
- Sum the areas of all these spaces and compare them to the net habitable area of the building using the following formula:

$$Compliant\ Area\ Percentage\ [\%] = \frac{A_C}{A_O} \times 100$$

A_C = Compliant habitable area (sum of the areas of the compliant habitable spaces) [m^2]

A_O = Net habitable 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 habitable area at hours between 8 am and 6 pm.

Exception: For projects not installing interior partitions, the $sDA_{300/50\%}$ achieved in the net floor area should be calculated instead of the $sDA_{300/50\%}$ achieved in the net habitable area.

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.

Any permanent interior obstruction should be considered in the modelling, but moveable furniture and partitions, and glare-control devices should not be considered.

$ASE_{1000,250}$ should be calculated through daylight modelling. $ASE_{1000,250}$ should represent no more than 20% of the net occupied area.

Submissions

Provisional Certification Stage	Option A	Option B
• Tender floor plans and elevations outlining all occupied spaces and indicating all glazing	✓	✓
• Tender specifications and/or manufacturer's data indicating VLT values of all the glazing to be installed	✓	✓
If using spreadsheet calculations:		
• Fully completed LOTUS Homes C&S Pilot Calculator - H-2 - Daylight Factor	✓	
If a daylight modelling software was used:		
• Report including average daylight factor output results and indicating inputs from daylight modelling software	✓	
• Calculations of the percentage of habitable spaces compliant	✓	
• Report including $sDA_{300/50\%}$ and $ASE_{1000,250}$ output results, indicating inputs from daylight modelling software		✓

Full Certification Stage	Option A	Option B
• As-built floor plans and elevations	✓	✓
• Photographs showing the exterior envelope glazing	✓	✓
If not already approved at Provisional Certification or if there is any change:		
• Manufacturer's data indicating VLT values of all the glazing installed	✓	✓
If using spreadsheet calculations:		
• Fully completed LOTUS Homes C&S Pilot Calculator - H-2 - Daylight Factor	✓	

If a daylight modelling software was used:		
• Final report showing average daylight factor output results and indicating inputs from daylight modelling software	✓	
• Final as-built calculations of the percentage of habitable spaces compliant	✓	
• Final report including $sDA_{300/50\%}$ and $ASE_{1000,250}$ output results, indicating inputs from daylight modelling software		✓

H-3 Acoustic Comfort

Intent

To provide a comfortable acoustic environment for occupants.

Requirements

Criteria	1 Point
Design all walls and floors to comply with the requirements of TCXDVN 277:2002 on airborne and impact sound insulation	1

Overview

As noise levels largely affect the health and comfort of residents, acoustic comfort is one of the most critical factors to ensure the 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 acoustic comfort.

Approach & Implementation

TCXDVN 277-2002 sets forth minimum requirements on sound insulation in residential buildings (see Table H.4). 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 (see Table H.5).

Table H.4: 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.5: Definition of floor and walls included in the noise classes (adapted from TCXDVN 277-2002)

Class	Definition
Class I	Elements requiring good sound insulation: - Floor and walls separating bedrooms or studies from a space containing noisy equipment or services
Class II	Elements requiring medium sound insulation: - Walls of bedrooms and living rooms between two houses; - Floor and walls separating bedrooms or living rooms with kitchens, toilets and stairs
Class III	Elements requiring low sound insulation: - Walls between rooms of the same unit

The TCVN standard outlines many strategies which can be applied. Reduction of noise inside and outside of the building should be considered but not be limited to the following strategies:

- 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 partitions and space dividers
- Avoid locating outside air intake or exhaust-air-discharge opening near windows, doors, or vents where noise can re-enter the building

Calculations

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
● 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
● 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	Points
SE-1	Site Selection	1 point
SE-2	Disaster resilience	2 points
SE-3	Vegetation	2 points
SE-4	Stormwater Runoff	2 points
SE-5	Heat Island Effect	2 points
SE-6	Construction Activity Pollution Control	1 point
SE-7	Green Transportation	2 points
SE-8	Greenery & Biophilia	2 points
SE-9	Outdoor Communal Facilities	2 points
	Total of points available	16 points

SE-1 Site Selection

Intent

To encourage development to occur in locations that will not harm the natural environment.

Requirements

Criteria	1 point
Locate the project on a redevelopment site	1

Overview

Site selection is an important aspect to consider for a green building. Projects should choose sites with low eco-value to limit their impact on the ecosystem.

Approach and Implementation

Credit is to be awarded if the project is located on a site that was previously developed. Previously developed sites are sites that once contained buildings, roadways, parking areas or areas that have been degraded or altered by direct human activities. These sites usually have no significant ecological value.

Submissions

Provisional Certification Stage
● Photographs or other evidence showing prior development of the site

Full Certification Stage
If not already approved at Provisional Certification or if there is any change: ● Photographs or other evidence showing prior development of the site

SE-2 Disaster resilience

Intent

To encourage designs resistant to natural disasters to adapt to climate change.

Requirements

Criteria	2 points
Strategy A: Flood Resistance	
Design a building resistant to floods	1
Strategy B: Typhoon Resistance	
Design a building resistant to typhoons	1

Overview

Vietnam is one of the most natural disaster-prone countries in the world. Natural disasters that occur include typhoons, tropical depressions, floods, droughts, landslides, forest fires, salt-water intrusion. etc. The different regions of Vietnam are prone to different types of disasters (Figure SE.2), but floods and typhoons (i.e. tropical storms) are the most common.

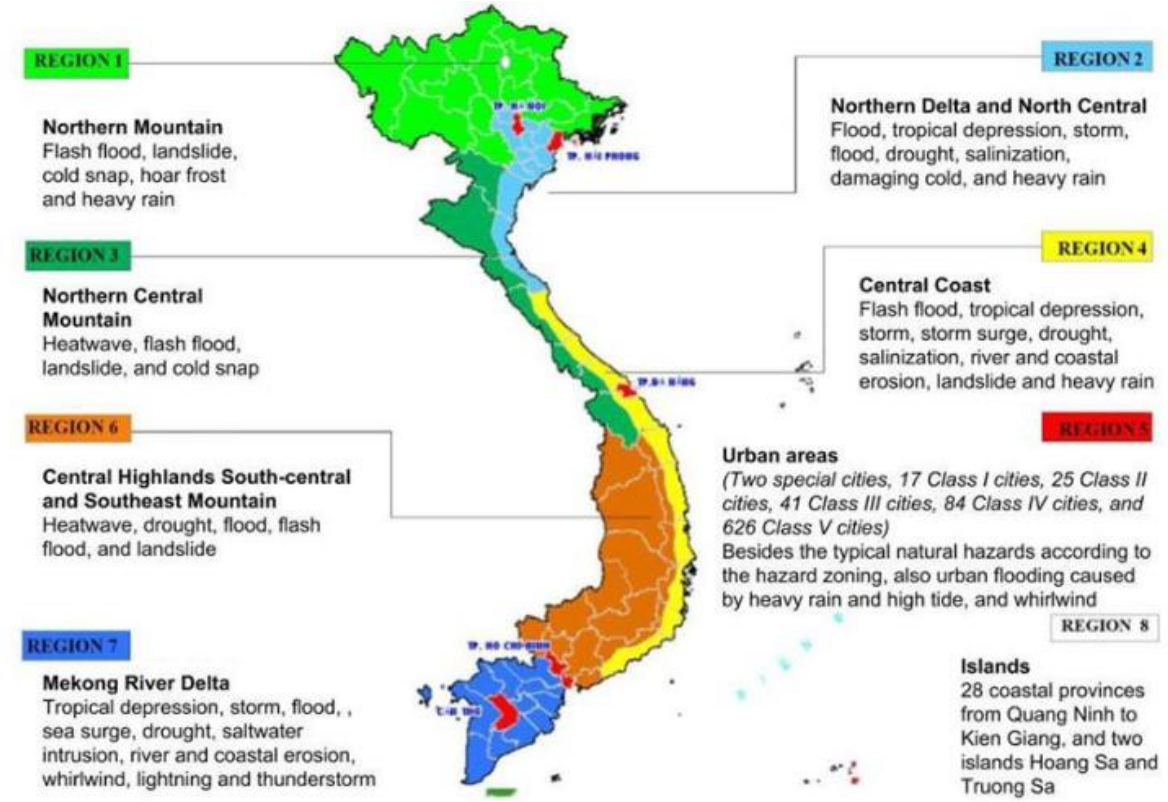


Figure SE.2: Disaster zones of Vietnam (Source: Asian Disaster Reduction Center)

Also, most recorded damage to buildings is caused by typhoons and flooding. For this reason, buildings are encouraged to make efforts to minimize the damage caused by these disasters, protecting occupants and property in the event of natural disasters.

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 usable maps over the next few years as research in this area grows in popularity amongst universities as well as the government.

Approach & Implementation

For buildings in Region 1 and Region 3 as shown in Figure SE.2, projects should also consider landslide resistance to be awarded points in the credit. Projects should first prepare a landslide risk assessment to identify if they are prone to landslide risk. If yes, projects should implement measures to mitigate landslide damage on buildings.

Strategy A: Flood Resistance

The project should prepare a local flood risk report including the following information:

- All relevant published data from local hydrometeorology institutes or other qualified organizations including:
  - Precipitation/rainfall data
  - Local history of storms
  - Local history of flooding (with a maximum of information: date, water level, areas touched, duration, cause, etc.)
  - Predicted climate change impacts like increased storm frequency or sea level rise
- A Flood map, if available, identifying whether the selected site is within flood prone area
- The results of a local flood survey that must be conducted to collect information from local communities and authorities regarding flooding in the past 15 years. The information collected should be gathered to produce a list of the flood events showing the flood level reached, the flood duration and the main cause(s) for each of the flood events. If there is no local history of flooding, the survey doesn't need to be conducted.

Then, based on all the information collected, the flood risk report should identify:

- the type of flood(s) threatening the building (river flood, pluvial flood and/or coastal flood).
- the current highest flood level, which is the highest flood level reached in the past 15 years or, if the project can calculate the probability of flood events, the flood level of the 20-year flood (flood event that has 5% probability of being equaled or exceeded in any given year).

Following the flood risk report, the project should produce a report showing that the building is designed to resist potential flood damage from the current highest flood level. For this, the report should describe the potential flood damages to the building and the strategies employed to increase building's ability to resist flood damage, such as:

- Elevate buildings above the highest 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

Strategy B: Typhoon Resistance

Typical houses are designed so that the vertical loads of the house are transferred from the roof to the foundation and are inadequate to resist strong winds that produce lateral loads and uplift forces.

For compliance, buildings should be able to withstand the expected lateral and uplift forces from strong winds, i.e. the integrity of the building envelope, including roofs and windows should be maintained.

For this, projects should employ a complete range of strategies to protect buildings all the way from foundation to the top of the roof. Below is a non-exhaustive list of strategies taken from the Guidelines for Disaster-Resilient Buildings & Structures by Ar. Rey S. Gabitan Head, UAP Emergency Architects:

- Foundations:

  The project should ensure that the ground under the building can bear the weight of the house. For this, the project should perform tests to determine the bearing capacity of the soil. Then, depending on the weight of the building and the bearing capacity of the soil, the project should select the most appropriate type of foundation.
- Building Shape:

  This is the most important single factor in determining the performance of buildings in typhoons. Simple, compact, symmetrical shapes (e.g. square plans or, even better, hexagonal or octagonal plans) are best as they allow high winds to go around them.

For rectangle buildings, the length should not more than three times the width. For L-shaped or U-shaped buildings, efforts should be made to strengthen the corners.

- Structure:

  The buildings should be designed with a regular and coherent structure.

  There should be an integrated structural ring beam around tops of doors and windows connected to columns and an integrated structural ring beam around top of walls connected to columns. If the house has triangular gable end walls, they must be structurally supported (e.g. strengthened with reinforced concrete).

- Roof-to-Wall Attachment:

Roof and wall structures should be joined to strengthen each other, to hold the roof firmly on the house and to transfer the uplift forces on the roof into the walls. For this, many solutions can be applied:

  - Anchor the roof frame to the masonry wall using properly designed anchor bolts and base plates
  - Provide a more rigid fastening system for the roof frame like metal tie-down straps (typhoon straps) that tie the roof structure all the way down to the foundation
  - Provide various structural connectors to reduce uplift
  - Let column reinforcement protrude from the top of concrete columns and bend column reinforcement around roof trusses for structural strength
  - Strap roof trusses with metal ties to the wall structure

- Tying walls to building structure:

Walls should be tied to columns so that they do not move separately when the forces from wind impact them and so that walls don't fall. For this:

  - Steel wall ties can be used to tie walls to the main building structure
  - Horizontal seismic bands made of reinforced concrete can be added at window lintel level to distribute lateral forces more evenly throughout the building and reduce the potential for damage to the walls

- Roof Trusses:
  - Roof trusses and gables must be braced.
  - The ridge should be secured by strongly connecting rafters using:
    - Collar Ties: Timbers connecting the rafters.
    - Gussets: Usually made of steel/plywood and used at the ridge.
    - Metal Straps over the top of the rafters.
    - Wielding roof trusses together, to purlins and to wall reinforcement (for metal roof trusses)

- Roof Overhangs:
  - Avoid large overhangs as high wind force builds up under them.

- Roof eaves can be limited to about 50 cm.
- Overhangs and canopies should be braced by ties held to the main structure.
- Roof overhangs for veranda, patio, terraces and balconies should be designed as separate construction rather than extensions of the main roof of the building.

- Roofing Sheets:
  - Use long-span roof sheets whenever possible
  - Roofing sheets usually fail at ridges where capping comes off, at gable ends where sheetings rolls up sideways and at eaves where sheets lift up. At ridges, eaves and overhangs, provide fixings at every two corrugations. At all other locations, provide fixings at every three corrugations at maximum spacing.
  - The connections of cladding/sheeting to the truss need to be designed for the increased forces, especially at the corners and the roof edges considered as zones of higher local wind suctions.

Also, beyond these design strategies, the project should ensure that:

- good construction practices are followed, for instance:
  - reinforced concrete columns should be made in one part before walls are built up,
  - a 135 degree bent should be used for stirrups that are essential parts of the column to tie up bars
- good materials are selected, for instance:
  - reinforcement steel should be made of deformed steel bar, rather than plain round bar,
  - gravel made of crushed rock, with no stones larger than 20mm should be used in the concrete mix

  Else, even with the best design, the house may not resist typhoons.

Submissions

Provisional Certification Stage
Strategy A: Flood Resistance
● Local flood risk report ● Report showing that the buildings are designed to resist potential flood damage from the current highest flood level ● Tender drawings indicating the flood resistance factors and strategies employed
Strategy B: Typhoon Resistance
● Report showing that the buildings are designed to resist typhoon winds ● Tender drawings indicating the strategies employed for the buildings to resist typhoon winds

Full Certification Stage
Strategy A: Flood Resistance
● As-built drawings 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 showing that the buildings are designed to resist potential flood damage from the current highest flood level
Strategy B: Typhoon Resistance
● As-built drawings indicating the strategies employed for the buildings to resist typhoon winds
If not already approved at Provisional Certification or if there is any change: ● Final report showing that the buildings are designed to resist typhoon winds

SE-3 Development Footprint

Intent

To minimize the development footprint and maximize open space for vegetation.

Requirements

Criteria	2 points
15% of the total site area is undeveloped	1
30% of the total site area is undeveloped	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.

Site vegetation largely contributes to improve the building site 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.

Approach & Implementation

Development footprint should be minimized to provide open space and allow residents to install a pond and a maximum of vegetation to create a lush landscaping.

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).

Calculation

The undeveloped site area percentage should be calculated in the following way:

$$Undeveloped\ Site\ Area\ [\%] = \left(\frac{A_S - A_B - A_O}{A_S}\right) \times 100$$

A_B = Building Footprint [m^2]

A_O = Other built structures area at ground floor [m^2]

A_S = Site area [m^2]

Submissions

Provisional Certification Stage
● Tender site plans highlighting the undeveloped area ● Calculations of the percentage of undeveloped area

Full Certification Stage
● As-built site plans highlighting the undeveloped area ● Photographs of the undeveloped area
If not already approved at Provisional Certification or if there is any change: ● Calculations of the percentage of undeveloped area

SE-4 Stormwater Runoff

Intent

To improve perviousness of site surfaces, thus reduce temporary load to municipal drainage system and improve groundwater recharge.

Requirements

Credit	2 points
Average perviousness of the site is at least 30%	1
Average perviousness of the site is at least 50%	2

Overview

Storm water runoff is the water created during precipitation events which is then fed into sewer or river systems.

Reducing storm water runoff reduces 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 will reduce the amount of pollutants washed into water bodies.

Approach & Implementation

The most effective strategy 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:

- Minimize hardscape areas and increase softscaping with gardens and lawns.
- Use permeable hardscaping materials for driveways, parking lots and walkways such as:
  - Open grid pavement systems
  - Permeable paving blocks
  - Porous asphalt/concrete
  - Unbound gravel
  - Brick, wood, cobbles or natural stone arranged to promote infiltration
- Use green roofs

Calculations

Projects should perform calculations using 'LOTUS Homes C&S Calculator - SE-4 - Stormwater Runoff'. The calculation shall take into account the entire site area, 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, soft scaping, landscaping and green roof) used
- Identify the runoff coefficient of each of these spaces
- Calculate the average site perviousness of the site using the following formula:

$$Site\ Perviousness\ [\%] = \frac{\Sigma A_i \times (1 - C_i)}{A_{site} + A_{green}} \times 100$$

Ai = Area of space n [m^2]

Ci = Run-off coefficient of covering material for space i

A_{site} = Total site area minus building footprint(s) [m^2]

A_{green} = Green roof area [m^2]

Note on landscaping areas: For this credit, only the surface of the ground, where stormwater will fall, should be considered. Therefore, canopy of trees should not be considered.

Runoff coefficients in Table SE.1 should be used for the average site perviousness calculation unless manufacturer's published data is available for a specific surface material.

Table SE.1: Runoff Coefficients of different surfaces
(*Source: 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
Others	
Garden bed/rain garden	0.15
Playgrounds	0.25

Character of surface	Runoff Coefficient
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

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that the average perviousness of the site is at least 70%.

Submissions

Provisional Certification Stage
● Tender site plan indicating all types of landscaped and paved areas ● If any green roof to be installed, tender roof plan showing the green roof ● If runoff coefficients other than those from Table SE.1 have been used in calculations, manufacturer's data or logical justification indicating all runoff coefficients used ● Fully completed LOTUS Homes C&S Calculator - SE-4 - Stormwater Runoff

Full Certification Stage
● As-built site plan ● If any green roof was installed, as-built roof plan showing the green roof ● Evidence showing the different landscaped and paved areas, and the green roof areas 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 landscaped and paved areas ● As-built site plan indicating all types of stormwater control practices installed to capture and/or infiltrate stormwater ● If runoff coefficients other than those from Table SE.1 have been used, manufacturer's data or logical justification indicating all runoff coefficients used ● Fully completed LOTUS Homes C&S Calculator - SE-4 - Stormwater Runoff

SE-5 Heat Island Effect

Intent

To reduce the urban heat island effect from the proposed development.

Requirements

Criteria	2 points
30% of the paved and roof area limits the heat island effect	1
50% of the paved and roof area limits the 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.1).

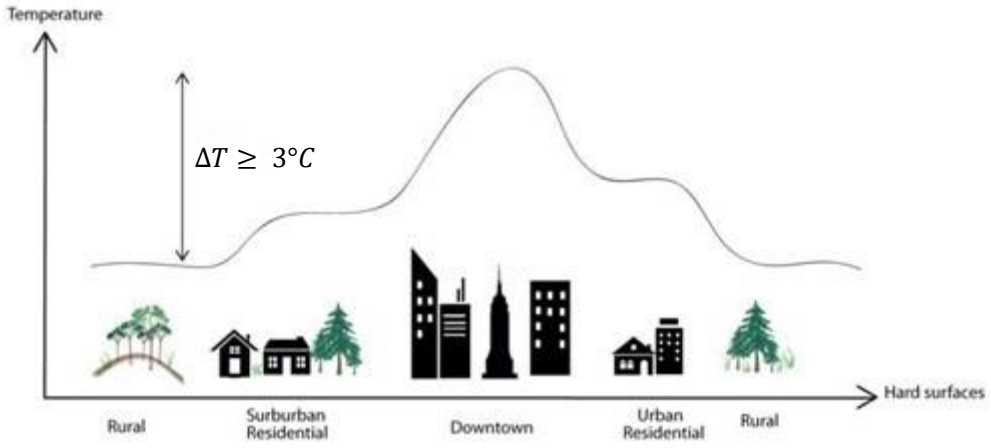


Figure SE.1: Heat Island effect

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 occur when surfaces made of brick, concrete and asphalt (such as streets, sidewalks, parking lots and buildings), 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 (PV, Collector)
- 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.

Note: For projects installing roofing materials with SRI higher than 78, information on the selection, maintenance and cleaning of reflective roofs should be included in the Sustainable Practice Guide required in Management Prerequisite 1.

Calculations

Projects should perform calculations using 'LOTUS Homes C&S Calculator – SE-5 - Heat Island Effect'. 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 natural light are counted as paved area.

Areas covered with mechanical equipment and/or skylights should be deducted from the paved and 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 surfaces considered as limiting heat island effect.

- For shading devices, the area to consider is 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:

$$Limiting\ Heat\ Island\ Effect\ Surface\ [\%] = \frac{A_{\ low} + \ 0.5\ \times A_{gc}}{A_{\ total\ paved + roof\ area}} \times 100$$

$A_{\ low}$ = Area limiting heat island effect [m²]

A_{gc} = Area of grey concrete pavements [m²]

$A_{\ total\ paved + roof\ area}$ = Sum of the roof area and total site's paved area minus deducted areas [m²]

Exceptional Performance

1-2 point in Credit EP-1 can be awarded if the project demonstrates that 70%-90% of the paved and roof area limits heat island effect.

Submissions

Provisional Certification Stage
● Tender site plan indicating the different types of paved areas ● Tender roof plan indicating the different types of roof surfaces ● For any SRI value used, tender specification extracts -OR- manufacturer's published data -OR- justification (data must be from a VGBC approved source) ● Fully completed LOTUS Homes C&S Pilot Calculator - SE-5 - Heat Island Effect

Full Certification Stage
● As-built roof plan and site plan ● Evidence showing the paving and roofing materials installed, such as photographs, invoices, receipts, commissioning report, etc.
If not already approved at Provisional Certification or if there is any change: ● For any SRI value used, manufacturer's published data -OR- justification (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 ● Fully completed LOTUS Homes C&S Pilot Calculator - SE-5 - Heat Island Effect

SE-6 Construction Activity Pollution Control

Intent

To limit pollution arising from construction activities.

Requirements

Criteria	1 point
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.). Construction activities also can cause noise pollution (from loud machinery, vehicles, raised voices and physical work such as hammering, drilling or digging) with harmful effects on health and wellbeing.

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, land and noise 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.

● Noise mitigation measures to prevent noise pollution, including:
- Limit noisy construction works to Monday - Friday from 9:00 am to 5:00 pm
- Notify neighbors of construction periods
- Install noise barriers that are highly sound absorbent and reduce construction noise
- Use properly maintained and lubricated equipment and machinery
- Use low-noise equipment and machinery
- Modify a noisy process or equipment to eliminate or reduce the noise and vibration output (e.g. adding new mufflers, or sound absorbing material)

All these measures shall be implemented after having identified the noise sensitive locations (including adjoining residential properties, schools and places of worship) and the noisy construction practices (such as jackhammering, heavy machinery).

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-7 Green Transportation

Intent

To encourage residents to use green transportation.

Requirements

Criteria	2 points
Strategy A: Public Transportation	
All dwelling units are within a 500 m walking distance from 2 different public transportation routes	1
Strategy B: Other Alternative Transports	
Single-family dwellings Option B1: Electric vehicle-ready homes Design and build electric vehicle-ready homes Option B2: Shared EV stations Install shared EV stations within 500 meters from every dwelling unit	1
Low-rise MFR (Multi Family Residential) projects Provide bicycle parking spaces and level 2 EV chargers for residents	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 private motor vehicles (cars and motor bikes) powered by fossil fuels 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: Public Transportation

All the following requirements should be met:

- All dwelling units of the project should be situated within a 500 meters walking distance from 2 existing or planned public transportation routes.
- All bus stops should be sheltered.
- Public transportation information including routes and schedules should be permanently displayed in obvious and accessible locations for all residents.

Strategy B: Other Alternative Transports

Single-family dwellings

Option B1: Electric vehicle-ready homes

With the demand for plug-in electric vehicles (EV) rapidly increasing and with most EV charging happening at home, developers are encouraged to build homes ready for Level 2 EV charging (up to 8 times faster than Level 1 EV charging).

Based on recommendations from Energy Star, to design and build electric vehicle-ready homes, the following requirements should be met:

- Pre-install conduit. Designate enough space and capacity on the main electrical panel or garage subpanel for at least a 40 amp, 230V dedicated branch circuit. Install conduit linking the electrical panel to the future location of the EV charger, near where cars will be parked (garage, driveway, etc.)
- Wire a Level 2-ready outlet. In addition to the pre-wire steps, install a 230V grounded alternating current receptacle, allowing a homeowner to purchase a plug-in Level 2 EV charger without the extra wiring expense.

Also, information on all the features that were integrated to the building to prepare for the installation of a Level 2 EV charger in the future should be handed to all home buyers, within the Sustainable Practice Guide (required in Management Prerequisite 1) or as a separate document.

Option B2: Shared EV stations

Shared EV stations with Level 2 EV chargers should be installed within 500 meters walking distance from every dwelling unit of the project.

Also, the minimum number of EV chargers to be installed should be equal to 5% of the number of dwelling units of the urban development project.

Low-rise MFR projects

In each low-rise MFR building of the project, the developer should:

- Provide covered and secured bicycle parking spaces for 15% of residents.
- Install Level 2 EV chargers for 5% of the total vehicle parking capacity of the building.

Calculations

Strategy B: Other Alternative Transports

Note: Non-integer values shall be rounded up. There should be at least one bicycle parking spots and one electric vehicle charging station in each building.

Single-family dwellings

Option B2: Shared EV stations

Calculation of the required number of EV chargers is based on the total number of dwelling units in the urban development project. It shall be calculated with the following formula:

$$Number\ of\ EV\ chargers = N_D \times 0.05$$

N_D = Total number of dwelling units in the urban development project

For C&S Homes projects with terraced houses sharing a common basement for parking: Calculation of the required number of bicycle parking spaces is based on number of residents. It shall be calculated with the following formula:

$$Number\ of\ bicycle\ parking\ spots = N_R \times 0.15$$

N_R = Number of building residents

Calculation of the required number of level 2 EV chargers is based on the total number of parking spaces. It shall be calculated with the following formula:

$$Number\ of\ level\ 2\ EV\ chargers\ = T \times 0.05$$

T = Total vehicle parking capacity (total number of parking spaces for cars and motorbikes)

Submissions

Provisional Certification Stage
Strategy A: Public Transportation
● Plans or maps indicating location of public transport stops in relation to the furthest homes of the project ● Documentation indicating the number of public transport routes by which the stops are serviced
Strategy B: Other Alternative Transports
Single-family dwellings Option B1: Electric vehicle-ready homes ● Design documents, specifications and drawings showing the conduit linking the electrical panel to the future location of the EV charger and the 230V receptacle. Option B2: Shared EV stations ● Plans indicating all shared EV stations, EV chargers, and showing walking distance from dwelling units ● Calculations demonstrating compliance with the requirements
Low-rise MFR projects ● Plans indicating all the parking spaces for cars, motorbikes and bicycles, and indicating the location of all the EV chargers ● Calculations demonstrating compliance with the requirements

Full Certification Stage

Strategy A: Public Transportation

- Photographs showing the sheltered bus stops and the information on public transportation displayed.

If not already approved at Provisional Certification or if there is any change:

- Plans or maps indicating location of public transport stops in relation to the furthest homes of the project
- Documentation indicating the number of public transport routes by which the stops are serviced

Strategy B: Other Alternative Transports

Single-family dwellings

Option B1: Electric vehicle-ready homes

- As-built electrical drawings and/or other as-built evidence showing the conduit linking the electrical panel to the future location of the EV charger and the 230V receptacle.
- Evidence showing that information on the installation of a Level 2 EV charger has been handed to all home buyers

Option B2: Shared EV stations

- As-built plans indicating all shared EV stations, EV chargers, and showing walking distance from dwelling units

If not already approved at Provisional Certification or if there is any change:

- Calculations demonstrating compliance with the requirements

Low-rise MFR projects

- Photographs of the bicycle parking spots and the EV chargers in the parking
- As-built plans indicating all the parking spaces for cars, motorbikes and bicycles, and indicating the location of all the EV chargers

If not already approved at Provisional Certification or if there is any change:

- Final as-built calculations demonstrating compliance with the requirements

SE-8 Greenery & Biophilia

Intent

To encourage the introduction of more sustainable greenery into the built environment.

Requirements

Criteria	2 points
Provide greenery to achieve a Greenery Index higher than 1.5	1
Provide greenery to achieve a Greenery Index higher than 2.0	2

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.

Approach & Implementation

Maximize greenery onsite with the following solutions:

- Maximize vegetated areas throughout the development
- Install a maximum of trees with dense and large canopies
- Plant clusters of palm trees
- Favor shrubs and groundcovers over lawn areas
- Plant densely

Calculations

Calculations are based on the total site area of the project excluding area of residential plots. If the project installed water features including ponds, fountains, cascades, etc. but excluding swimming pools, they should also be deducted from the total site area. However, aquatic plants growing on the site (if any) should be included in calculations of Greenery Index.

Projects should perform calculations using 'LOTUS Homes C&S Pilot Calculator - SE-8 - 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:

$$Total\ leaf\ area = \sum \quad A_i \times B_i \times C_i$$

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.2.

Table SE.2: 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 & aquatic plants	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 Homes C&S Pilot Calculator - SE-8 - 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, aquatic plants, 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.1) should be considered.

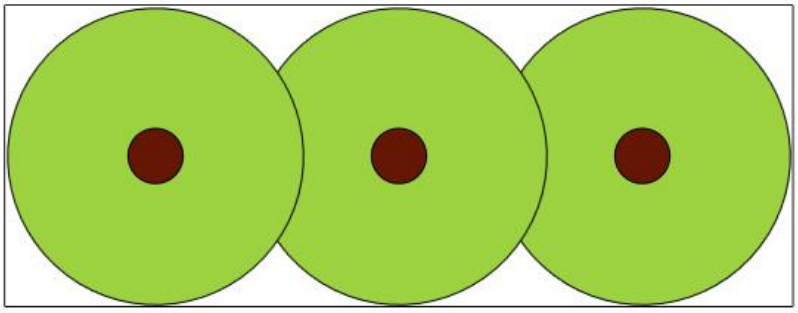


Figure SE.1: Determination of planted area for overlapping trees canopies

- 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.3.

Table SE.3: 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:

$$W = \frac{\sum \quad W_i \times A_i \times B_i \times C_i}{Site\ area}$$

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 m2 not counting area of residential plots 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.4: 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.5: 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 leaf 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 1 point can be awarded.

Exceptional Performance

One point in Credit EP-1 can be awarded if the project demonstrates that a Greenery Index higher than 2.5 has been achieved.

Submissions

Provisional Certification Stage
● 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 Homes C&S Pilot Calculator - SE-8 - 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

Full Certification Stage
● 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 Homes C&S Pilot Calculator - SE-8 - 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

SE-9 Outdoor Communal Facilities

Intent

To provide facilities for use and enjoyment by the community.

Requirements

Criteria	2 points
Provide 2 outdoor communal facilities for occupants	1
Provide 4 outdoor communal facilities for occupants	2

Overview

Outdoor communal facilities help to improve the quality of life, increase the social interactions among residents, and provide recreational and sportive activities.

Approach & Implementation

The project should provide outdoor communal facilities accessible to all residents and located within 800 meters from any C&S Homes of the development.

Provide the following types of outdoor communal facilities for residents:

- 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
- Other communal facilities may be accepted (subject to VGBC approval)

Submissions

Provisional Certification Stage
● List of all the outdoor communal facilities to be provided
● Tender site plan showing the location of the facilities

Full Certification Stage
● 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

To attain the standards expected of a LOTUS Homes 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 so that the building's design features are understood and used, ensuring the intended performance goals are met throughout the life of the building.

The concept of an "eco-charrette", is a crucial pre-design step, during which the project team made up of a minimum of the developer/client, the architect and the consultant engineers (if any), 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 design development and construction.

During the construction phase, it is necessary to limit the impacts of construction works (noise, dust, stormwater pollution, waste generation, etc.) that disturb the environment as well as the local community.

Credit/ Prerequisite	Title	Points
Man-1	Effective Design Process	1 point
Man-2	Construction Stage	1 point
Man-PR-1	Home Buyer Guidance	Prerequisite
Man-3	Home Buyer Guidance	1 point
Man-4	Green Awareness	1 point
	Total of points available	4 points

Man-1 Effective Design Process

Intent

To encourage projects to follow effective design processes in order to reach high performance.

Requirements

Criteria	1 Point
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 relies 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 3 points can be 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

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

Criteria	1 Point
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 endeavours, 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.

The Project Management shall be undertaken by internal or external individuals with experience and/or competence (i.e. have a Project Manager Certification) on the project management 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 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
● Set of Project Management documents (such as: management plan, issues log, status report, change log, requirements traceability matrix, performance report, etc.) used during construction in accordance with requirements of the Project Management framework followed ● Evidence showing the experience and/or competence of individual(s) in charge of Project Management (such as company profile, certificates, etc.)
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-PR-1 & Man-3 Home Buyer Guidance

Intent

To explain to home buyers how to select products and equipment to have as green a home as possible.

Requirements

Credit Man-3 is only available at Full Certification.

Criteria	1 point
Provide a Sustainable Practice Guide to all home buyers	Man Prerequisite 1
Provide an after-sales service to guide and assist home buyers	1

Overview

As some finishes and equipment will be left for home buyers to complete in the dwelling-units, it is necessary for the developer to guide home buyers and explain them how to select products and equipment to have as green a home as possible.

Approach & Implementation

Management Prerequisite 1:

Produce a Sustainable Practice Guide which should be an easy-to-understand but complete guide with information for home buyers about:

- Selection of air-conditioning systems that are both energy-efficient and have a limited refrigerant atmospheric impact.

  The selection of split-unit systems with 5 stars under VNEEP label and using R32 refrigerant gas should be encouraged. Also, the guide should recommend selecting equipment with the highest energy efficiency value (hiệu suất năng lượng) possible. This value is shown on the label and corresponds to the CSPF value of the air-conditioner. On the market, some air-conditioners can be found with a CSPF value higher than 7.0 and are a lot more efficient than many of the equipment with 5 stars.
- Selection of energy-efficient lighting fixtures:

  The use of LED lights should be recommended. Also, information on lumen efficacy which is a measure of how well a light source produces visible light in lumens per watt (lm/W) should be included and selection of lighting fixtures with as high lumen efficacy as possible

should be encouraged. Ideally, lighting fixtures with a lumen efficacy higher than 100 lm/W should be installed.

- Selection of energy-efficient appliances:

  For every house appliance, selection of appliances with a high score under an energy efficient label should be encouraged. Under VNEEP label, many appliances of all types reach 5 stars. For appliances outside the scope of VNEEP labelling scheme, EU energy label or Energy Star should be recommended.

Figure Man.1: VNEEP Energy label for a 5-star equipment

- Installation of an ERV (Energy recovery ventilation) system:

  This ventilation system simultaneously supplies and exhausts air from the house and allows heat and humidity to be exchanged between supply air and exhaust air, resulting in reduction of cooling demand and energy use for air-conditioning, while providing good indoor air quality if used in combination with air filtration.

- Installation of energy control solutions:

  Energy control solutions can help to reduce energy use and should be recommended:

  - Light occupancy sensors to automatically turn lights on and off based on occupancy in bathrooms, hallways, entryways, etc.
  - Light dimmers to provide variable indoor lighting in living rooms and dining rooms
  - Daylight sensors to adapt the use of artificial lighting depending on the amount of natural lighting in the areas with daylight
  - Automated shadings to optimise the use of daylight and minimize solar heat gains
  - Plug load controls to automatically turn receptacles off and on as needed

- Installation of a home energy monitor:

  A home energy monitor is an electronic device that provides feedback on electricity consumption and allows 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 behaviour and leads to a reduction of the household energy use.

Installation of a permanent home energy monitor with the following features should be recommended:

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

- Selection of water-efficient fixtures:
  - Dual flush WCs with flush rates lower than (or equal to) 3 / 4.5 liters per flush
  - Shower heads with flowrates lower than (or equal to) 0.14 liters per second
  - Bathroom and kitchen taps with flowrates lower than (or equal to) 0.12 liters per second
  - Clothes washers with a water use lower than (or equal to) 100 liters per load (8kg)
- Strategies to improve Indoor Air Quality:
  - Ventilation system supplying fresh air combined with air filtration (c.f. requirements in Credit H-1)
  - Provision of a vented range hood in the kitchen (c.f. Credit H-1)
  - Selection of low-VOC/formaldehyde emissions products for finishes: paints, coatings, adhesives, sealants, composite wood, flooring, ceiling, etc.
  - Monitoring of indoor and/or outdoor air quality
  - Use of environmentally friendly cleaning products that are less hazardous and less toxic
- Selection of sustainable materials for partitions, ceilings and floorings:
  - Selection of non-baked materials for partitions
  - Selection of materials with recycled content, rapidly renewable materials, sustainable timber, materials third-party certified based on whole lifecycle analysis, local materials…
- Strategies to minimize waste:
  - Reduce: Don’t create waste if you don’t have to.
  - Reuse: Reuse, share, sell, or give away still usable items.
  - Repair: Fix stuff before tossing it and buying new.
  - Rot: Make compost with kitchen scraps and yard trimmings
  - Recycle: Last, find a way to recycle stuff
- Benefits of using green transport alternatives.

Also, the Sustainable Practice Guide should include information to encourage:

- Selection of native and climate-adapted plant species that are water-efficient
- Growing vegetables onsite
- Composting onsite

After-sales service:

The project should provide an after-sales service to guide and assist home buyers in the fit-out works. Guidance should not be limited to but should have a strong emphasis on sustainable solutions to make houses more energy-efficient, more water-efficient and healthier. The after-sales service should include some technical experts with experience in construction/fit-out works and knowledge on sustainable solutions.

Submissions

Provisional Certification Stage
Management Prerequisite 1
● Copy or template of the Sustainable Practice Guide ● Signed letter from the developer committing that a complete Sustainable Practice Guide will be produced and handed to all home buyers
Management Credit 3
● This Credit is not available at Provisional Certification Stage and no submissions are required.

Full Certification Stage
Management Prerequisite 1
● Evidence showing that the Sustainable Practice Guide has been and will be handed to all home buyers ● Copy of the Sustainable Practice Guide
Management Credit 3
● Evidence showing that an after-sales service is provided to all home buyers ● Evidence showing that technical experts are part of the after-sales service

Man-4 Green Awareness

Intent

To promote general public awareness on sustainability and green buildings.

Requirements

Criteria	1 Point
Perform at least two actions to promote general public awareness	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. The creation of a sustainable future strongly depends on the knowledge and participation of the people who need to have an understanding of the consequences of individual 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

Promote general public awareness about LOTUS, green buildings and sustainability by performing some of the following actions:

- Build a show house that highlights the green features of the building and provide information to increase green awareness of visitors
- Organize a green building conference/seminar including topics such as:
  - Strategies implemented by the project to achieve LOTUS Homes C&S
  - The importance of a good fit-out and selection of equipment to have efficient and healthy buildings
- Create at least three pages on the developer's website and/or on a website created specifically for the project that provide detailed information about:
  - the green features of the project,
  - the benefits of green buildings, and
  - the importance of individual behavior in achieving sustainable outcomes.
- Write and release a press release on the project and/or organize a press conference for the LOTUS Certification ceremony

- Other actions may be accepted (subject to VGBC approval)

Submissions

Provisional Certification Stage
● Report indicating the actions that will be performed to enhance general public awareness ● Signed letter of intent from the developer that the actions described in the report will be performed

Full Certification Stage
● Report indicating the actions that have been performed to enhance general public awareness ● Evidence showing that the actions have been performed such as photographs, advertisement banners/flyers, copy of press release, 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	Points
EP-1	Enhanced Performance	8 points
EP-2	Innovative Solutions	
	Total of points available	8 points

EP-1 Enhanced Performance

Intent

To encourage exceptional performance and recognize projects that achieve environmental benefits in excess of the current LOTUS rating system benchmarks.

Requirements

Criteria	8 Points
Significantly exceed the credit requirements of LOTUS Homes C&S 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 significantly exceed 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 Homes C&S 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.
Example: Credit SE-4 Stormwater Runoff

- Requirement (Level 1) – average perviousness of the site is at least 30%
- Requirement (Level 2) – average perviousness of the site is at least 50%
- Surpass by the next increment – average perviousness of the site is at least 70%.

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 Man-1 Effective Design Process

- Strategy A – An integrated design process has been followed.
- Strategy B – A coordinated BIM model has been used to design the buildings.
- The building can be awarded 1 point in Credit Man-1 and 1 point in credit EP-1.

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

Intent

To promote innovative solutions that are not considered in LOTUS Homes C&S.

Requirements

Criteria	8 Points
Implement innovative solutions that are outside the scope of LOTUS Homes C&S	1-8

Overview

LOTUS Homes C&S 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 Homes C&S 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 VGBC 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 an Assessment 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 duration of 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 Certification stage by the VGBC Representative. 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 the LOTUS Certificate. 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. Buildings that apply for LOTUS certification are obliged to fulfil all the prerequisites in the LOTUS rating system. 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 VGBC Representative for assessment.

Submission Section - In each Credit, the Submission Section details all the documentation that projects must submit to the Assessment Organization to demonstrate compliance with the credit.

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.

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.

Delivery note - A document accompanying a shipment of goods that lists the description and quantity of the goods delivered.

Drawings - Technical drawings that communicate how to construct (or, in the case of as-built drawings, how was constructed) the building. Drawings include architectural drawings (floor plans, site plans, elevations, sections, detail drawings, etc.), structural, electrical, mechanical, plumbing and finishing drawings.

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.

Letter - A written or printed communication addressed to a person or an organization.

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.

Photographs - Photographs can be used as evidence to show that a strategy has been implemented, a piece of equipment has been installed, etc. The following requirements must be met when submitting photographs as evidence:

- Photographs should be dated
- Photographs should not be blurry or distorted
- Several photographs (at varying levels of proximity) should be taken for each green feature meeting LOTUS requirements. In this manner, both the general location and

the specifics (model name, rated power input, etc.) of the green feature can be observed.

- All measures concerning a credit within a project must be verified with a photograph

Report - 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 Plan - 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.

Tender 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.

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.

Hardscaping - The practice of landscaping that refers to paved areas like streets & sidewalks, large business complexes & housing developments and other industrial areas.

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

Vegetated Area - Any areas on the building site that are not paved and have plant cover.

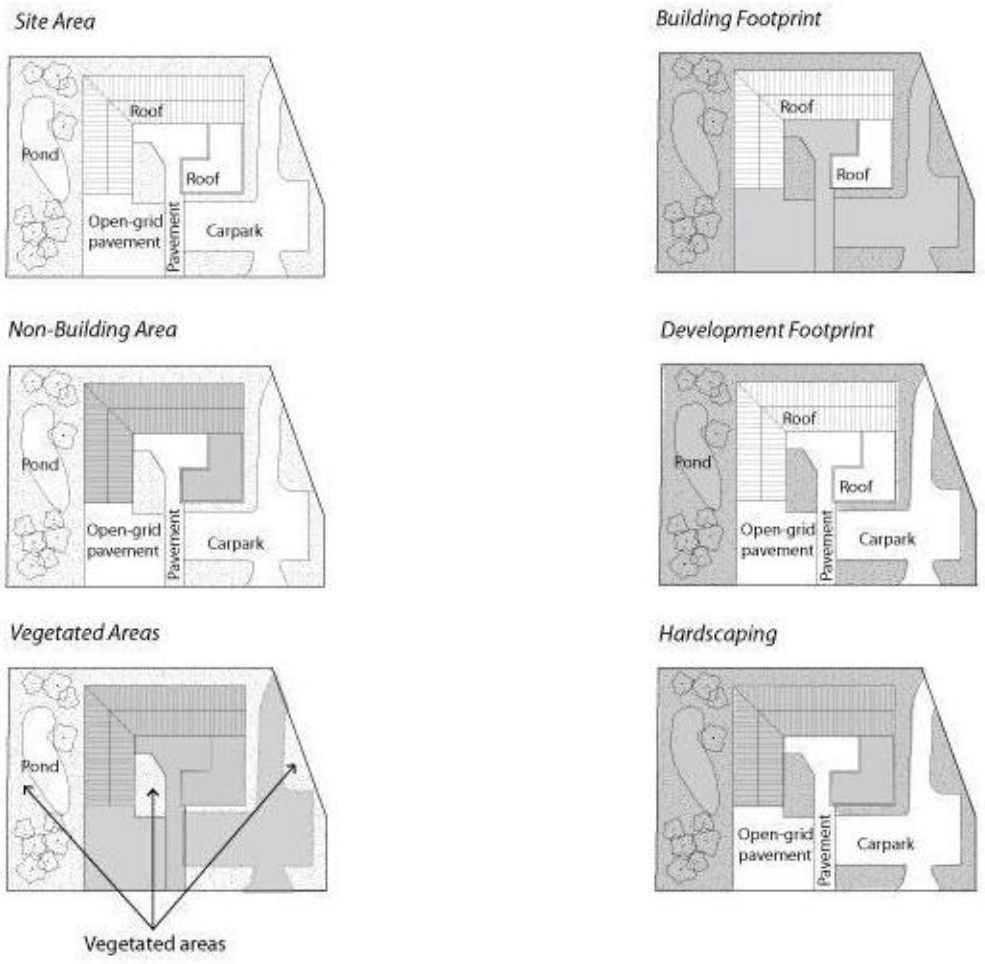


Figure G.1: Site area illustrations

Technical Terms

Baseline building - A baseline building is used to compare the performance of the project (referred to as “proposed building”) with standard, typical buildings. The baseline building inherits characteristics of the project (e.g. orientation, GFA, number of occupants, number of floors, shape, local weather conditions, number of operational days, etc.), but, the materials and equipment used in the baseline model are conventional ones, as opposed to the proposed building, to which green and efficient practices will be applied.

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.

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 (CPSF) - As defined in ISO 5151, CPSF 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, CPSF represents the efficiency over a full year of operation.

Daylight factor (DF) - DF is the ratio of the light level inside a room to the light level outdoors. It is used to assess the internal natural lighting levels as perceived on working planes or surfaces.

Dwelling-unit - Also called housing unit. It is a room or group of rooms providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation. For a room or apartment to be defined as a dwelling-unit, it must be distinctly separated from the other living spaces within the building.

Fenestration - Any light-transmitting component in a building wall or roof. The fenestration includes glazing material (which may be glass or plastic), framing, external shading devices, internal shading devices, and integral (between-glass) shading devices.

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 (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) 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.

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.

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 lighting - 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.

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 Habitable Area - The total area of all the habitable spaces in a building.

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.

Openable area of openings - The openable area (also sometimes referred to as free area, effective open area, operable area, etc.) of an opening represents the area through which outdoor air can flow. It depends on the size and the type of openings. In LOTUS, the openable area of an opening can be determined using 2 different methods:

- It can be calculated as the total area of the opening (area of fixed frames should be deducted) multiplied with the effective open area coefficient of the opening set as:
  - 100% for openings with no windows/doors,
  - 90% for casement (side-hung) openings (that open outwards and/or inwards) with no restrictors,
  - 75% for jalousie windows (louvered windows),
  - 75% for awnings (top-hung windows that open outward, away from the building),
  - 50% for openings with fixed louvers,
  - 45% for hoppers (bottom-hung windows that open inward, into the building)
  - 45% for horizontal sliding openings.
- Or, it can be calculated using geometry to determine the net free unobstructed area of the opening through which outdoor air can flow.

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 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.

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.

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.

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.

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.

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.

WWR (window to wall ratio) - The WWR of a facade is the glazing area of the facade (including mullions and frames) divided by the total external wall area of the facade. In WWR calculations, spandrel glass (opaque panels covering structural elements or other layers of materials) should not be considered as glazing but as solid wall.

Xeriscaping - Landscaping that minimizes the need for supplemented watering. Xeriscaping is particularly encouraged in areas where freshwater accessibility is limited.

Annex 1: Procedures for projects with different Homes

Credit/Strategy/ Option	Strategy/ Option	Procedures for Group Certification of different types of Homes
E-1 Net-Zero Energy-Ready Home		All the C&S Homes of the project should individually demonstrate that it is net-zero energy ready following the requirements of the Technical Manual and the Net-zero energy-ready C&S Homes Guidelines. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of C&S Homes are worse-performing, energy simulation and calculations showing net-zero energy readiness are only required for these C&S Homes. If they can achieve compliance, other types of Homes will also be considered as compliant.
E-2 Passive Design	Strategy A	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the east and west facades areas of all the C&S Homes of the project.
E-2 Passive Design	Strategy B	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the WWR of the east and west facades of all the Homes of the project. Exception: For projects with many different types of Homes: When projects can demonstrate with a rule of thumb method that some types of C&S Homes are worse-performing, calculations of the WWR of the east and west facades can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.
E-2 Passive Design	Strategy C	All the C&S Homes of the project should individually demonstrate that it is compliant with the requirements of the Technical Manual.
E-3 Building Envelope	Strategy A	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the average R-value of the walls of all the C&S Homes of the project. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of Homes are worse-performing, calculations of the average R-value of the walls can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.
E-3 Building Envelope	Strategy B	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the average R-value of the roofs of all the C&S Homes of the project. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of C&S Homes are worse-performing, calculations of the average R-value of the roofs can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.
E-3 Building Envelope	Strategy C	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the average SHGC values of glazing of all the Homes of the project. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of Homes are worse-performing, calculations of the average SHGC values of glazing can be performed only for these C&S Homes. Then, points will be awarded based

		on the average performance of these C&S Homes.
E-3 Building Envelope	Strategy D	All the C&S Homes of the project should individually demonstrate that strategies to reduce the solar radiation have been implemented.
E-4 Natural Home Cooling	Strategy A	All the C&S Homes of the project should individually demonstrate that a vent column or an effective rooftop turbine vent has been installed.
E-4 Natural Home Cooling	Strategy B	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the percentage of living rooms and bedrooms of all the Homes of the project which are designed with effective cross ventilation. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of Homes are worse-performing, calculations of the percentage of living rooms and bedrooms which are designed with effective cross ventilation can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.
E-5 Renewable Energy	Option A	All the C&S Homes of the project should individually demonstrate that it is solar PV-ready following the requirements of the Technical Manual.
E-5 Renewable Energy	Option B	All the C&S Homes of the project should individually demonstrate that it is compliant with the requirements of the Technical Manual.
E-6 Solar Hot Water-Ready Home		All the C&S Homes of the project should individually demonstrate that it is solar hot water-ready following the requirements of the Technical Manual.
W-1 Rainwater Harvesting		For 1 point, all the C&S Homes of the project should individually demonstrate that rainwater harvesting-ready following the requirements of the Technical Manual. For 2 points, all the C&S Homes of the project should individually demonstrate that a rainwater harvesting system has been installed.
MR-1 Environmental Impact of Construction Materials	Strategy A	For 1 point, the project should calculate the total cradle-to-gate embodied carbon of all the C&S Homes of the project. For 2 points, the project should demonstrate that the total cradle-to-gate embodied carbon of all the C&S Homes of the project has been reduced by optimizing design.
MR-1 Environmental Impact of Construction Materials	Strategy B	For 1 point, the project should calculate the total environmental impacts of all the Homes of the project through life-cycle assessment. For 2 points, the project should demonstrate that the total environmental impacts of all the C&S Homes of the project have been reduced by optimizing design using lifecycle assessment.
MR-2 Reduced Concrete Use	Strategy A	All the C&S Homes of the project should individually demonstrate that it is built with slabs that reduce concrete use.
MR-2 Reduced Concrete Use	Strategy B	All the C&S Homes of the project should individually demonstrate that it is built with beams and columns that reduce concrete use.
MR-2 Reduced Concrete Use	Strategy C	All the C&S Homes of the project should individually demonstrate that it is built with non-structural systems that reduce concrete use.

MR-4 Non-baked Materials		Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the percentage of all the non-structural walls of all the C&S Homes that are made up of non-baked materials. Exception: For projects with many different types of C&S Homes S: When projects can demonstrate with a rule of thumb method that some types of C&S Homes are worse-performing, calculations of the percentage of non-structural walls that are made up of non-baked materials can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes S.
MR-5 Demolition and Construction Waste	Strategy A	The project should implement a single Waste Management Plan for all C&S Homes. Then, the performance should be calculated considering the total amount of demolition and construction waste generated by the construction of all the C&S Homes of the project.
MR-5 Demolition and Construction Waste	Strategy B	For all C&S Homes, the project should implement a single Waste Management Plan and should implement at least 2 strategies to reduce the waste generation during construction.
MR-3 Sustainable Materials		Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the percentage of the total value of the materials in the project that is from sustainable materials. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of Homes C&S are worse-performing, calculations of the percentage of non-structural walls that are made up of non-baked materials can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.
MR-6 Operation Waste Management		All the C&S Homes of the project should individually demonstrate that it is compliant with the requirements of the Technical Manual.
H-1 Ventilation for indoor air quality	Strategy A	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the percentage of the total net habitable area of all the C&S Homes of the project that is supplied with sufficient fresh air.
H-1 Ventilation for indoor air quality	Strategy B	All the C&S Homes of the project should individually demonstrate that air filters have been installed on fresh air intakes.
H-1 Ventilation for indoor air quality	Strategy C	All the C&S Homes of the project should individually demonstrate that a local exhaust system has been installed in wet areas.
H-2 Daylighting	Option A	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the percentage of the habitable spaces of all the C&S Homes of the project that has an average daylight factor above 1.5%. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of C&S Homes are worse-performing, calculations of the percentage of the habitable spaces that has an average daylight factor above 1.5% can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.

H-2 Daylighting	Option B	Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the percentage of net habitable area of all the Homes of the project that is compliant with the requirements. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of C&S Homes are worse-performing, calculations of the percentage of net habitable area that is compliant with the requirements can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.
H-3 Acoustic Comfort		All the C&S Homes of the project should individually demonstrate that it is compliant with the requirements of the Technical Manual.
SE-1 Site Selection		All the C&S Homes of the project should be located on a redevelopment site.
SE-2 Disaster resilience	Strategy A	All the C&S Homes of the project should be designed to be resistant to floods.
SE-2 Disaster resilience	Strategy B	All the C&S Homes of the project should be designed to be resistant to typhoons.
SE-3 Development Footprint		Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the percentage of the total site area of all the Homes of the project that is undeveloped. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of Homes are worse-performing, calculations of the percentage of the total site area that is undeveloped can be performed only for these Homes C&S. Then, points will be awarded based on the average performance of these Homes C&S.
SE-4 Stormwater Runoff		Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the average perviousness of the sites of all the C&S Homes of the project. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of Homes are worse-performing, calculations of the average site perviousness can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.
SE-5 Heat Island Effect		Points are awarded based on the average performance of all the C&S Homes of the project. The project should calculate the percentage of the paved and roof area that limits the heat island effect considering all the C&S Homes of the project. Exception: For projects with many different types of C&S Homes: When projects can demonstrate with a rule of thumb method that some types of C&S Homes are worse-performing, calculations of the percentage of the paved and roof area that limits the heat island effect can be performed only for these C&S Homes. Then, points will be awarded based on the average performance of these C&S Homes.
SE-6 Construction Activity Pollution Control		The project should implement strategies to limit pollution arising from the construction activities of all the C&S Homes of the project.
SE-7 Green Transportation	Strategy A	N/A
SE-7 Green Transportation Requirement for Single-family dwellings	Option B1	All the C&S Homes of the project should individually demonstrate that it is electric vehicle-ready following the requirements of the Technical Manual.

SE-7 Green Transportation Requirement for Single-family dwellings	Option B2	The project should install shared EV stations within 500 meters from every C&S Homes of the project.
SE-7 Green Transportation Requirements for Low-rise MFR projects		The project should provide bicycle parking spaces and level 2 EV chargers for residents of all the C&S Homes of the project.
SE-8 Greenery & Biophilia		N/A
SE-9 Outdoor Communal Facilities		N/A
Man-1 Effective Design Process	Strategy A	All the C&S Homes of the project should be designed following an integrated design process.
Man-1 Effective Design Process	Strategy B	All the C&S Homes of the project should be designed using a coordinated BIM model.
Man-1 Effective Design Process	Strategy C	The project should demonstrate that the design of all the C&S Homes is cost-effective.
Man-2 Construction Stage	Strategy A	Project management for the construction of all the C&S Homes of the project should be performed in accordance with an internationally recognized system.
Man-2 Construction Stage	Strategy B	The project should conduct training on the green aspects of the building design for all the trades (M&E and Civil works) involved in the project.
Man-PR-1 Home Buyer Guidance		The project should provide a Sustainable Practice Guide to all home buyers.
Man-3 Home Buyer Guidance		The project should provide an after-sales service to guide and assist home buyers for all the C&S Homes of the project.
Man-4 Green Awareness		N/A