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

LOTUS Homes V1

Technical Manual
September 2017

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LOTUS Homes Authors and contributors

Lead Authors

Samantha Miller, Xavier Leulliette

Supporting Authors

Hugo Fontourcy, Melissa Merryweather, Vũ Hồng Phong

Contributors

Charles Gallavardin, Dung Thanh Nguyen , Ho Minh Nhat, Nguyen Chi Tam, Nguyen Duc An, Nguyen Van Muon, Nicolas Jallade, Patrick Bivona, Phạm Hoàng Trung, Tim Middleton, Yannick Millet

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The VGBC would also like to thank its generous and valuable members (as of September 2017):

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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

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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 Non-Residential (LOTUS NR)
- LOTUS Multi-family Residential (LOTUS MFR)
- LOTUS Building in Operation (LOTUS BIO)
- LOTUS Homes
- LOTUS Small Buildings (LOTUS SB)
- LOTUS Interiors
- LOTUS Small Interiors (LOTUS SI)

LOTUS Accreditation for Professional Practitioners

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

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

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LOTUS Homes Rating System

Scope and Eligibility

LOTUS Homes is used for single family dwellings. These are formally described as individual residential houses under QCVN 03:2012/BXD & Circular 12/2012/TT-BXD, dated on 28.12.2012. The following types of development are covered by this description:

- Villas: detached villa, semi-detached villa, deluxe villa and resort villa
- Terraced house: Townhouse, terraced house with garden
- Traditional rural house

LOTUS Homes can also be used for:

- Individual villas built in developments such as resorts.
- Refurbishment projects

For such projects, a close liaison with VGBC or a LOTUS AP will be necessary to ensure that certification is achievable.

Apartment buildings and Hostels, as defined under QCVN 03:2012/BXD & Circular 12/2012/TT-BXD, are not eligible for certification under LOTUS Homes.

Categories

LOTUS Homes is composed of 6 Categories (plus “Innovation”), each containing a varying number of Credits. Against each credit, specific criteria have been set carrying individual scoring points.

Energy (E) - To monitor and reduce the energy consumption of a building through, for example, passive design, the use of natural ventilation and the installation of energy-efficient equipment (HVAC, lighting, water heater, etc.).

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

Materials (M) - To encourage use of sustainable materials and reduce use of high-embodied-energy materials, for example through the use of re-used and/or recycled materials.

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Local Environment (LE) - To protect the ecology of the site of the building and surrounding area, to encourage recycling practices, and to integrate adaptation and mitigation strategies.

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

Community and Management (CM) - To increase the awareness of how buildings affect the community and to ensure that, throughout the project, all targets set up are competently and effectively managed.

In addition to the above categories, an "Innovation" (Inn) category rewards exceptional performance or initiatives which are not specifically addressed by LOTUS. This category awards additional "bonus" points.

Prerequisites

Unlike other LOTUS rating systems, LOTUS Homes does not encompass any prerequisite.

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.

Options and strategies

Some credits can be satisfied through different options or strategies. A project can select only one option with its assigned points. A project can implement any or all strategies and accumulate points for the credit (while being restricted by the maximum number of points).

Best practice credits

LOTUS Homes include some best practice credits rewarding bonus points for achieving best practice in design and construction. Best practice credits often require extra calculations or sophisticated documentation. These credits may be aspirational and not easily achievable for most projects, so, projects that do not achieve these credits will not lose points and the overall certification level will not be affected. Best practice credits are listed in the Appendix A.

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Performance and Prescriptive paths

Some credits, options or strategies in LOTUS Homes can be achieved with either a Prescriptive path or a Performance path.

The Prescriptive path requires specific solutions and is a "black-and-white" approach. The Performance path provides flexibility so that a design team may design a solution taking into account project requirements. A project may choose a Performance path for one credit and a Prescriptive path for another.

All the Performance paths are listed in Appendix B.

Weighting

The current weighting of categories within LOTUS Homes (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 Weighting

Categories	Weight (%)	Points	Bonus Points
Energy	30%	24	5
Water	10%	8	4
Materials	17.5%	14	0
Health & Comfort	13.75%	11	3
Local Environment	20%	16	1
Community & Management	8.75%	7	3
Innovation	0%	0	4
Total	100 %	80	20

Certification Levels

There will be 80 points available in LOTUS Homes, plus up to 20 bonus points available with the best practice credits and the Innovation category. The thresholds for Certification Levels have been kept similar to the other LOTUS rating systems.

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The first certification level for LOTUS Homes has been benchmarked at 40% (LOTUS Certified) of the total amount of points excluding bonus points. 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.

Uncertified	Certified	Silver	Gold	Platinum
0-39% 0-31 points	40-54% 32-43 points	55-64% 44-51 points	65-74% 52-59 points	≥ 75% ≥ 60 points

Figure 1: Certification System & Performance levels

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LOTUS Homes 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 Timeline

LOTUS Homes Certification happens in the following steps:

- Application and Registration
- Pre-assessment stage (optional)
- Certification stage

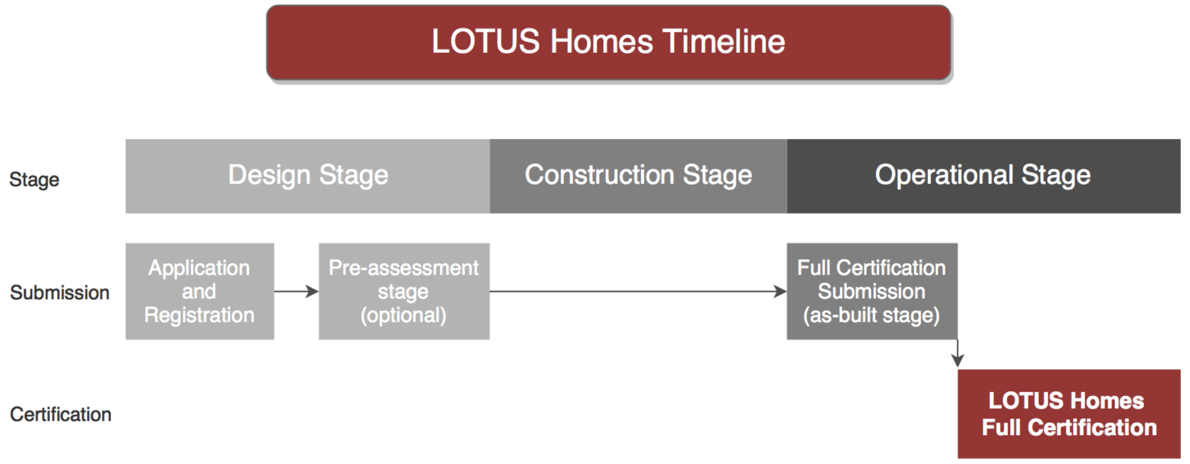

Figure 2: LOTUS Homes Timeline

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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 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 signed copy of the certification agreement, an Assessment Fee will be invoiced and must be paid prior to any submission of documentation. The project registration is complete when the Assessment Fee is paid. The Applicant will then be issued with a Project Identification Number (PIN) and assigned an Assessment Organization Representative for the certification process.

Pre-assessment stage

During the design stage the Applicant may prepare the submissions for the Pre-assessment stage, which is optional. The Pre-assessment stage aims to verify that the project is on right track with realistic targets, no mistakes, a safety margin for certification, etc.

At Pre-assessment stage, the content of submissions is simplified to a minimum. The Applicant should fill in the User Tool (described below in *Submissions*) to define the pathway and targets for the project and to understand clearly what needs to be done for Certification. Only few of the credits that will be targeted at Certification stage may be completed for Pre-assessment and no further documentation is required.

The Assessment Organization will reply to the Applicant in 10 working days and provide an Assessment Report including corrections, advices and recommendations. As such, no definitive score and no certification will be given at Pre-assessment stage.

The VGBC strongly encourages projects to follow this stage in order to have a successful Certification.

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Certification stage

The Certification Stage is the actual stage of submission for certification under LOTUS Homes. It should happen at the end of the construction stage.

Round 1

The Applicant Representative submits the fully completed User Tool along with all required documentation (as specified in the Submissions section of credits).

The data supplied will be assessed by the Assessment Organization. Results of the assessment will be provided to the Applicant Representative within 20 working days of the submission date.
Based on the results of the assessment of the Certification Submission, a LOTUS Small Buildings Certificate will be issued.

Round 2

In case that submission for any credit submitted for LOTUS Certification is denied, or if the Applicant would like the opportunity to score higher for that credit, a second round of submissions for re-assessment is available to projects. This round will give the possibility to provide further evidence to demonstrate to the Assessment Organization that pending credits have finally been achieved. There is no limit to the number of credits that may be re-submitted, and the applicant is encouraged to re-submit all queried credits so long as they can provide new submittal information.

Results of the assessment will be provided to the Applicant Representative within 20 working days of the submission date. In special cases further appeals and/or applications may be permitted, however these may generate additional fees.

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

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LOTUS Homes Submissions

At Certification stage, for each credit pursued, supporting evidence demonstrating that a project meets the requirements of the credit targeted should be submitted. The list of documents to provide is given in the 'Submissions' section of each credit. Definition of the different terms is provided in the Glossary under the 'LOTUS Submission Terms' section.

In LOTUS Homes, documents drawn by hand such as drawings, plans, elevations, etc. will be accepted by the Assessment Organization as long as they are signed and legible.

Once payment for the Assessment Fee has been received, the Assessment Organization Representative provides the Applicant Representative with a complete package of documentation that includes the Project Submission Folder and a Resources folder.

Project Submission Folder

The Project Submission Folder is the main folder provided that, upon completion, should be returned to the Assessment Organization Representative for assessment. The Project Submission Folder contains 7 category folders for the 7 LOTUS Homes Categories. Within each of these folders, the Applicant should include all the supporting evidence for the credits of the category that are pursued

Resources Folder

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

- LOTUS Homes V1 - User Tool
- LOTUS Calculator - OTTV Calculation. VGBC strongly encourages the use of this tool to perform the OTTV calculations necessary for E-BPC-1 OTTV calculation or to perform U-values calculations for E-2 Building Envelope – Performance Path.

User Tool

The main material to LOTUS Homes Submissions is the LOTUS Homes User Tool. This tool is a template for the applicant to:

- have a complete overview of LOTUS Homes
- complete all the information and perform all the calculations required in the credits

The User Tool has been developed in such a way that the users only need to fill in some relevant information about the project and all the results are computed automatically.

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LOTUS Homes Credit list

Note: Best practice credits are included in Appendix A and are not listed below.

Credit	Title	Points
	ENERGY	24 points
E-1	Passive Design	5
E-2	Building Envelope	4
E-3	Home Cooling	6
E-4	Artificial Lighting	3
E-5	Water heating	2
E-6	Energy Efficient Appliances	3
E-7	Energy Monitors	1
	WATER	8 points
W-1	Water Efficient Fixtures	5
W-2	Water Efficient Landscaping	2
W-3	Drinking Water	1
	MATERIALS	14 points
M-1	Building Structure Materials	3
M-2	Non-structural Walls	3
M-3	Windows and Doors	2
M-4	Flooring Materials	2
M-5	Roofing Materials	2
M-6	Furniture	2
	HEALTH & COMFORT	11 points
H-1	Fresh Air Supply	2
H-2	Ventilation in Wet Areas	1
H-3	Low-VOC Emissions	4
H-4	Daylighting	3
H-5	Acoustic Comfort	1

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LOCAL ENVIRONMENT		16 points
LE-1	Site Selection	5
LE-2	Site Design	2
LE-3	Vegetation	2
LE-4	Heat Island Effect	2
LE-5	Flood Risk Mitigation	1
LE-6	Stormwater Runoff	2
LE-7	Refrigerants	1
LE-8	Waste Management	1
COMMUNITY & MANAGEMENT		7 points
CM-1	Design Management	1
CM-2	Construction Management	5
CM-3	Operational Management	1
INNOVATION		4 bonus points
Inn-1	Exceptional Performance Enhancement	4
Inn-2	Innovative techniques/initiative	

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Energy

As urbanization is speeding 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.

For developing countries like 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 reduce their energy consumption up to 50%, thus climate change improvement can be realized.

With this target in mind, LOTUS Homes rewards efforts taken to reduce the building energy consumption through passive design, optimized thermal performance, incorporation of natural ventilation and energy efficient technologies, as well as utilizing sustainable energy sources.

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Energy		24 points
Item	Criteria	Points
E-1	Passive Design	5 points
	Strategy A: East and west facade	
	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
E-2	Building Envelope	4 points
	Strategy A: Heat transfer through walls	
	All the external walls are made with any or any combination of the following: AAC blocks, a layer of insulation material with a thickness of at least 40mm, lightweight hollow blocks or equivalent.	1
	Strategy B: Heat transfer through roofs	
	All the roofs are made with any or any combination of the following: An air layer of at least 40mm, a layer of insulation material with a thickness of at least 40mm, a fixed sunshade, a green roof or equivalent.	1
	Strategy C: Solar radiation through windows	
	All the glazing systems installed are any or any combination of the following: solar control glasses or low solar heat gain low-E double glazing windows	1
	Strategy D: Solar radiation on solid surfaces	
	Limit solar radiation on 95% of the solid surfaces	1

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Item	Criteria	Points
E-3	Home cooling	6 points
	Strategy A: Natural cooling	
	Strategy A1: Stack Ventilation Install a vent column or an effective rooftop turbine vent to create stack ventilation	1
	Strategy A2: Minimized use of air-conditioning For 3 points, only bedrooms are equipped with air-conditioning systems For 6 points, no air-conditioning system is installed in the building	6
	Strategy B: Mechanical cooling with air-conditioning system	
	Strategy B1: Variable speed compressors All air-conditioners are equipped with variable speed compressors	1
	Strategy B2: Energy efficient air-conditioners For 1 point, all air-conditioners have at least 3 stars in the energy labelling program of VNEEP For 2 points, all air-conditioners have at least 4 stars in the energy labelling program of VNEEP For 3 points, all air-conditioners have 5 stars in the energy labelling program of VNEEP	3
E-4	Artificial Lighting	3 points
	Average luminous efficacy is higher than 60 lm/W	1
	Average luminous efficacy is higher than 70 lm/W	2
	Average luminous efficacy is higher than 80 lm/W	3
E-5	Water Heating	2 points
	Option A: Solar water heating	
	Solar thermal system produces the domestic hot water	2
	Option B: Heat pump water heating	
	Heat pump water heater produces the domestic hot water	2
E-6	Energy Efficient Appliances	3 points
	40% of appliances and equipment installed have an energy efficiency label	1
	1 point for every additional 20% of appliances and equipment installed that have an energy efficiency label (up to 80%)	3
E-7	Energy Monitor	1 point
	Install a home energy monitor to record electricity consumption	1

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E-1 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	5 points
Strategy A: East and west facade	
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 building's exposure to the sun. With less heat entering the building, this will result in an improved comfort and a decreased energy consumption.

Approach & Implementation

Strategy A: East and west facade

The buildings should be oriented in such 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).

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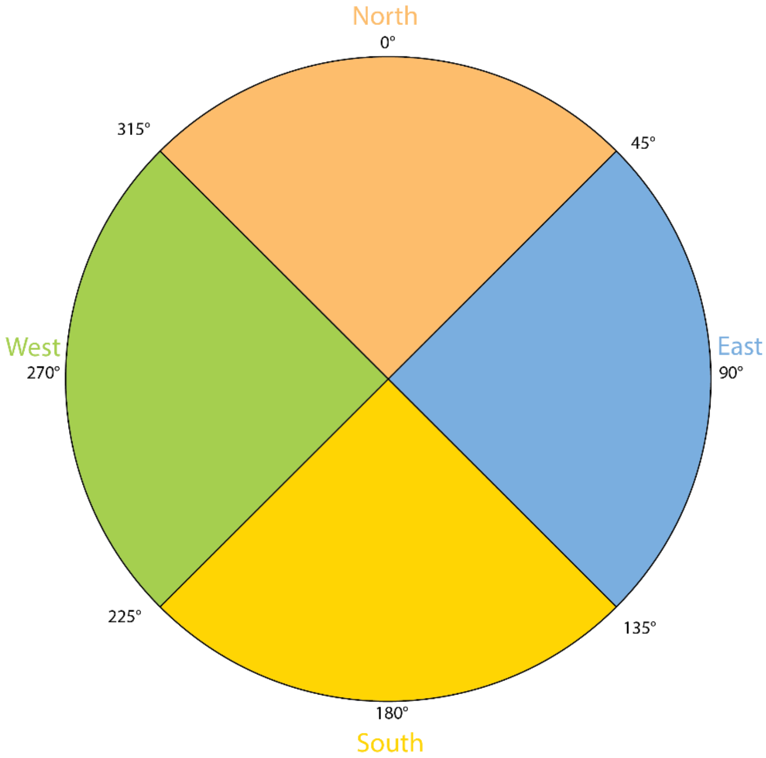

Figure E.1: Definition of the different facing façades

Strategy B: Window-to-wall ratio

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

Strategy C: Shading devices

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

- horizontal overhangs that achieves 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.

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Table E.1: A coefficient for horizontal sunshades placed on or above the upper window edge (*Source: Table 2.4 of VBEEC*)

R = b / H	N	NE or NW	E or W	SE or SW	S
0.10	1.23	1.11	1.09	1.14	1.20
0.20	1.43	1.23	1.19	1.28	1.39
0.30	1.56	1.35	1.3	1.45	1.39
0.40	1.64	1.47	1.41	1.59	1.39
0.50	1.69	1.59	1.54	1.75	1.39
0.60	1.75	1.69	1.64	1.89	1.39
0.70	1.79	1.82	1.82	2.00	1.39
0.80	1.82	1.89	1.89	2.13	1.39
0.90	1.85	2.00	2	2.22	1.39
1.00	1.85	2.08	2.08	2.27	1.39

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%.

All strategies:

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

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

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

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

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

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-1.

Submissions

Certification Stage
Strategy A: East and west facade
• Elevations showing the size of the facades • Photographs of the facades
Strategy B: Window-to-wall ratio
• Elevations showing the glazing areas and their size • Photographs of the facades showing the glazing areas
Strategy C: Shading devices
• Plans and elevations showing the shading devices and their size • Photographs of the facades showing the shading devices

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E-2 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

Projects can follow the requirements below or follow the performance path in Appendix B.

Criteria	4 points
Strategy A: Heat transfer through walls	
All the external walls are made with any or any combination of the following: AAC blocks, a layer of insulation material with a thickness of at least 40mm, lightweight hollow blocks or equivalent.	1
Strategy B: Heat transfer through roofs	
All the roofs are made with any or any combination of the following: An air layer of at least 40mm, a layer of insulation material with a thickness of at least 40mm, a fixed sunshade, a green roof or equivalent.	1
Strategy C: Solar radiation through windows	
All the glazing systems installed are any or any combination of the following: solar control glasses or low solar heat gain low-E double glazing windows	1
Strategy D: Solar radiation on solid surfaces	
Limit solar radiation on 95% of the solid 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, the 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.

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Approach & Implementation

Strategy A: Heat transfer through walls

All the external walls are made with any or any combination of the following:

- AAC blocks,
- a layer of insulation material (material with a thermal conductivity ≤ 0.05 W/m.K) with a thickness of at least 40mm,
- lightweight hollow blocks
- materials, techniques with an equivalent performance (subject to VGBC approval)

Strategy B: Heat transfer through roofs

All the roofs are made with any or any combination of the following:

- an air layer of at least 40mm,
- a layer of insulation material (material with a thermal conductivity ≤ 0.05 W/m.K) with a thickness of at least 40mm
- a fixed sunshade (it must be installed at a minimum clearance of 0.3 m from the roof surface to have ventilation between the roof and the sunshade)
- a green roof
- materials, techniques with an equivalent performance (subject to VGBC approval)

Strategy C: Solar radiation through windows

All the glazing systems installed are any of the following:

- solar control glass
- double-glazed, low-solar-gain low-E glazing

Solar control glass is a type of glass provided with a solar control coating that allows sunlight to pass through a window or façade while radiating and reflecting away a large degree of the sun's heat.

Similarly, double-glazed, low-solar-gain low-E glazing reduce solar heat gain while retaining a relatively high visible transmittance thanks to a low-E coating. But compared to solar control glass, double glazed glass have a better thermal performance and help to limit heat transfer through windows.

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Strategy D: Solar radiation on solid surfaces

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

- 95% of the solid 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 solid walls surface should meet any or any combination of the following:
  - Have a solar reflectivity > 0.4
  - Be green walls
  - Have external shadings

Under this strategy, as solar reflectivity values are not always provided by manufacturers, all white-coloured solid surfaces will be considered as having a solar reflectivity higher than 0.7.

Submissions

Certification Stage
Strategy A: Heat transfer through walls
• Evidence showing the materials used for the external walls assemblies such as as-built drawings, photographs, etc. • Evidence showing the thermal performance of the materials used such as manufacturer's published data, photographs, etc.
Strategy B: Heat transfer through roofs
• Evidence showing the materials used for the roof assemblies such as as-built drawings, photographs, etc. • Evidence showing the thermal performance of the materials used such as manufacturer's published data, photographs, etc.
Strategy C: Solar radiation through windows
• Evidence showing the types of glazing systems used such as as-built drawings/elevations, photographs, etc. • Evidence showing the thermal performance of the materials used such as manufacturer's published data, photographs, etc.
Strategy D: Solar radiation on solid surfaces
• Evidence showing the types of solid surfaces installed such as as-built drawings/elevations, photographs, etc. • For surfaces with high solar reflectivity, evidence justifying the high solar reflectivity value such as manufacturer's published data, photographs, etc.

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E-3 Home Cooling

Intent

To reduce the need for HVAC systems and increase natural air flow and to encourage the installation of energy efficient HVAC systems.

Requirements

Projects can follow the requirements below or follow the performance path in Appendix B.

Note: Under credit E-3, it is possible to follow the prescriptive path for one strategy and follow the performance path for the other strategy.

Criteria	6 points
Strategy A: Natural cooling	
Strategy A1: Stack Ventilation Install a vent column or an effective rooftop turbine vent to create stack ventilation	1
Strategy A2: Minimized use of air-conditioning For 3 points, only bedrooms should be equipped with air-conditioning systems For 6 points, no air-conditioning system should be installed in the building	6
Strategy B: Mechanical cooling with air-conditioning system	
Strategy B1: Variable speed compressors All air-conditioners are equipped with variable speed compressors (inverters)	1
Strategy B2: Energy efficient air-conditioners For 1 point, all air-conditioners should have at least 3 stars in the energy labelling program of VNEEP For 2 points, all air-conditioners should have at least 4 stars in the energy labelling program of VNEEP For 3 points, all air-conditioners should have 5 stars in the energy labelling program of VNEEP	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).

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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.

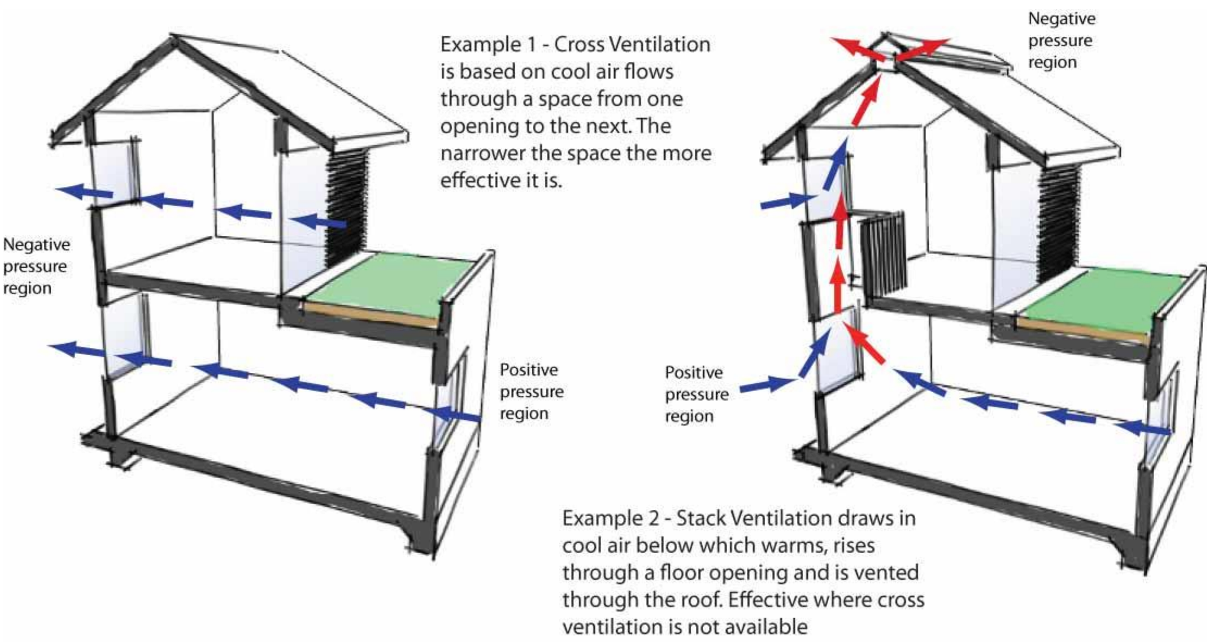

Figure E.2: Natural ventilation can be provided in a building through two methods: wind driven ventilation and stack ventilation

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.

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Approach & Implementation

Strategy A: Natural cooling

Strategy A1: 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 A2: Minimized use of air-conditioning

Minimize the use of air-conditioning by installing air-conditioning units only in the bedrooms or by not installing any air-conditioning unit at all.

To earn points following this path, ceiling fans or wall-mounted fans, with a minimum density of 1 per 20 m^2, must be provided in the living rooms, bedrooms and kitchens which are not equipped with any air-conditioning unit.

Strategy B: Mechanical cooling with air-conditioning system

Strategy B1: Variable speed compressors

Select air-conditioners systems that are equipped with variable speed compressors (often referred to as inverters for split-units) to ensure better part-load systems efficiency.

Strategy B2: Energy efficient air-conditioners

Select air conditioning systems that are labelled under the energy label developed by VNEEP and the Ministry of Industry and Trade. To make sure to select the most efficient systems, consider only the systems with 4 or 5 stars.

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Submissions

Certification Stage
Strategy A: Natural cooling
Strategy A1: Stack ventilation • Plans showing the vent column or the rooftop turbine vent with the dimensions • Photographs showing the vent column or the rooftop turbine vent
Strategy A2: Minimized use of air-conditioning • Plans showing the fans installed in the living rooms, bedrooms and kitchens without air-conditioning. • Letter of confirmation that no air-conditioning system has been used in the bedrooms -OR- in the whole house.
Strategy B: Mechanical cooling with air-conditioning system
Strategy B1: Variable speed compressors: • Technical data and/or photographs showing that the units feature inverter technology • Evidence of the air-conditioning units were installed such as photographs, invoices, etc.
Strategy A2: Energy efficient air-conditioners • Technical data and/or photographs showing the number of stars under VNEEP labelling of the air-conditioning units installed • Evidence of the air-conditioning units were installed such as photographs, invoices, etc.

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E-4 Artificial Lighting

Intent

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

Requirements

Projects can follow the requirements below or select the performance path in Appendix B.

Criteria	3 points
Average luminous efficacy is higher than 60 lm/W	1
Average luminous efficacy is higher than 70 lm/W	2
Average luminous efficacy is higher than 80 lm/W	3

Overview

Artificial lighting contributes significantly to a building overall energy consumption. The application of appropriate levels of lighting contributes to occupant well-being and building aesthetics. Using efficient lighting fixtures to reduce the amount of energy used to meet the lighting requirements of a building and its occupants is a strategy which will lower operating costs. Natural lighting can be applied, where possible, to reduce the electrical load associated with lighting requirements (c.f. Credit H-4)

Approach & Implementation

Specify lighting fixtures with high luminous efficacy (such as fluorescent T5, LED, etc.).

The luminous efficacy of a source is a measure of the efficiency with which the source provides visible light from electricity. It is the ratio of luminous flux (in lumen, lm) to power (in watts, W). Luminous efficacy values are usually included the technical data of the lighting fixtures. If missing, contact VGBC for guidance and approval. Depending on the type of lights used (for example, fluorescent T5 or LED), points may be awarded.

Submissions

Certification Stage
• Technical data of the lighting fixtures showing wattage and lumen output • Evidence of the lighting fixtures installed such as photographs, invoices, receipts, etc.

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E-5 Water Heating

Intent

To reduce the energy consumption of domestic water heating.

Requirements

Criteria	2 points
Option A: Solar water heating	
A solar thermal system produces the domestic hot water	2
Option B: Heat pump water heating	
A heat pump water heater produces the domestic hot water	2

Overview

Technologies and strategies which help to reduce the most efficiently energy consumption for water heating include solar water heating and heat pump water heating systems.

Approach & Implementation

Option A: Solar water heating

Select a properly sized solar water heating system.

Option B: Heat pump water heating

Select a properly sized heat pump water heating system with a COP value higher than VBEEC requirements (Table E.2). As the conditions of air temperature and relative humidity are not indicated in the VBEEC, use COP values calculated at conditions which are the most representative of winter conditions at the location of the project.

Table E.2: Minimum COP requirements for Heat pump water heaters (VBEEC Table 2.21)

Equipment Type	Minimum COP
Air-heated heat pumps	3
Water-heated heat pumps	3.5
Heat recovery air conditioners	
Hot water supply only	3
Air conditioning and hot water supply	3.5

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Submissions

Certification Stage
Option A: Solar water heating
• Evidence of the solar water heater installed such as photographs, invoices, receipts, etc.
Option B: Heat pump water heating
• Technical data of the heat pump water heating systems installed showing the COP values • Evidence of the heat pump water heating system installed such as photographs, invoices, receipts, etc.

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E-6 Energy Efficient Appliances

Intent

To reduce the energy consumption of equipment and appliances

Requirements

Criteria	3 points
40% of appliances and equipment installed have an energy efficiency label	1
1 point for every additional 20% of appliances and equipment installed that have an energy efficiency label (up to 80%)	3

Overview

Household appliances (refrigerators, washing machines, televisions, etc.) account for a large percent of energy consumption in houses. Careful selection of appliances and equipment that have energy efficiency labels will help to save energy and reduce environmental impact without compromising lifestyle.

Approach & Implementation

Install energy efficient equipment and appliances. All the following types of appliances and equipment should be considered in the credit:

- Washing machines
- Refrigerators and freezers
- Dishwashers
- Fans
- Televisions
- Computers (desktops and laptops)
- Displays (computer monitors)
- Rice cookers

LOTUS will consider as energy efficient appliances, all the appliances that are certified (or can demonstrate equivalent performance with the minimum requirements of the labels):

- Energy Star
- VNEEP energy label with 4 or 5 stars
- European Union Energy Label with class A label or better

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- EMSD (Hong Kong) Energy Efficiency Labelling Scheme with Grade 1 or Grade 2 labels
- EMSD's Voluntary Energy Efficiency Labelling Scheme with Recognition type label
- Australian Energy Rating Label Program with 3 stars or higher for Appliances that carry an energy label
- Australian Energy Rating Label Program MEPS for Products registered for MEPS.
- Other labels may be accepted under VGBC approval.

Calculation

Projects must calculate the percentage of energy efficient appliances and equipment with the following method:

- Identify and calculate the total rated-power of all the appliances and equipment that are considered in the credit
- Identify and calculate the total rated-power of all the energy-efficient appliances and equipment
- Calculate the percentage of energy efficient appliances and equipment installed using the following formula:

$$\text{Percentage of Energy efficient appliances } [\%] = \frac{P_{EE}}{P_T}$$

P_{EE} = Total rated-power of all the energy efficient appliances and equipment [W]

P_T = Total rated-power of all the appliances and equipment [W]

Submissions

Certification Stage
• Evidence showing that the appliances are certified under a recognised energy efficiency label such as photographs, technical data, etc. • Evidence showing that the appliances were installed such as photographs, invoices, etc.

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E-7 Energy Monitor

Intent

To have access to energy use information and encourage energy conservation.

Requirements

Criteria	1 point
Install a home energy monitor to record electricity consumption	1

Overview

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

Approach & Implementation

A permanent home energy monitor should be installed and should:

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

Submissions

Certification Stage
• Evidence showing that an energy monitor is installed such as photographs, invoice, etc. • Evidence showing that the energy monitor can analyze data at regular intervals and can provide the data to a visual display or to a PC such as photographs, technical data, etc.

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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.

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

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

Understanding the circumstance, LOTUS prioritizes the reduction of water consumption and emphasizes this in the requirements of the Water Category. Credits within this category encourage water-efficient equipment and water-efficient landscaping.

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Water		8 Points
Item	Criteria	Points
W-1	Water Efficient Fixtures	5 points
	Install the following fixtures: - 1 point for installing dual flush low flow WCs - 2 points for installing low flow shower heads - 1 point for installing low flow kitchen and bathroom taps - 1 point for low-water clothes washers	5
W-2	Water Efficient Landscaping	2 points
	Strategy A: Plant Selection	
	Select plants to minimise water demand for irrigation	1
	Strategy B: Water Efficient Irrigation System	
	Install a water efficient irrigation system	1
W-3	Drinking Water	1 point
	Install a drinking water filtration system supplying at least one faucet in the house	1

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W-1 Water Efficient Fixtures

Intent

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

Requirements

Projects can follow the requirements below or select the performance path in Appendix B.

Criteria	5 points
Install the following fixtures: - 1 point for installing dual flush low-flow WCs - 2 points for installing low-flow shower heads - 1 point for installing low-flow kitchen and bathroom taps - 1 point for low-water clothes washers	5

Overview

The world's fresh water is a finite resource that is becoming ever more increasingly polluted. Incorporating water use reduction measures such as water efficient fixtures into building designs can reduce this dependency on the ever diminishing water supplies while reduce the operational costs.

Approach & Implementation

The following fixtures should be installed:

- 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)

Submissions

Certification Stage
• Manufacturer's data for each water efficient fixtures installed showing the water usage of the fixture (flowrate, flush size and/or water use per load) • Evidence that the water efficient fixtures have been installed such as photographs, receipts, etc.

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W-2 Water Efficient Landscaping

Intent

To reduce potable water consumption on landscaping

Requirements

Projects can follow the requirements below or select the performance path in Appendix B.

Criteria	2 points
Strategy A: Plant Selection	
Select plants to minimise water demand for irrigation	1
Strategy B: Water Efficient Irrigation System	
Install a water efficient irrigation system	1

Overview

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

Approach & Implementation

The amount of domestic water used for irrigation can be reduced through a number of different strategies. In this credit applicants can demonstrate their reduction through any combination of the methods outlined in this section.

Strategy A: Plant Selection

Select plants to minimize water demand for irrigation with the following practices:

- Plant climate adapted plants (native or non-native to Vietnam) to reduce irrigation requirements. Some examples of drought resistant plants are:
  - Succulent plants: Cactus, Aloe, Euphorbiaceae family, etc.
  - Plants of Acacia genus: Acacia auriculiformis, Acacia mangiumare, etc.
- Reduce lawn areas since lawn is usually a high consumer of water

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Strategy B: Water Efficient Irrigation System

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

The following are considered as water efficient irrigation systems:

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

The following irrigation management principles should also be followed:

- Develop a precise watering plan based on the knowledge of all plants' properties in order to reduce the amount of water used in irrigation.
- Water at a rate so that it does not pond, pool or run off
- Do not water when the soil is already adequately moist to sustain plant growth
- Water in such a manner so that it does not fall on buildings or hard surfaces
- Do not water in windy conditions where the distribution pattern of the irrigation systems will be affected
- Only water gardens that are sufficiently mulched to reduce evaporation

Submissions

Certification Stage
Strategy A: Plant Selection
• Landscape plan outlining the landscape design with a list of all plants
Strategy B: Water Efficient Irrigation System
• Evidence of the efficient irrigation system such as photographs, manufacturer's data, etc.

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W-3 Drinking Water

Intent

To reduce consumption of bottled drinking water and to improve drinking water quality.

Requirements

Criteria	1 point
Install a drinking water filtration system supplying at least one faucet in the house	1

Overview

Due to the poor tap water quality perceived by people, the consumption of bottled water is relatively high. The environmental impacts of drinking bottled water are immense with, among others, toxic chemicals being released into the environment during the manufacture and with the disposal of the bottles which often end up in landfills or in the nature.

Approach & Implementation

Municipal tap water can contain many kind of contaminants such as dissolved metals (including lead and iron), nitrates, chlorine and mineral salts. It can also contain other undesirable substances such as sulfates, mercury, asbestos and arsenic.

Install a proper drinking water filtration system to get clean drinking water. As a minimum the filtration system should contain filters that can remove:

- dust, particles, and rust
- heavy metals
- chlorine
- bacteria

A drinking water filtration system including filters such as sediment filters, reverse-osmosis filters and activated carbon filters is advised.

Submissions

Certification Stage
• Product technical data showing the types of filters contained in the water filtration system • Evidence showing that the water filtration system was installed such as photographs, invoices, receipts, etc.

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Materials

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.

With the fast urbanization rate reaching 28% (Vietnam Ministry of Construction), construction sites are rising in all corners of Vietnam. Along with this, the demand of construction materials is expected to rise by 10% annually (Vietnam Association of Building Materials). However, this growth will not be sustainable as the production of those construction materials mostly relies on the exploitation of virgin materials. Moreover, since materials exploitation in Vietnam is usually small-scaled and processing technologies are often outdated, natural resources are being wasted and serious damages are being done to the environment.

By setting a common goal of construction materials conservation, the Materials Category of LOTUS encourages strategies and materials which are not only re-used or recycled, but also sustainable and accessible. By responsibly specifying materials and construction processes, the impact of any project on the natural environment can be significantly reduced.

The Material Category of LOTUS includes two main goals which are to reduce the amount of virgin natural resources used, and to promote the use of low-energy sustainable materials. To achieve the goals, credits within this category encourage onsite reuse of building materials and structure, consumption of recycled materials, materials from sustainable sources and unbaked materials.

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Materials		14 points
Item	Criteria	Points
M-1	Building Structure Materials	3 points
	40% of the structure materials are sustainable	1
	1 point for every additional 20% of the structure materials that are sustainable (up to 80%)	3
M-2	Non-structural Walls	3 points
	40% of the non-structural walls are sustainable	1
	1 point for every additional 20% of the non-structural walls that are sustainable (up to 80%)	3
M-3	Windows and Doors	2 points
	40% of windows and doors are made up of sustainable materials	1
	80% of windows and doors are made up of sustainable materials	2
M-4	Flooring Materials	2 points
	40% of the flooring materials are sustainable	1
	80% of the flooring materials are sustainable	2
M-5	Roofing Materials	2 points
	40% of the roofing materials are sustainable	1
	80% of the roofing materials are sustainable	2
M-6	Furniture	2 points
	25% of all furniture items are sustainable	1
	50% of all furniture items are sustainable	2

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M-1 Building Structure Materials

Intent

To encourage and recognise developments that use sustainable materials for building structure.

Requirements

Criteria	3 Points
40% of the structure materials are sustainable	1
60% of the structure materials are sustainable	2
80% of the structure materials are sustainable	3

Overview

The use of materials in building construction has a big impact on virgin natural resources and energy use for manufacturing. Building structure should be made with materials that limit the amount of virgin natural resources used and that are low-energy embodied.

Approach & Implementation

This credit takes into account all the structure materials:

- Foundations
- Columns
- Beams
- Structural roof components
- Floors and subfloors
- Load-bearing walls

The following materials are considered as sustainable under this credit:

- Reused materials
- Materials with at least 10% pre-consumer or 5% post-consumer recycled content
- Non-baked Materials (only applicable for walls) such as concrete blocks, gypsum panels, aerated autoclaved concrete, etc.
- Rapidly renewable materials, which are natural building materials planted and harvested within a 10 year cycle, such as: bamboo, cork, coconut, etc.

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- Timber from sustainable sources, preferably accredited by the Forest Stewardship Council in Vietnam (FSC), Programme for the Endorsement of Forest Certification (PEFC), Malaysia Tiber Certification Council (MTCC) or other.
- Materials that are locally extracted, harvested and manufactured

Calculation

Calculation is based on volume or mass. The selected units must be applied consistently for all materials throughout the calculations. Use the following method to determine the percentage of structure materials which are sustainable:

- Quantify the volume/mass of structure materials required in the project
- Quantify the volume/mass of sustainable materials used for the building structure
- Present materials in table form (Table M.1) and demonstrate the percentage of sustainable materials with the following formula:

$$\text{Sustainable structure materials [\%]} = \left(\frac{S_s}{S_{tot}}\right) \times 100$$

S_s = Amount of sustainable materials used for the building structure [m^3 or kg]

S_{tot}= Total amount of materials used for the building structure [m^3 or kg]

Table M.1: Example of Sustainable building structure materials percentage calculation

Building structure materials	Sustainable Material?	Volume [m^3]	Volume of sustainable materials [m^3]
Concrete	No	30	0
Steel rebar	> 5% post-consumer recycled content	20	20
Steel roof structure	Reused	2	2
Total		52	22
Percentage of sustainable structure materials (%)		42 %	

Submissions

Certification Stage
• Evidence showing that the materials installed are sustainable such as photographs, manufacturer's data, etc. • Evidence showing that the materials were installed such as photographs, invoices, receipts, etc.

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M-2 Non-structural Walls

Intent

To encourage and recognise developments that use sustainable materials for non-structural walls.

Requirements

Criteria	3 Points
40% of the non-structural walls are sustainable	1
60% of the non-structural walls are sustainable	2
80% of the non-structural walls are sustainable	3

Overview

The use of materials in building construction has a big impact on virgin natural resources and energy use for manufacturing. Non-structural walls of the building should be made with materials that limit the amount of virgin natural resources used and that are low-energy embodied.

Approach & Implementation

This credit takes into account all the following materials:

- Walls and partitions (non-load bearing space dividers)
- Toilet partitions; shower partitions including shower screens
- Internal stairs
- Wall coverings, such as tiles, timber, skirting, etc.

Structural elements, fenestration, insulation and wall coverings such as paint, paper, vinyl and textile are not considered in this credit.

The following materials are considered as sustainable:

- Reused materials
- Materials with at least 10% pre-consumer or 5% post-consumer recycled content
- Non-baked materials such as concrete blocks, gypsum panels, aerated autoclaved concrete, etc.
- Rapidly renewable materials, which are natural building materials planted and harvested within a 10 year cycle, such as: bamboo, cork, coconut, etc.

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- Timber from sustainable sources, preferably accredited by the Forest Stewardship Council in Vietnam (FSC), Programme for the Endorsement of Forest Certification (PEFC), Malaysia Tiber Certification Council (MTCC) or other.
- Materials that are locally extracted, harvested and manufactured

Exception: Baked materials such as clay bricks cannot be considered as sustainable materials unless they are reused materials.

Calculation

Calculation is based on the area of the non-structural wall items (m^2). Percentage of sustainable material can be calculated by the following method:

- Quantify the area of all the non-structural wall items
- Quantify the area of the sustainable non-structural wall items
- Present materials in table form (Table M.2) and demonstrate the percentage of sustainable material with the following formula:

$$\text{Sustainable non} - \text{structural walls } [\%] = \left(\frac{W_b}{W_{tot}}\right) \times 100$$

W_b = Area of sustainable non-structural wall items [m^2]

W_{tot}= Total area of non-structural wall items in the project [m^2]

Table M.2: Example of sustainable non-structural walls percentage calculation

Project non-structural wall items	Sustainable Material?	Area of wall item [m^2]	Area of sustainable wall item [m^2]
Gypsum panels	Recycled content	50	50
Clay bricks	No	30	0
Concrete blocks	Non-baked material	90	90
Bamboo covering	Rapidly renewable	20	20
Total		190	160
Sustainable non-structural walls (%)		84 %	

Submissions

Certification Stage
• Evidence showing that the materials installed are sustainable such as photographs, manufacturer's data, etc. • Evidence showing that the materials were installed such as photographs, invoices, receipts, etc.

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M-3 Windows and Doors

Intent

To encourage and recognise developments that use sustainable materials for windows and doors.

Requirements

Criteria	2 Points
40% of windows and doors are made up of sustainable materials	1
80% of windows and doors are made up of sustainable materials	2

Overview

The use of materials in building construction has a big impact on virgin natural resources and energy use for manufacturing. Windows and doors of the building should be made with materials that limit the amount of virgin natural resources used and that are low-energy embodied.

Approach & Implementation

Only window frames, door and door frames shall be considered in this credit.

The following materials are considered as sustainable:

- Reused windows and doors (can be salvaged from a previous house or purchased from a second-hand retailer)
- Materials with at least 10% pre-consumer or 5% post-consumer recycled content
- Sustainable timber which is timber coming from sustainable sources
- Rapidly renewable materials, which are natural building materials planted and harvested within a 10 year cycle, such as: bamboo, cork, coconut, etc.
- Materials that are locally extracted, harvested and manufactured

To be qualified as a product made up of sustainable materials, a product must be made up of at least 50% of sustainable materials by weight.

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Calculation

Calculation is based on the area of the window frames, doors and door frames (m^2).

Area of window frames, doors and door frames is calculated as the total length of the item multiplied by its total height.

Percentage of windows and doors made up of sustainable materials can be calculated by the following method:

- Quantify the area of window frames, doors and door frames used in the project
- Quantify the area of window frames, doors and door frames made up of sustainable materials
- Present window and door items in table form (Table M.3) and demonstrate the percentage of window and door items made up of sustainable materials with the following formula:

$$\text{Window and door items from sustainable materials [\%]} = \left(\frac{W_s}{W_{tot}}\right) \times 100$$

W_s = Area of window and door items made up of sustainable materials [m^2]
W_{tot} = Total area of window and door items in the project [m^2]

Table M.3: Example of windows and doors made up of sustainable materials percentage calculation

Window and door items	Sustainable?	Area [m^2]	Area of sustainable items [m^2]
Kitchen door	Reused	2	2
Steel door frame	10% pre-consumer recycled content	0.5	0.5
Bedroom doors	Rapidly renewable materials (bamboo)	3 doors x 2 m^2	6
Main entrance door	No	3	0
Total		11.5	8.5
Windows and doors from sustainable materials (%)		74 %	

Submissions

Certification Stage
• Evidence showing that the materials installed are sustainable such as photographs, manufacturer's data, etc. • Evidence showing that the materials were installed such as photographs, invoices, receipts, etc.

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M-4 Flooring Materials

Intent

To encourage and recognise developments that use sustainable flooring materials.

Requirements

Criteria	2 Points
40% of the flooring materials are sustainable	1
80% of the flooring materials are sustainable	2

Overview

The use of materials in building construction has a big impact on virgin natural resources and energy use for manufacturing. The building should use flooring materials that limit the amount of virgin natural resources used and that are low-energy embodied.

Approach & Implementation

This credit takes into account all the following types of flooring materials:

- Floor coverings (fixed, supported or floating) such as: carpet, timber, resilient flooring, hard flooring, etc.
- Flooring underlay (backing material for floor coverings)
- Exposed concrete (area of concrete floor surface that is uncovered, this may be polished or sealed as needed)

Exclusions: Rugs (similar to carpet but not exceeding the length of 2m), sealants and paint finishes are excluded.

The following materials shall be considered as sustainable under this credit:

- Rapidly renewable materials, which are natural building materials planted and harvested within a 10 year cycle, such as: bamboo, cork, coconut, straw, etc.
- Timber from sustainable sources, accredited by the Forest Stewardship Council in Vietnam (FSC), Programme for the Endorsement of Forest Certification (PEFC), etc.
- Reused materials (tiles, floorboards, carpets, etc. can be reused)
- Materials with at least 10% pre-consumer or 5% post-consumer recycled content
- Exposed concrete (eliminating the need for carpeting and other floor coverings)
- Materials that are locally extracted, harvested and manufactured

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Calculation

Calculation is based on the area of flooring items (m^2). Percentage of sustainable flooring items can be calculated by the following method:

- Quantify the total area of flooring items in the project
- Quantify the area of the sustainable flooring items
- Present materials in table form (Table M.4) and demonstrate the percentage of sustainable flooring items by using the following formula:

$$\text{Sustainable floor covering } [\%] = \left(\frac{F_s}{F_{tot}}\right) \times 100$$

F_s = Area of the sustainable flooring items [m^2]

F_{tot} = Total area of the flooring items of the project [m^2]

Note: Floor coverings, flooring underlay and exposed concrete surfaces must be considered. Then, the total area of flooring items may be higher than the internal floor area.

Table M.4: Example of Sustainable flooring materials percentage calculation

Flooring material items	Sustainable material?	Area of floor covering items [m^2]	Area of sustainable floor covering items [m^2]
Bamboo flooring	Rapidly renewable material	70	70
Exposed concrete	Exposed concrete	20	20
Carpet	Reused	5	5
Ceramic tiles	No	80	0
Laminate flooring	No	30	0
Total		205	95
Percentage of Sustainable flooring materials (%)		46.3 %	

Submissions

Certification Stage
• Evidence showing that the materials installed are sustainable such as photographs, manufacturer's data, etc. • Evidence showing that the materials were installed such as photographs, invoices, receipts, etc.

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M-5 Roofing Materials

Intent

To encourage and recognise developments that use sustainable roofing materials.

Requirements

Criteria	2 Points
40% of the roofing materials are sustainable	1
80% of the roofing materials are sustainable	2

Overview

The use of materials in building construction has a big impact on virgin natural resources and energy use for manufacturing. The building should use roofing materials that limit the amount of virgin natural resources used and that are low-energy embodied.

Approach & Implementation

This credit takes into account all roof coverings, roof sunshade and roof sheathing materials. Exceptions: Structural roofing, insulation materials and roof underlayment (extra layer of protection on top of the sheathing) should not be considered.

The following roofing materials shall be considered as sustainable under this credit:

- Rapidly renewable materials, which are natural building materials planted and harvested within a 10 year cycle, such as: rice straw, bamboo, cork, coconut, etc.
- Timber from sustainable sources, preferably accredited by the Forest Stewardship Council in Vietnam (FSC), Programme for the Endorsement of Forest Certification (PEFC), Malaysia Tiber Certification Council (MTCC) or other.
- Reused materials (metal roofing, tiles and slate, wood sheathing, shingles, etc. can all be reused)
- Materials with at least 10% pre-consumer or 5% post-consumer recycled content
- Materials that are locally extracted, harvested and manufactured

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Calculation

Calculation is based on the area of roofing items (m^2). Percentage of sustainable roof covering items can be calculated by the following method:

- Quantify the total area of roofing items of the project
- Quantify the total area of sustainable roofing items
- Present materials in table form (Table M.5) and demonstrate the percentage of sustainable roofing items by using the following formula:

$$\text{Sustainable roofing materials [\%]} = \left(\frac{R_s}{R_{tot}}\right) \times 100$$

R_s = Area of sustainable roofing items [m^2]

R_{tot} = Total area of roofing items of the project [m^2]

Note: Roof covering, roof sheathing and roof sunshade areas must be considered. Then, the total area of roof covering items may be higher than the roof area.

Table M.5: Example of Sustainable roofing materials percentage calculation

Roofing items	Sustainable material?	Area of roofing items [m^2]	Area of sustainable roofing items [m^2]
Metal roof sunshade	Reused	40	40
Concrete roof	No	35	0
Total		75	40
Percentage of Sustainable roofing materials (%)		53.3 %	

Submissions

Certification Stage
• Evidence showing that the materials installed are sustainable such as photographs, manufacturer's data, etc. • Evidence showing that the materials were installed such as photographs, invoices, receipts, etc.

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M-6 Furniture

Intent

To encourage and recognise developments that use sustainable materials for fitted furniture.

Requirements

Criteria	2 Points
25% of all furniture items are sustainable	1
50% of all furniture items are sustainable	2

Overview

The use of materials in building construction has a big impact on virgin natural resources and energy use for manufacturing. Furniture installed in the building should be made with materials that limit the amount of virgin natural resources used and that are low-energy embodied.

Approach & Implementation

This credit takes into account all types of furniture including fitted furniture (fitted cupboard, fitted wardrobe, etc.) and loose furniture (chairs, tables, desks, cabinets, etc.)

The following types of furniture shall be considered as sustainable under this credit:

- Reused Furniture (can be either reused from previous house or purchased from a second-hand retailer)
- Furniture made with reused materials (reused components should exceed 50% of the furniture by mass)
- Furniture made with rapidly renewable materials, such as: bamboo, cork, coconut, etc. (rapidly renewable materials should exceed 50% of the furniture)
- Furniture made with timber coming from sustainable sources, preferably accredited by the Forest Stewardship Council in Vietnam (FSC), Programme for the Endorsement of Forest Certification (PEFC), Malaysia Tiber Certification Council (MTCC) or other (sustainable timber should exceed 50% of the furniture by mass)

Calculation

Calculation is based on number of furniture items.

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Percentage of sustainable furniture used on a project can be calculated by the following method:

- Quantify the total number of furniture items in the project
- Quantify the number of sustainable furniture items
- Present materials in table form (Table M.6) and demonstrate the percentage of sustainable furniture items by using the following formula:

$$\text{Sustainable furniture items } [\%] = \left(\frac{U_s}{U_{tot}}\right) \times 100$$

U_s = Total number of sustainable furniture items in the project

U_{tot} = Total number of furniture items in the project

Table M.6: Example of sustainable furniture items percentage calculation

Furniture	Sustainable product?	Quantity	Compliant quantity
Bookcase	Yes (Reused)	25	25
Closets	No	20	0
Kitchen cabinet	Yes (more than 50% of bamboo used)	30	30
Total		75	55
Percentage of Sustainable furniture items (%)		73%	

Submissions

Certification Stage
• Evidence showing that the furniture items installed are sustainable such as photographs, manufacturer's data, etc. • Evidence showing that the furniture items were installed such as photographs, invoices, receipts, etc.

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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 targets the overall improvement of the indoor environment in buildings. The improvements aim exactly at four 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, acoustically and thermally for most of the occupants of the building.

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Health & Comfort		11 Points
Item	**Criteria**	**Points**
H-1	Fresh Air Supply	2 points
	Provide sufficient fresh air supply to a minimum of 90% of the total net habitable area of the building	2
H-2	Ventilation in Wet Areas	1 point
	Ventilate wet areas with a local exhaust system or openable windows	1
H-3	Low-VOC Emissions	4 points
	Strategy A: Paints and coatings	
	Specify and install low-VOC emission paints and coatings	1
	Strategy B: Adhesives and sealants	
	Specify and install low-VOC emission adhesives and sealants	1
	Strategy C: Floorings	
	Specify and install low-VOC emission floorings	1
	Strategy D: Wood furniture	
	Specify and install low-formaldehyde emission wood furniture	1
	Strategy E: Ceilings, partitions and insulation	
	Specify and install low-VOC emission ceiling, partition and insulation products	1
H-4	Daylighting	3 points
	50% of all the habitable spaces have a daylit zone area of more than 75% of their floor area	1
	70% of all the habitable spaces have a daylit zone area of more than 75% of their floor area	2
	90% of all the habitable spaces have a daylit zone area of more than 75% of their floor area	3
H-5	Acoustic Comfort	1 point
	Design all walls and floors to comply with the requirements of TCXDVN 277:2002 on airborne and impact sound insulation for all classes	1

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H-1 Fresh Air Supply

Intent

To ensure the provision of enough fresh air to maintain good indoor air quality during occupancy.

Requirements

Criteria	2 Points
Provide sufficient fresh air supply to a minimum of 90% of the total net habitable area of the building.	2

Overview

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 pollutant. Increased fresh air supply can help decrease respiratory illnesses.

Approach & Implementation

This credit 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.

3 types of ventilation are considered to provide fresh air to the habitable spaces:

- Mechanical ventilation: when a mechanical fan or an air handling unit is supplying fresh air from outside to inside
- Natural ventilation: when the air in a space is changed with outdoor air without the use of mechanical system
- Mixed mode ventilation: when both mechanical and natural ventilation processes are used in combination.

<u>For naturally ventilated spaces:</u>

To receive sufficient fresh air supply through natural ventilation, a habitable room must:

- be within 8 meters of (and permanently open to) an operable wall or roof opening
- have a total area of wall or roof openings of at least 4% of the floor area of the room.

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A habitable room 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).

For mechanically ventilated spaces:

Fresh air supply in mechanical ventilation systems must meet or surpass the requirements of a recognised standard including but not limited to the following:

- TCVN 5687:2010 - Ventilation- Air Conditioning, Design Standards
- ASHRAE 62.2 - Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential 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.

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.

For mixed-mode ventilated spaces:

Both the above requirements for natural ventilation and for mechanical ventilation must be met.

Calculations

For naturally and mixed-mode ventilated habitable spaces:

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

For mechanically and mixed-mode ventilated habitable spaces:

For each of these habitable spaces, calculate minimum ventilation rates (fresh air supply) in accordance to one of the standards from the above list and demonstrate that designed ventilation rates meet the requirements of the selected standard.

If a project wants to pursue this credit with mechanically ventilated and/or mixed-mode ventilated spaces, please contact VGBC for more information.

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Submissions

Certification Stage
For naturally ventilated spaces and mixed-mode ventilated spaces:
• Plans and elevations marking all operable wall and roof openings with their size • Photographs showing all operable wall and roof openings
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 the project follows requirements of a standard different from TCVN 5687:2010: • Calculations demonstrating that the requirements of the recognized standard selected are met

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H-2 Ventilation in Wet Areas

Intent

To reduce moisture and odours from wet areas.

Requirements

Criteria	1 Point
Ventilate wet areas with a local exhaust system or openable windows	1

Overview

Wet areas are the rooms or spaces containing sanitary fixtures and appliances. They are subject to high levels of moisture from direct wetting, high humidity levels and condensation. Mould can grow in wet areas caused by high humidity that can result from everyday activities like cooking or showering 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 ventilation can improve indoor air quality and prevent mould from growing.

Approach & Implementation

This credit 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); and

Each of these rooms must meet the requirements on either continuous local ventilation exhaust, intermittent local ventilation exhaust or openable windows.

- 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

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- 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 or with a vented range hood. However, if the exhaust fan flow is less than 5 air changes per hour, a vented range hood is required.

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

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

Certification Stage
• Photographs of the exhaust fans installed and photographs of the operable windows in bathrooms and toilets • Technical data of the exhaust fans installed showing capacity

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H-3 Low-VOC Emissions Products

Intent

To minimize the negative impacts of volatile organic compounds (VOCs) & formaldehydes from building materials on occupant's health.

Requirements

Criteria	4 Points
Strategy A: Paints and coatings	
Specify and install low-VOC emission paints and coatings	1
Strategy B: Adhesives and sealants	
Specify and install low-VOC emission adhesives and sealants	1
Strategy C: Floorings	
Specify and install low-VOC emission floorings	1
Strategy D: Wood furniture	
Specify and install low-formaldehyde emission wood furniture	1
Strategy E: Ceilings, partitions and insulation	
Specify and install low-VOC emission ceiling, partition and insulation products	1

Overview

Volatile organic compounds (VOCs) are organic origin gases emitted from certain solid or liquid materials. VOCs feature in a wide range of chemicals, including some that have short and long-term negative effects on human health. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors and can cause significant health problems for frequent occupants. VOCs are emitted from a variety of products (e.g. paints and lacquers, paint strippers, cleaning supplies, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions).

Formaldehyde is an important chemical used widely by industry to manufacture building materials and numerous household products. Thus, it may be present in substantial concentrations in indoor environments. The most significant sources of formaldehyde are

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likely to be pressed wood products made using adhesives that contain urea-formaldehyde (UF) resin or phenol-formaldehyde (PF) resin. Pressed wood products made for indoor use include: particleboard (used as sub-flooring and shelving and in cabinetry and furniture); hardwood plywood panelling (used for decorative wall covering and used in cabinets and furniture); and medium density fiberboard (used for drawer fronts, cabinets, and furniture tops). Medium density fiberboard contains a higher resin-to-wood ratio than any other UF pressed wood product and is generally recognized as being the highest formaldehyde-emitting pressed wood product.

Approach & Implementation

Specify and install low-VOC emission and low-formaldehyde emission products.

Are considered low-VOC emission products, the products which either:

- are certified as low-VOC emission products by any internationally or regionally recognized authorities/labels (e.g. Singapore Green Label, GreenGuard, Global Green Tag, etc.);
- or, have a VOC content lower than the limits set by any internationally or regionally recognized authorities/labels. The VOC content of the products should appear either on manufacturer's published data or on laboratory test results following relevant test methods such as: US EPA Reference Method 24, EN 16516, ASTM D6886, etc.;
- or, are inherently non-emitting VOC (stone, ceramics, powder-coated metals, plated metals or anodized metals, glass, concrete, clay brick, and unfinished/untreated solid wood)

Are considered as low-formaldehyde emission products, the wood furniture which:

- do not exceed a concentration limit of 0.05 ppm of formaldehyde (0.06 mg/m2.h when expressed as emission rate) as tested following an internationally recognized standard
- or, are made with inherently non-emitting formaldehyde components (unfinished/untreated solid wood)
- or, are completely finished off-site and contains no urea-formaldehyde (UF) resin nor phenol-formaldehyde (PF) resin
- or, are classified as U.L.E.F. (ultra-low-emitting formaldehyde) or N.A.F. (no added formaldehyde)
- or, are salvaged and reused wood furniture

Strategy A: Paints and coatings

Install only low-VOC emission interior paints and coatings.

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Strategy B: Adhesives and sealants

Install only low-VOC emission interior adhesives and sealants.

Strategy C: Floorings

Install only low-VOC emission flooring products and systems.
For floorings with inherently non-emitting products (ceramic tiles, solid timber, stone, polished concrete, etc.), if finishing products are used, they must be low-VOC products.

Strategy D: Wood furniture

Install only low-formaldehyde emission wood furniture products and use adhesives with no added urea-formaldehyde to fabricate furniture assemblies.

Strategy E: Ceilings, partitions and insulation

Install only low-VOC emission ceiling, partition and insulation (including thermal and acoustic insulation but not HVAC ductwork insulation) products and systems.

Submissions

Certification Stage
Strategy A, Strategy B, Strategy C and Strategy E
• For each low-VOC product, evidence showing that the products installed are low-VOC products such as manufacturer's published data, certificate, test reports, etc. • Evidence showing that the low-VOC products have been installed such as invoices, receipts, delivery notes, photographs, etc.
Strategy D: Wood furniture
• For each low-formaldehyde product, evidence showing that the products installed are low-formaldehyde products such as manufacturer's published data, certificate, test reports, etc. • Evidence showing that the low-formaldehyde products have been installed such as invoices, receipts, delivery notes, photographs, etc.

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H-4 Daylighting

Intent

To encourage building designs which maximize the use of daylight.

Requirements

Projects can follow the requirements below or select the performance path in Appendix B.

Criteria	3 Points
50% of all the habitable spaces have a daylit zone area of more than 75% of their floor area	1
70% of all the habitable spaces have a daylit zone area of more than 75% of their floor area	2
90% of all the habitable spaces have a daylit zone area of more than 75% of their floor area	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:

- Window arrangement
- Skylights
- Interior light shelves (horizontal surfaces that reflect daylight deep into a building)
- Open plan design

Daylit zone area is defined as the sum of the sidelit daylit area and the skylit daylit area.

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Sidelit daylit area is the area on a plan directly adjacent to each vertical glazing, two window head height deep into the area, and window width plus 0.5 times window head height wide on each side of the rough opening of the window, minus any area on a plan beyond a permanent obstruction that is 1.5 meters or taller as measured from the floor. Figure H.1 shows how to measure sidelit daylit area.

Skylit daylit area is the rough area in plan view under each skylight, plus 0.7 times the average ceiling height in each direction from the edge of the rough opening of the skylight, minus any area on a plan beyond a permanent obstruction that is taller than one - half the distance from the floor to the bottom of the skylight.
The bottom of the skylight is measured from the bottom of the skylight well for skylights having wells, or the bottom of the skylight if no skylight well exists.

For the purpose of determining the skylit daylit zone, the geometric shape of the skylit daylit zone shall be identical to the plan view geometric shape of the rough opening of the skylight; for example, for a rectangular skylight the skylit daylit zone plan area shall be rectangular, and for a circular skylight the skylit daylit zone plan area shall be circular

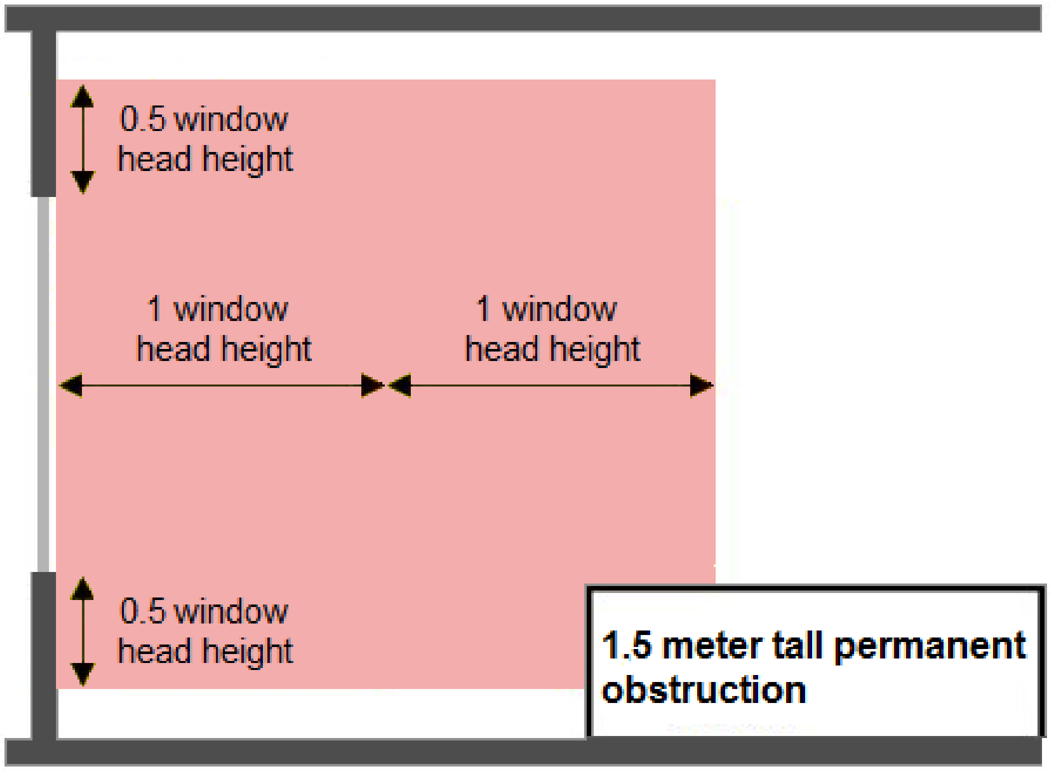

Figure H.1: Measurement of the sidelit daylit area (top view)

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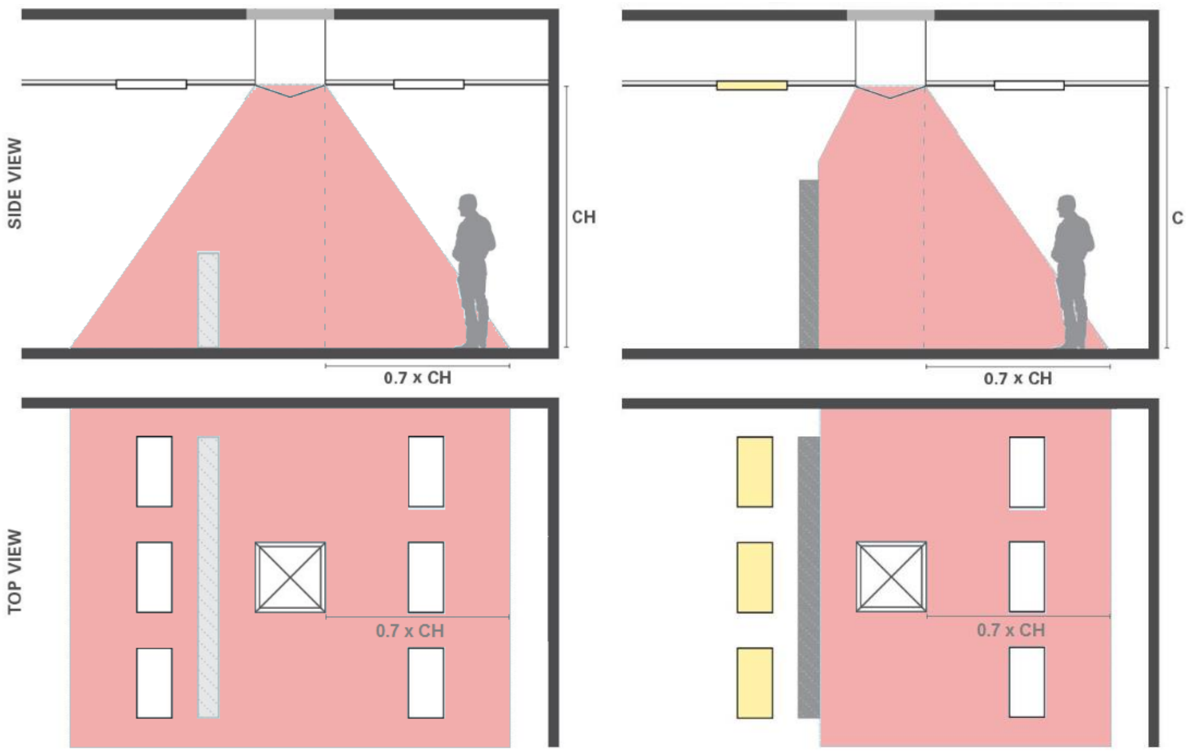

Figure H.2: Measurement of the skylit daylit area

Submissions

Certification Stage
• Plans and elevations outlining habitable spaces, daylit areas and indicating all glazing and its size

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H-5 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 for all classes	1

Overview

Noise levels largely affect the health and comfort of residents. Disruptive noise sources include external and internal ones, as well as building service equipment. Vietnam standard TCXDVN 277-2002 - Sound insulation standards of building elements between rooms - sets forth a maximum noise level in each area and advises on noise insulation between rooms, spaces and premises, as well as impact noise between floors.

Approach & Implementation

TCXDVN 277-2002 sets forth minimum requirements on sound insulation in residential buildings (see Table H.1). CK^{tc} index is equivalent to the weighted noise reduction index (Rw) and CV^{tc} is equivalent to the weighted normalised 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.2).

Table H.1: Minimum requirements for airborne and impact sound insulation of building elements between rooms (*Source: TCXDVN 277-2002*)

Class	Airborne Sound Insulation	Impact Sounds Insulation
Class I	$CK^{tc} \geq 55$	$CV^{tc} \leq 58$
Class II	$CK^{tc} \geq 50$	$CV^{tc} \leq 62$
Class III	$CK^{tc} \geq 45$	$CV^{tc} \leq 66$

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Table H.2: Definition of floor and walls included in the noise classes of 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: Floor and walls of bedrooms and living rooms between units; 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 outline 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
- Wrapping or enclosing rectangular ducts with isolation materials and use sound attenuators and acoustic plenums to reduce noise in ductwork

Calculations

The calculations 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

Certification Stage
• Calculations of the airborne and impact sound insulation of all the building elements showing compliance with TCXDVN 277-2002 • Technical data of the building elements showing airborne and impact sound insulation (if available)

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Local Environment

In the 21st century, local environments in Vietnam are under the threat of many factors. The fast but difficult to manage rate of Vietnam's urbanization is quickly turning virgin land into construction sites and habitats are disappearing together with the species living within them. The impacts of climate change can now be seen in the form of stronger and more frequent storms, frequent flooding and drought, sea level rise, and other extreme weather phenomena. Vietnam's urban areas generate over 8 million tonnes of solid waste per year, of which only about 70% is collected and treated. This means almost 2.5 million tonnes of untreated solid waste is released into the environment each year.

Therefore, to reduce these threats on the environment, construction projects should be following strategies to protect the natural ecosystems (selecting sites with low-ecological value and increasing vegetation with local species), to minimize waste and pollution (using cleaner refrigerants and diverting waste from landfills and nature), to improve building's resistance towards flooding and to alleviate its own impacts on climate change (increasing the perviousness of the site and limiting the heat island effect).

All credits within the Local Environment of LOTUS Homes consider these strategies that will contribute to protect the ecology of the site of the building and surrounding area, to encourage recycling practices, and to integrate adaptation and mitigation measures.

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Local Environment		16 Points
Item	**Criteria**	**Points**
LE-1	**Site Selection**	**5 points**
	Strategy A: Land with low-ecological value	
	Do not situate building on a site with high-eco value	1
	Strategy B: Infill or redevelopment site	
	Locate building on an infill or a redevelopment site	1
	Strategy C: Mass transit Transport	
	Locate development within 800m of mass transit services	1
	Locate development within 400m of mass transit services	2
	Strategy D: Community Connectivity	
	There are at least 5 different types of basic services within a 0.5 km radius of the site	1
LE-2	**Site Design**	**2 points**
	Strategy A: Site Analysis	
	Provide a Site Analysis considering local environmental conditions such as sunlight, prevailing winds, topography and existing vegetation.	1
	Strategy B: Undeveloped Site Area	
	At least 20% of the site area is undeveloped	1
LE-3	**Vegetation**	**2 points**
	Strategy A: Vegetated Area in outdoor garden	
	15% of the total site area is vegetated with native or adapted vegetation	1
	30% of the total site area is vegetated with native or adapted vegetation	2
	Strategy B: Pot Plants	
	Provide 1 pot plant unit for every 10 m^2 of GFA, balconies and rooftop area	1
	Provide 1 pot plant unit for every 5 m^2 of GFA, balconies and rooftop area	2
LE -4	**Heat Island Effect**	**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
LE -5	**Stormwater Runoff**	**2 points**
	Average perviousness of the site is at least 30%	1
	Average perviousness of the site is at least 50%	2

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LE -6	Flood Mitigation	1 point
	Prepare a local flood risk identification statement for the site - AND - Implement flood risk mitigation strategies if required	1
LE-7	Refrigerants	1 point
	No R-22 refrigerant is used in the building - AND - Refrigerators/freezers use natural refrigerants	1
LE-8	Waste Management	1 point
	Provide a storage place with different bins for recyclables, organic wastes and garbage	1

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LE-1 Site Selection

Intent

To encourage development to occur in suitable locations that will reduce harm on the natural environment and promote the health and wellbeing of occupants

Requirements

Criteria	5 points
Strategy A: Land with low-ecological value	
Do not situate building on a site with high-eco value	1
Strategy B: Infill or redevelopment site	
Locate building on an infill or a redevelopment site	1
Strategy C: Mass transit Transport	
Locate building within 800m of mass transit services	1
Locate building within 400m of mass transit services	2
Strategy D: Community Connectivity	
There are at least 5 different types of basic services within a 0.5 km radius of the site	1

Overview

Site selection is an important aspect to consider for a green building. Projects should choose sites with low eco-value (sites with limited ability to support native life forms as a part of the natural ecosystem) to limit their impact on the ecosystem. Also, it is encouraged to locate the house near mass transit services and near basic services for the convenience of occupants and to lessen the need for individual motorised transportation.

Approach and Implementation

Strategy A: Land with low-ecological value

No site with significant ecological value should be selected for construction to prevent the loss of prime farmland or key habitat. Tables LE.1 and LE.2 provide a checklist to determine whether the site is of high eco-value or not.

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Table LE.1: Critical ecological features of the site

Part 1: Critical ecological features of the site		
If YES is chosen for any question in Part 1, the site is determined as high eco-value land. If NO is chosen for all questions in Part 1, proceed to Part 2 of this checklist.		
1	Is the land/site identified as habitat of endangered or vulnerable or threatened species (according to IUCN Red List, international research or Vietnam Red List)?	☐ Yes ☐ No
2	Is the land/site identified as nursery ground supporting a diverse group of species?	☐ Yes ☐ No
3	Are there any natural lakes, streams or rivers on/running through the site?	☐ Yes ☐ No
4	Is there any marsh, wetland or riparian wetland present on the site?	☐ Yes ☐ No
5	Is there any indigenous/protected/functional forest present on the site?	☐ Yes ☐ No
6	Does the site consist of virgin/undeveloped land with wild habitat?	☐ Yes ☐ No

Table LE.2: Type of land to be used

Part 2: Type of land to be used for the new buildings, hard surfaces, landscaping or for site access		
Only continue Part 2 when NO is recorded against all questions in Part 1. If YES is answered for at least one of the questions in Part 2, the site can be defined as having low-ecological value		
1	Has the land been included in the government urban development plan?	☐ Yes ☐ No
2	Does the development site consist of land which is entirely within the floor plan(s) of existing building(s) or building(s) demolished within the past 5 years?	☐ Yes ☐ No
3	Does the development site consist of land which is entirely covered by other development such as sporting hard surfaces, car parking or such constructions which have been demolished within the past 5 years?	☐ Yes ☐ No
4	Does the development site consist of land which is contaminated by industrial or other waste to the extent that it would need remediation before building?	☐ Yes ☐ No
5	Does the site consist of land which is a mixture of existing building, paved surfaces and/or contaminated land?	☐ Yes ☐ No
6	Has 80% of the land within the development site been used for Intensive farming for at least the last 3 years?	☐ Yes ☐ No
7	Has the development site consisted entirely of bare ground -OR- Consisted of regularly cut lawns and/or sports fields for more than 2 years?	☐ Yes ☐ No

Strategy B: Infill or redevelopment site

Credit to be awarded if the project is adjoining existing development or 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.

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Strategy C: Distance to mass transit services

Mass transit services include:

- Proposed metro stations
- Existing bus stops

Distance should be measured on a radial basis from the service location to the closest corner of the site.

Strategy D: Community Connectivity

Preference is given to construction or renovation of a building within an existing urban area with pedestrian access to a variety of basic services.

The different types of basic services include, but are not limited to those listed in Table LE.3.

Table LE.3: Types of basic services

1. Bank	10. Laundry	19. Restaurant/Coffee shop
2. Beauty/Hairdresser	11. Library	20. School
3. Cleaners	12. Hospital/Clinic/Dental/Optician	21. Senior care facility
4. Community center	13. Museum	22. Supermarket
5. Convenience grocery	14. Playground/Park	23. Art/Entertainment center
6. Day care	15. Pharmacy	24. Electronic Repair Shops / Vehicle Repair Shops
7. Fitness center/Sport center/Swimming pool	16. Place of worship	25. Police station
8. Fire station	17. Post Office	26. Bookstore
9. Petrol Station	18. ATM	27. Wet market

Distance should be measured on a radial basis from the service location to the closest corner of the site.

Submissions

Certification Stage
Strategy A: Land with low-ecological value
• Photographs showing the site prior construction -OR- site's land use right certificate -OR- Site development history approved by local authority

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Strategy B: Infill or redevelopment site
• Photographs showing prior development of the site or showing adjoining existing development
Strategy C: Distance to mass transit services
• Map or plan indicating position of the mass transit service within a 400m or 800 m radius of the building site
Strategy D: Community Connectivity
• Map or plan indicating position of at least 5 different types of basic services located within a 0.5 km radius of the site • Photographs of the basic services

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LE-2 Site Design

Intent

To analyse and consider the site layout in order to preserve existing vegetation and minimise building footprint.

Requirements

Criteria	2 points
Strategy A: Site Analysis	
Provide a Site Analysis considering local environmental conditions such as sunlight, prevailing winds, topography and existing vegetation.	1
Strategy B: Undeveloped Site Area	
At least 20% of the site area is undeveloped	1

Overview

Site analysis is a preliminary phase of architectural and urban design processes dedicated to the study of the climatic, geographical, and infrastructural context of a specific site. It should be used as a starting point for the development of environment-related strategies during the design process.

Minimizing the development footprint helps conserve the existing natural areas and restore damaged areas to provide habitat and promote biodiversity. Providing open space can contribute to the mitigation of environmental impacts including land consumption and rainwater runoff, and create physiological as well as psychological benefits for building occupants and the community.

Approach & Implementation

Strategy A: Site Analysis

The Site Analysis can be realised with a Site Analysis Plan showing the following details:

- Site area
- Adjoining development
- Existing structures on the site
- Existing site entry and exit points
- Existing vegetation to be retained
- Existing vegetation to be removed

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- Topography
- North Point
- Sunlight arc (sun path)
- Significant view corridors
- Any prevailing winds

The Site Analysis can also be conducted using the drop down menu shown in Table LE.4.

Table LE.4: Site Analysis drop down menu

Site area	Insert area in m^2
Site orientation	North / north east / east / south east / south / south west / west / north west
Existing development to the east	Major road / minor road / house up to 3 storeys / terrace house greater than 3 storeys / shop / office building / block of flats / river / park / empty lot
Existing development to the north	Major road / minor road / house up to 3 storeys / terrace house greater than 3 storeys / shop / office building / block of flats / river / park / empty lot
Existing development to the west	Major road / minor road / house up to 3 storeys / terrace house greater than 3 storeys / shop / office building / block of flats / river / park / empty lot
Existing development to the south	Major road / minor road / house up to 3 storeys / terrace house greater than 3 storeys / shop / office building / block of flats / river / park / empty lot
Describe existing structures on site	Free text
Topography	Land is flat / slope front to rear / slope rear to front / slope across site / centre highest point
Describe existing views	Free text

Strategy B: Undeveloped Site Area

The building and other built structures must not exceed 80% of the site area. The proposed building is to be shown on a Site Plan including the following details:

- Site Area
- Building Footprint
- Other built structures

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Calculation

Strategy B: Undeveloped Site Area

The undeveloped site area percentage is calculated in the following way:

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

A_B = Building Footprint [m^2]

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

A_S = Site area [m^2]

Submissions

Certification Stage
Strategy A: Site Analysis Plan
• Provide a site analysis plan or complete the table LE-4 • Photographs showing the existing site layout
Strategy B: Undeveloped Site Area
• Site master plan (can be a sketch drawn by hand) showing the building footprint and other built structures • Photographs of the site at the end of construction

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LE-3 Vegetation

Intent

To encourage the introduction and preservation of plants on site.

Requirements

Criteria	2 points
Strategy A: Vegetated Area in outdoor garden	
15% of the total site area is vegetated with native or adapted vegetation	1
30% of the total site area is vegetated with native or adapted vegetation	2
Strategy B: Pot Plants	
Provide 1 pot plant unit for every 10 m^2 of GFA, balconies and rooftop area	1
Provide 1 pot plant unit for every 5 m^2 of GFA, balconies and rooftop area	2

Overview

Site vegetation largely contributes to improve the building site microclimate, ventilation and scenery. Moreover, vegetation can lead to the restoration of topsoil and prevent erosion. Site vegetation preservation is considered as conserving natural resources. The purpose is to enhance the native plant communities and wildlife habitat on the site while limiting the disturbance and damage to ecosystems.

Approach & Implementation

Strategy A: Vegetated Area in outdoor garden and Strategy B: Pot Plants

The following techniques of vegetation preservation/restoration and biodiversity enhancement should be considered:

Directly introduce new species to the site, but where possible only species native/endemic to Vietnam and the surrounding region of Indochina as they are better adapted to the regional climate and local conditions
Consider the light and water demands of species when deciding where to plant them (particularly for shaded areas)
Introducing structures and species that themselves further promote a native community. (e.g. bird boxes, trees/shrubs that are a natural feeding/nesting site for native birds or a habitat for invertebrates)

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When undertaking any construction, renovations or major maintenance install temporary fencing to the extent of the determined tree protection zone around any vegetation potentially affected by the activities. Fencing should be constructed of at least 1.2 m tall metal posts and bunting.

Calculation

Strategy A: Vegetated Area in outdoor garden

Percentage of vegetated site area can be calculated by the following method:

Quantify area of vegetated area using the following classifiers:

- Grasses and small vascular plants that have colonised naturally have low/negligible value and so cannot be counted towards vegetative coverage
- Low lying vegetation and shrubs: overall vegetative area coverage as if seen from above.
- Trees: standard set coverage of $1m^2$, applied to all species, shape and size
- If a green roof is installed then the area of the green roof can be included in the vegetated area, regardless of what species or type of vegetation is planted
- If outdoor pot plants are installed, the area of the opening at the top of the pot should be used

Demonstrate amount of vegetated area with the following formula:

$$\text{Vegetated site area } [\%] = \left(\frac{A_V}{A_S}\right) \times 100$$

A_V = Area of vegetation [m^2]

A_S = Site area (including roof) [m^2]

Strategy B: Pot Plants

Density of pot plant unit should be calculated by the following method:

- Quantify the number of pot plant units based on the width at the opening of the pot in accordance with Table LE.5.
- Calculate the total area to consider for this strategy as the sum of the GFA of the building, the rooftop area and the balconies area.
- Calculate the density of pot plant units installed using the following formula:

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$$\text{Density of pot plant units } [\%] = \left(\frac{A_T}{N_P}\right) \times 100$$

A_T = Area, sum of the GFA of the building, the rooftop area and the balconies area [m^2]

N_P = Number of pot plant units

Table LE.5: Equivalence between plant unit number and width at the opening of the pot

Width at the opening of the pot (mm)	Plant unit number
< 100	0.2
≥ 100 and < 200	0.33
≥ 200 and < 250	0.5
≥ 250 and < 320	1
≥ 320 and < 400	2
≥ 400 and < 550	3
≥ 550	4
Bed & Vertical Planting	Determine number of equivalent pots based on a width of 250mm.

Submissions

Certification Stage
Strategy A: Vegetated Area in outdoor garden
• Site plan highlighting the vegetated areas. • Photographs of the vegetation
Strategy B: Pot Plants
• Evidence of the pot plants installed such as photographs.

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LE-4 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 LE.2).

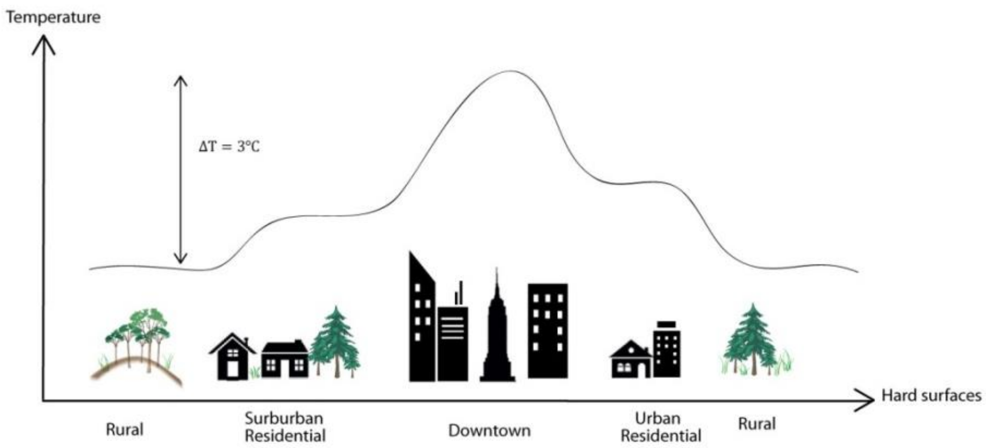

Figure LE.2: Heat island effect

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.

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Approach & Implementation

The following items contribute to reduce the urban heat island effect:

- Open grid pavement systems to reduce paved areas (at least 50% pervious)
- Shading devices with solar reflectance index (SRI) higher than 29 or 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
- 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
- Solar panels

Calculation

Calculation is based on paved and roof area.

All areas on site that are paved or covered so that natural soil is not exposed to natural light are counted as paved area.
Areas covered with mechanical equipment should be deducted.

The strategies listed in the Approach & Implementation constitute the exhaustive list of surfaces considered as limiting heat island effect.

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 the 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 m^2 per tree can also be considered.
    - For the other surfaces considered as limiting heat island effect, the area to consider should be equal to their actual areas.
- Quantify areas that should be deducted from the total paved and roof area

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- Demonstrate amount of surfaces limiting heat island effect with the following formula:

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

A_{low}= Area limiting heat island effect [m^2]

$A_{\text{total paved + roof area}}$ = Sum of the roof area and total site's paved area minus deducted areas [m^2]

Submissions

Certification Stage
• Site plan highlighting the different roof and paved areas • Photographs of the different roof and paved areas

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LE-5 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:

- Minimise hardscape areas and increase landscaping 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 vegetated swales, biofiltration swales, wetlands, dry wells and rain gardens improving water quality and infiltration
- Use retention and/or detention ponds
- Use green roofs

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Calculation

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 and deduct all building footprints not covered by a green roof
- Identify the area of each type of hardscaping or landscaping used
- Identify the runoff coefficient of each type of hardscaping or landscaping used
- Calculate average site perviousness using the following formula:

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

A_i = Area of space n [m^2]

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

A_{site} = Total site area less building footprints not covered by a green roof [m^2]

Runoff coefficients in Table LE.6 should be used for the average site perviousness calculation unless manufacturer's published data is available for a specific surface material.

Table LE.6: 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

Submissions

Certification Stage
• Site plan highlighting the different landscape and hardscape areas (and green roof, if any)
• Photographs of the different landscape and hardscape areas (and green roof, if any)

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LE-6 Flood Risk Mitigation

Intent

To encourage flood resistant designs and building features to adapt to climate change

Requirements

Criteria	1 point
Prepare a local flood risk identification statement for the site - AND - Implement flood risk mitigation strategies if required	1

Overview

Flooding is one of the biggest problems for urban areas as it causes severe damage to communities, buildings and the local economy. It is expected that flooding frequency and intensity will increase dramatically due to the impacts of climate change. In addition, the rapid growth of both Vietnam's economy and population has contributed to a great pressure on its aging and inadequate infrastructure system. Drainage systems in highly populated cities are seasonally overloaded and natural drainage systems are gradually disappearing in the rapid expansion of population and urban structures.

Currently flood hazard mapping is very limited in Vietnam but there will be increasing availability of useable maps over the next few years as research in this area grows in popularity amongst universities as well as the government.

Approach & Implementation

A 'local flood risk identification statement' can be a simple one page document added to the architectural plan set. This document must include a flood map if available, identifying whether the selected site is within flood prone area. If a flood map is not available, a location plan identifying possible sources of water inundation must be provided.

The following are examples of strategies which can be employed to increase a building's ability to resist flood damage:

- Elevate buildings above the predicted flood level by piers, piles, columns or bearing walls
- Flood-proof the lower levels of buildings by sealing them against water penetration
- Employ wet flood-proofing methods

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- 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 floor

Submissions

Certification Stage
• Local flood risk identification statement including flood map or a location plan identifying possible sources of water inundation • If there is a flood risk: Photographs, site plan or narratives showing and explaining the strategies employed to increase the building’s ability to resist flood damage.

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LE-7 Refrigerants

Intent

To encourage the selection and use of refrigerants that do not increase global warming nor damage the ozone layer.

Requirements

Credit	1 point
No R22 refrigerant is used in the building - AND - Refrigerators/freezers use natural refrigerants	1

Overview

R-22 is a Hydrochloroflourocarbon (HCFC) refrigerant that is still commonly used in Vietnam (mainly for air-conditioning) but it has a significant Ozone Depleting Potential (ODP), and thus contribute to ozone depletion when emitted to the atmosphere. Under the 2007 Montreal Adjustment on Production and Consumption of HCFCs, Vietnam (Article 5 (developing country) Parties) committed to phase out HCFCs (including R-22) with 10% reduction by 2015, 35% reduction by 2020, 67.5% reduction by 2025, and 100% reduction by 2030.

Common chemical refrigerants used in refrigerators and freezers are Hydroflourocarbons (HFCs) such as R-410A and R-134A. These refrigerants are not ozone depleting substances but they have significant Global Warming Potential (GWP), thus they contribute to global warming when emitted to the atmosphere.

Natural refrigerants all have a very low GWP and can provide efficient performance when carefully designed. Hydrocarbons (such as isobutane – R600a) are excellent natural refrigerants for small hermetically sealed systems and their use should be encouraged.

Approach & Implementation

Do not select any system or equipment using R-22 and select refrigerators/freezers using natural refrigerants.

In the case that old refrigerators/freezers are re-used, the refrigerants don’t have to be natural refrigerants.

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Submissions

Certification Stage
• Technical data of all the air-conditioning systems and refrigerators/freezers installed showing the type of refrigerant used • Evidence that the aforementioned equipment were installed such as photographs, etc.

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LE-8 Waste Management

Intent

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

Requirements

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 to separate the following types of waste:

- Recyclables
- Organic wastes
- Garbage

Submissions

Certification Stage
• Evidence showing that different bins for recyclables, organic wastes and garbage are provided such as photographs, etc.

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Community & 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 projects 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.

At completion of construction, producing a building operation and maintenance manual (O&M manual) including the necessary information for the operation and maintenance of the building is an important measure to ensure a good performance of the building during operation.

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Community & Management		7 Points
Item	Criteria	Points
CM-1	Design Management	1 point
	Perform an Eco-Charrette	1
CM-2	Construction Management	5 points
	Strategy A: Stormwater pollution prevention, erosion control and sediment control	
	Implement best management practices for stormwater pollution prevention, erosion and sediment control.	1
	Strategy B: Demolition and construction waste	
	Implement strategies to minimize demolition and construction waste	1
	Strategy C: Construction noise	
	Implement adequate mitigation measures to limit construction noise	1
	Strategy D: Neighborhood Impact Plan	
	Implement adequate measures to reduce construction impacts on neighboring properties	1
	Strategy E: Construction Worker Management	
	Implement a Construction Worker Management Plan	1
CM-3	Operational Management	1 point
	Provide a Building Operation & Maintenance Manual	1

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CM-1 Design Management

Intent

To ensure all sustainable design aspects are identified and planned for at the earliest stage of the project.

Requirements

Criteria	1 point
Perform an Eco-Charrette	1

Overview

An Eco-Charrette is an interactive, multi-stakeholder, team-building exercise that explores the key green building and green development aspects of a project before any design decisions are made. Through this process, stakeholders work together to generate and target green building and sustainability goals prior to developing a more detailed approach. This is usually a minimum one-day facilitated meeting but is highly dependent on the size and complexity of the project.

Approach & Implementation

An Eco-charrette must be held during the design stage of the project. The Eco-Charrette should bring together a mix of:

- Owners
- Architects, engineers and designers
- Contractors
- Local officials, planners and neighbours

Through a process of education, discussion and small-group activities, the Eco-Charrette should utilise the skills of participants to arrive at major design decisions. This will allow full recognition of the potential interactions of green building measures with building requirements. More specifically, its defined objectives should be to:

- Set up sustainability targets and objectives for the project
- Educate the team, owner, and community about environmental issues
- Gain a long-term perspective of environmental impacts from building development
- Begin the collaborative approach necessary for a successful integrated design

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- Form an expanded network of expertise and experience for input and advice throughout the project
- Instill all parties with a sense of mission and ownership of the process and outcome

Submissions

Certification Stage
• Minutes of meeting of the Eco-Charrette • Photographs of the event showing the participants at the Eco-Charrette

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CM-2 Construction Management

Intent

To improve the construction practices on development sites to minimize the impact of construction on the local environment and surrounding land users.

Requirements

Criteria	5 points
Strategy A: Stormwater pollution prevention, erosion and sediment control	
Implement best management practices for stormwater pollution prevention, erosion and sediment control.	1
Strategy B: Demolition and construction waste	
Implement strategies to minimize demolition and construction waste	1
Strategy C: Construction noise	
Implement adequate mitigation measures to limit construction noise	1
Strategy D: Neighborhood Impact Plan	
Implement adequate measures to reduce construction impacts on neighboring properties	1
Strategy E: Construction Worker Management	
Implement a Construction Worker Management Plan	1

Overview

The environmental impacts of construction works are numerous and diverse: noise, dust, stormwater pollution, waste generation, etc. All these impacts should be considered and identified as early as possible. Then, construction practices can be improved by incorporating appropriate measures to minimize these impacts.

Approach & Implementation

Strategy A: Stormwater pollution prevention, erosion and sediment control

Analyze potential disturbances during construction and implement appropriate best management practices to control stormwater pollution, erosion and sedimentation.

- Erosion control measures to control erosion and prevent associated water pollution and soil loss. Such measures include: mulching, vegetation, erosion control blankets etc.

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- Sediment control measures to keep eroded soil on the construction site. Such measures include: Silt Fence, Sediment Basin, Sediment Trap, Check Dam, Fiber Rolls, Sandbag Barrier, Storm Drain Inlet Protection, etc.

Strategy B: Demolition and construction waste

A construction and demolition waste minimization strategy must include the following:

- Identification and classification of all sources of waste
- Strategies to reduce the generation of waste on site
- Strategies to reuse waste directly on site
- Strategies to reuse, salvage or recycle waste off site
- Disposal locations of all waste (recycling facilities, reuse location, landfill, etc.)

Strategy C: Construction noise

A Construction Noise Mitigation Strategy must include the following:

- Identification of noise sensitive locations including adjoining residential properties, schools and places of worship
- Identification of high impact construction practices such as jackhammering, heavy machinery,
- Identify ways to reduce noise impact on sensitive receivers:
  - Limit construction hours to 9:00 am – 5:00 pm
  - Notify neighbors of construction periods
  - Noise barriers
  - Modify a noisy process or equipment
  - Use well-maintained equipment

Strategy D: Neighborhood Impact Plan

A Neighborhood Impact Plan must include the following:

- Identification of any common access points for the site and neighboring properties
- Ensure storage areas for any construction materials and waste are not blocking common access
- Ensure construction vehicles are not blocking access to neighboring properties
- Allow adjoining properties access to the Neighborhood Impact Plan

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Strategy E: Construction Worker Management

A Construction Worker Management Plan must identify the following:

- Construction hours
- Total number of workers on site
- Location of rubbish and waste collection of workers
- Location of toilet facilities for workers
- Worker rest areas within the boundary of the site

Submissions

Certification Stage
Strategy A: Stormwater pollution prevention, erosion control and sediment control
• Evidence showing each measure implemented such as photographs, etc.
Strategy B: Demolition and construction waste
No documentation needs to be submitted for this strategy
Strategy C: Construction noise
• Evidence showing each measure implemented such as photographs, etc.
Strategy D: Neighborhood Impact Plan
• Plan showing the common access points, storage areas and location for construction vehicles to be stationed
Strategy E: Construction Worker Management
• Site master plan showing the locations of waste collection, toilet facilities and rest areas.

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CM-3 Operational Management

Intent

To ensure that the completed development is managed in a sustainable manner.

Requirements

Criteria	1 point
Provide a Building Operation & Maintenance Manual	1

Overview

The building operation and maintenance manual (O&M manual) includes the necessary information for the operation and maintenance of the building.

Approach & Implementation

The building operation and maintenance manual should include:

- A description of the main design principles
- As-built drawings and specifications
- Instructions for building operation and maintenance (including health and safety information, general instructions for efficient operation and periodical maintenance)
- Schedule of all equipment
- Commissioning and testing results (if any)
- Guarantees, warranties and certificates

Submissions

Certification Stage
• Photographs of the Building Operation & Maintenance Manual showing the different documents included

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Innovation

The purpose of this category is to reward innovative techniques/initiatives, as well as exceptional performance enhancement.

There are up to 4 points available over the 2 credits, but these points are not specifically assessed to one or the other credit.

Innovation		4 bonus Points
Item	Criteria	Points
Inn-1	Exceptional Performance Enhancement	4
	Exceed significantly the credit requirements of LOTUS credits	
Inn-2	Innovative techniques / initiatives	
	Implement innovative techniques/initiatives that are outside the scope of LOTUS	

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Inn-1 Exceptional Performance Enhancement

Intent

To encourage exceptional performance, and recognize projects that achieves environmental benefits in excess of the current LOTUS Rating System benchmarks.

Requirements

Criteria	4 Points
Exceed significantly the credit requirements of LOTUS credits	1-4

Overview

The weightings and benchmarks in LOTUS have been set to reflect what is perceived as possible in the current market. However, if any innovative idea allows the design team to exceed significantly the requirements of the highest threshold, points will be rewarded. The applicant must describe what innovative strategies/initiatives have been implemented in order to achieve the Exceptional Performance Enhancement Credit. The VGBC reserves the right to not award points where the performance improvement is not demonstrated to be achieved by innovative measures or where required evidence is not adequately provided.

Approach & Implementation

Innovation credits are considered on a case by case basis. Up to 4 Exceptional Performance Enhancement Innovation credits may be targeted (1 point each) out of a maximum of 4 points available in the Innovation category. In special cases, the VGBC may consider awarding more than 1 Innovation point for a single initiative.

There are three different cases where Exceptional Performance Enhancement points can be awarded:

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 LE-3 Vegetation – Strategy A

Requirement (Level 1) – 15% of the total site area is vegetated with native or adapted vegetation Requirement (Level 2) – 30% of the total site area is vegetated with native or adapted vegetation

Surpass by the next increment – 45% of the total site area is vegetated with native or adapted vegetation

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Case 2: In a credit with only one performance threshold, the building performance significantly exceeds the credit requirement.

Example: Credit H-1 Fresh Air Supply

Requirement - Provide sufficient fresh air supply to a minimum of 90% of the total net habitable area of the building.

A building that exceeds the fresh air supply requirement of a national or international standard by 30% may be eligible for an Innovation point

Case 3: 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 LE-3 Vegetation

- Strategy A – The building has more than 30% of the total site area that is vegetated with native or adapted vegetation and 2 points can be earned.
- Strategy B – The building has installed more than 1 pot plant unit for every 10 m^2 of GFA, balconies and rooftop area and 1 point can be earned.
- The building can be awarded 2 points in Credit LE-3 Vegetation and 1 point in credit Inn-1.

Calculation

The calculation of each exceeded benchmark has to be done exactly the same way as the given credit specifies it.

Submissions

Certification Stage
For each Exceptional Performance Enhancement of a credit: • Submissions as per initial credit requirements

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Inn-2 Innovative Techniques/Initiatives

Intent

To promote techniques and/or initiatives that are out of the scope of the current LOTUS Rating System.

Requirements

Criteria	4 Points
Implement innovative and environmentally friendly solutions that are not considered in the scope of LOTUS Homes	1-4

Overview

An innovative submission must be a concise report that clearly articulates the nature and magnitude of the environmental benefit achieved by proposed initiative(s).

Approach & Implementation

LOTUS Homes 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 a strategy or practice in the building that is not addressed by any LOTUS Homes credits.

An Inn-2 submission must be a concise report that clearly articulates the nature and magnitude of the environmental benefit achieved by the proposed initiative. Innovation credits are 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 and environmental benefit cannot be provided. For this reason it is advisable to confirm the proposed innovation credit nature, thresholds and submittal requirements with the LOTUS team at any time prior to submittal.

Submissions

Certification Stage
For each Innovative Technique/Initiative: • Evidence demonstrating that the construction, installation or implementation has been done according to the description provided. • If necessary, supporting evidence verifying the expected performance such as manufacturer's data, calculations, etc.

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Appendix A: Best Practice Credits

Best Practice Credit List

Credit	Title	Bonus Points
ENERGY		5 bonus points
E-BPC-1	OTTV reduction	1 bonus
E-BPC-2	Renewable Energy	3 bonus
E-BPC-3	Home Energy Controls	1 bonus
WATER		4 bonus points
W-BPC-1	Rainwater harvesting	1 bonus
W-BPC-2	Water recycling/reuse	2 bonus
W-BPC-3	Swimming Pool Water Efficiency	1 bonus
HEALTH & COMFORT		3 bonus points
H-BPC-1	Indoor Air Pollution Prevention	1 bonus
H-BPC-2	Lighting Comfort	1 bonus
H-BPC-3	Sound	1 bonus
LOCAL ENVIRONMENT		1 bonus points
LE-BPC	Composting	1 bonus
COMMUNITY & MANAGEMENT		3 bonus points
CM-BPC-1	LOTUS AP	1 bonus
CM-BPC-2	Public Awareness Campaign	1 bonus
CM-BPC-3	Comprehensive Construction Management Plan	1 bonus

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E-BPC-1 OTTV Calculation

Intent

To optimize the thermal performance of the building.

Requirements

Criteria	1 point
Building's average OTTV surpasses VBEEC requirements by 40%	1

Approach & Implementation

A good method to assess the overall performance of the building envelope involves the calculation of the Overall Thermal Transfer Value (OTTV). This factor determines the maximum thermal transfer permissible into the building through its walls, roof and windows due to solar heat gain and outdoor-indoor temperature difference. A well designed building envelope with a low OTTV value will minimise external heat gain while reducing the load on mechanical systems. Maximum OTTV values required by the VBEEC are 60 W/m^2 for walls and 25 W/m^2 for roofs.

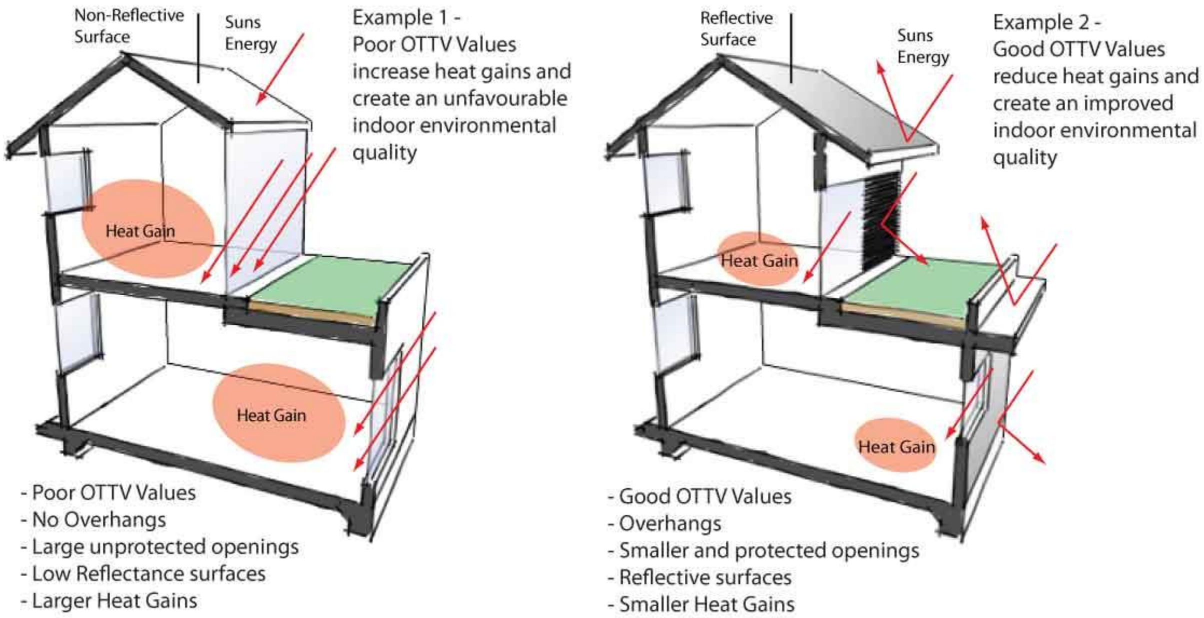

Figure E.2: OTTV to assess the overall performance of the building envelope

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

- Specification of materials with high thermal insulation for opaque walls and roofs
- Specification of proper techniques for the construction of the building envelope
- Optimised positioning and orientation of the building to reduce loads
- Proper sealing of windows, doors, mechanical openings and other assemblies within or penetrating the building envelope
- Provision of external shading to reduce unnecessary heat gains from solar irradiation
- Specification of glazing with low SHGC (solar heat gain coefficient)
- Specification of surface materials with a high solar reflectance

Calculation

Use the OTTV calculation tool provided by VGBC or follow the below steps to calculate OTTV:

- Step 1. Calculations of the OTTV values for each facade and roof

Calculations must be undertaken for each wall and roof assembly according to the normative reference of the VBEEC.

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

Where:

WWR = Window-to-wall area ratio for the gross exterior wall being considered. The ratio of window area over the general area of the wall concerned or the ratio of skylight over the general area of roof (non-dimensional)

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

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

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

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

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

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

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

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

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

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

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

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

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

- Step 3. Calculations of the maximum VBEEC compliant average building OTTV

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

- Step 4. Calculation of the improvement compared to the VBEEC

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

Submissions

Certification Stage
• Completed file 'LOTUS Calculator - OTTV calculation' including all calculations

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E-BPC-2 Renewable Energy

Intent

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

Requirements

Criteria	3 points
Install a renewable electricity generation system with a power output of more than 1 kW	1
Install a renewable electricity generation system with a power output of more than 2 kW	2
Install a renewable electricity generation system with a power output of more than 3 kW	3

Approach & Implementation

Produce energy with a renewable electricity generation system installed on-site. Renewable energy sources that can be used include:

- Biomass, subject to VGBC approval
- Photovoltaic (PV)
- Wind
- Micro-hydro

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

Certification Stage
• Evidence showing that the renewable electricity generation systems are installed such as photographs, invoices, etc. • Evidence showing the power output of the renewable electricity generation systems installed such as technical data, photographs, etc.

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E-BPC-3 Home Energy Controls

Intent

To encourage the use of energy control solutions to save energy

Requirements

Criteria	1 point
Install at least 2 different types of energy control solutions in the house	1

Approach & Implementation

Install at least 2 different types of energy control solutions in the house where it can be effective:

- 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 daylit zone areas (cf credit H-4 Daylighting)
- Automated shadings to optimise the use of daylight and minimise solar heat gains
- Plug load controls to automatically turn receptacles off and on as needed

Submissions

Certification Stage
• Evidence showing that the energy control solutions are installed such as photographs, invoices, etc.

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W-BPC-1 Rainwater Harvesting

Intent

To encourage rainwater harvesting as a means to reduce domestic water consumption

Requirements

Criteria	1 point
Install a rainwater harvesting system to catch rainwater falling on the roof	1

Approach & Implementation

Rainwater can be collected from impervious surfaces to be used for non-potable water usage and to reduce rainwater runoff and control infrastructure demand.

To design a rainwater harvesting system, the following elements should be considered:

- Catchment area. The roof surface should be used as the catchment area. The slope of the roof will affect how quickly water will runoff during a rain event. With a steep roof, rainwater will be collected faster, in bigger quantity and cleaner (less potential for contamination) than with low-slope or flat roofs.
- Conveyance. The gutters should be sized so that they adequately move rainwater runoff from storm events. Downspouts should also be sized properly, a downspout area of 10 cm^2 for 15 m^2 of roof area is advised.
- Storage. The storage tank is where the captured rainwater is diverted to and stored for later use. The size of the tank will depend on the daily rainwater consumption, the duration of the dry season, the catchment area, the space available at the location where the tank will be located…
- Treatment. Treatment of rainwater ensures that the water will be safe to use. Two types of treatment should be done (pre-storage and after-storage treatment) to treat microbiological contaminants, chemical contaminants and debris.
  - Pre-storage treatment: The goal of pre-storage treatment is to clean the rainwater runoff as much as possible before it enters the storage tank. This helps to reduce organic matter from collecting in the tank, and it reduces the amount of treatment needed after storage. Pre-storage treatment targets “large” debris that can easily be seen. It is done by two different methods: diversion or screening.

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Diversion is when the first flush of roof water runoff is collected and separated from entering the storage container. This first flush contains the most amount of debris from the roof surface. In such case, simple but regular inspection and maintenance of the mechanism is necessary.

Debris screens filter out large contaminants before they end up in the storage container. There are several locations along the conveyance network where they can be used. The first type is the gutter debris screen. This device attaches to a gutter and removes leaves and other debris from entering the system. Screens can also be placed on the downspout.

- After-storage treatment: Treatment of the water after the storage and before use is critical for both health of the users and maintenance of the system. The level of treatment will depend of the intended use of the water 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). 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 they are checked and changed on a regular basis so that they maintain their effectiveness.
    - 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 with viruses and bacteria. An advantage to chlorine is that is 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

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microorganisms so that they can't reproduce. There are a 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 the filtration before the 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.

  - Adsorption. Adsorption uses activated carbon (charcoal filters) to bind to harmful contaminants, such as VOCs. These are the types of filters commonly used on faucets. They can also be used to remove chlorine from water used for disinfection.

- Distribution. The distribution component of a rainwater harvesting system includes all of the piping, pumps, and other devices that move water from the storage and treatment to the point-of-use.

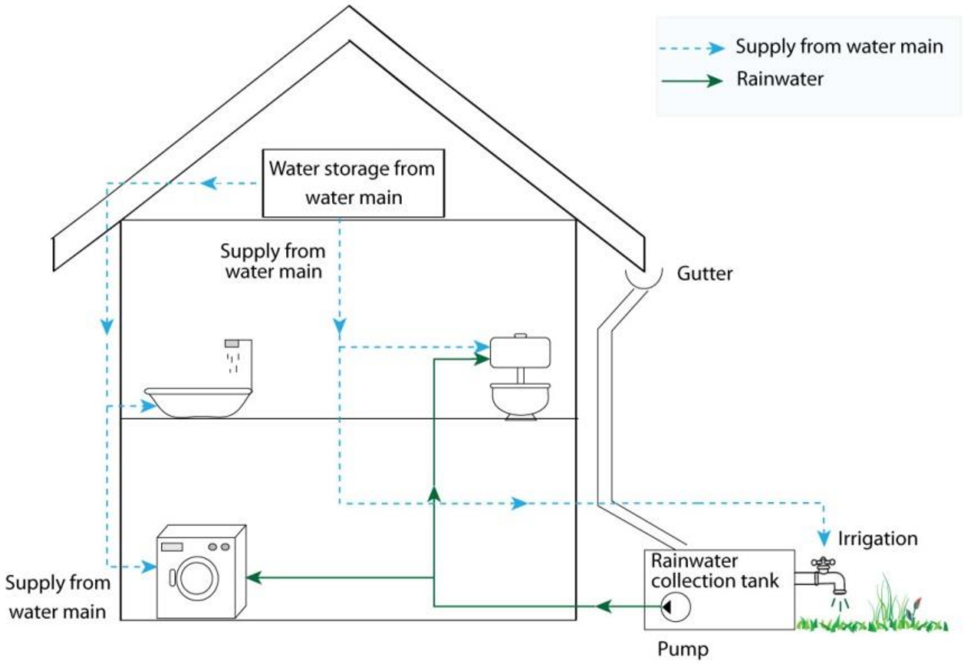

Figure W.1: Rainwater harvesting system

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Submissions

Certification Stage
• Photographs showing the different components of the rainwater harvesting system (catchment area, gutters, storage tank, treatment methods, distribution pumps, etc.) • Schematics showing the water distribution system

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W-BPC-2 Domestic Water reuse

Intent

To encourage water recycling and reuse as a means to reduce domestic water consumption

Requirements

Criteria	2 points
Strategy A: Reuse water for irrigation	
Use reused water to meet the water demand for irrigation	1
Strategy B: Reuse water for WC flushing	
Use reused water to meet the water demand for WC flushing	1

Approach & Implementation

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

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

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

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

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

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

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To ensure that the uses associated with treated gray water are always supplied (e.g. so that the tanks can continuously discharge) the system should be complemented by another source of water supply.

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

Recycled or reused water must comply at the point of delivery with minimum quality requirements of national or international standards.

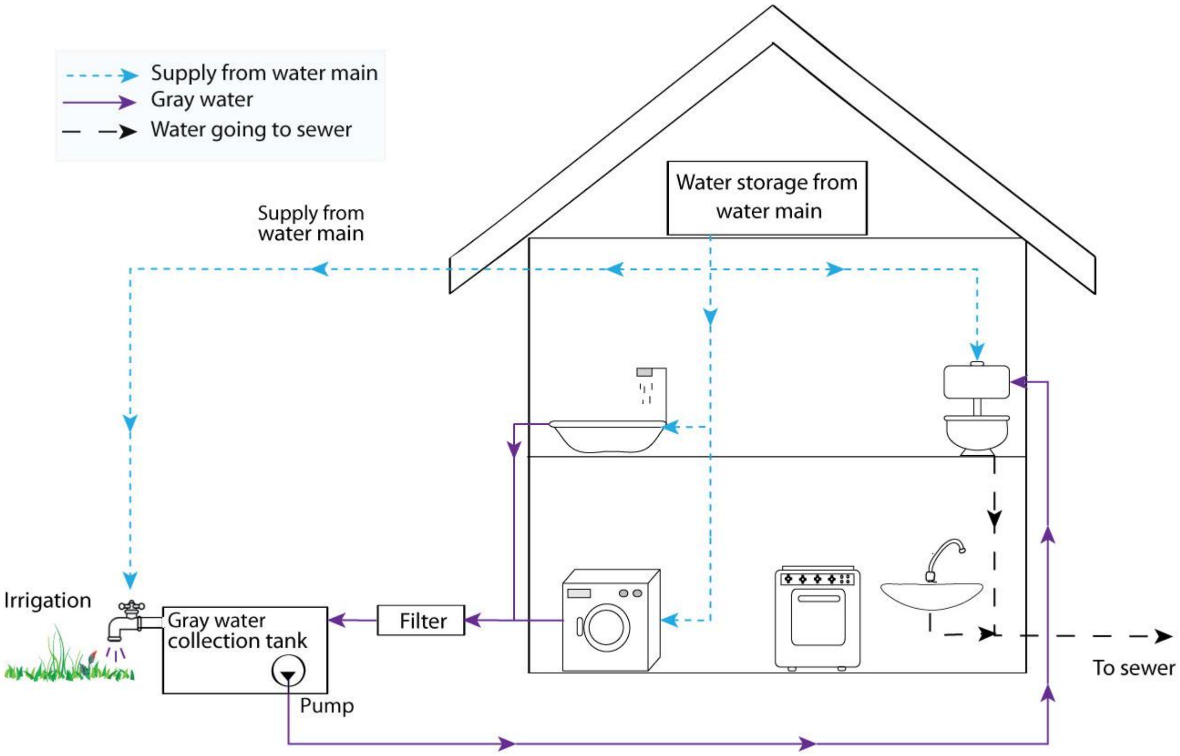

Figure W.2: Gray water collection system

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

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

Strategy A: Reuse water for irrigation

Use reused water (gray or black water) to meet the water demand for irrigation.

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Water demand for irrigation shall be calculated following the description in the performance path of credit W-2 Water Efficient Landscaping. Alternative methods of calculation may be accepted and shall be subject to VGBC approval.

Strategy B: Reuse water for WC flushing

Use reused water (gray or black water) to meet the water demand for WC flushing.
Water demand for WC flushing shall be calculated following the description in the performance path of credit W-1 Water Efficient Fixtures.

Submissions

Certification Stage
• Photographs showing the different components of the water reuse system (storage tank, treatment methods, distribution pumps, etc.) • Schematics showing the water distribution system

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W-BPC-3 Swimming Pool Water Efficiency

Intent

To reduce water consumption of swimming pools.

Requirements

Criteria	1 point
Implement strategies to reduce water use for swimming pools	1

Approach & Implementation

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

- Reduce evaporation with the installation of a pool cover. The pool should be covered anytime it is not being used.
- Use more water efficient filter systems such as cartridge filters which do not need backwashing. If sand filter is used, a pressure drop sensor should be installed in order to know when backwash is needed, and the backwash water should be reused to water plants or for any other beneficial use.
- Monitor pool filling to be able to detect leaks (when a sharp increase of the amount of water needed to fill the pool is noticed.)
- Other strategies may be applied but shall be subject to VGBC approval

Submissions

Certification Stage
• Photographs showing the strategies implemented

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H-BPC-1 Indoor Air Pollution Prevention

Intent

To regulate indoor air quality via CO_2 monitoring and to prevent the leakage of combustion gases into the house

Requirements

Criteria	1 Point
Option A: CO_2 monitoring	
Specify and install a CO_2 monitoring system	1
Option B: Basic Combustion Venting Measures	
Implement basic combustion venting measures	1

Approach & Implementation

Option A: CO_2 monitoring

CO_2 sensors should be installed in bedrooms and living rooms equipped with air-conditioning systems.
They should be located between 1 and 2 meters above the finished floor (breathing zone) and configured to generate an alarm when the CO_2 concentration gets higher than a CO_{2max} concentration (a maximum CO_2 level of 600 ppm is advised). The alarm should be able to alert the building occupants through visible or audible alerts.

In the case that hazardous gas risks (carbon monoxide, hydrogen sulfide, nitrogen dioxide etc.) are identified for a project, continuous monitoring systems to warn of dangerous conditions can be designed. Such a strategy may be eligible for an Innovation credit.

Option B: Basic Combustion Venting Measures

This best practice option only applies to projects with either:
an attached garage,
a fireplace, or
a gas heater or appliance

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Implement the following measures to prevent leakage of combustion gases:

No unvented combustion appliances (e.g., decorative logs) are allowed.
A carbon monoxide (CO) detector must be installed on each floor and at proximity to sleeping areas
All fireplaces and woodstoves must have doors.

Submissions

Certification Stage
Option A: CO_2 monitoring
• Photographs and technical data of the CO_2 sensors installed
Option B: Basic Combustion Venting Measures
• Photographs showing all the installed carbon monoxide (CO) detectors and photographs showing the fireplaces and woodstoves (if any)

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H-BPC-2 Lighting Comfort

Intent

To encourage the provision of high quality lighting that provides good comfort to occupants.

Requirements

Criteria	1 point
95% of the habitable spaces meet recommended illuminance levels	1

Approach & Implementation

Illuminance is the total luminous flux incident on a surface, per unit area. It is a measure of how much the incident light illuminates the surface,

Ensure sufficient light levels in the habitable spaces by meeting recommendations on illuminance in Table H.3.

Table H.3: Minimum illuminance for different locations of the house

Location	Minimum illuminance (lux)
Kitchen - ambient	100
Kitchen - task	500
Living room	50
Dining room	50
Bedroom - ambient	50
Bedroom - reading	400
Study - desk	400

Internationally recognized systems (SLL Code for Lighting from CIBSE, AS/NZS 1680.1:2006, EN12464-1, etc.) may also be used to demonstrate compliance on average illuminance.

Calculations

Illuminance levels can be calculated as follows:

$$illuminance\ of\ ambient\ lighting\ (lux) = \frac{lumen\ output\ of\ ambient\ lights\ (lm)}{area\ of\ the\ space\ (m^2)}$$

$$illuminance\ of\ task\ lighting\ (lux\ = \frac{lumen\ output\ of\ task\ lights\ (lm)}{area\ of\ the\ work\ surface(m^2)}$$

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Example: Method to determine the appropriate lighting for a 12m^2 kitchen with a countertop (surface used for food preparation) measuring 4m x 0.6m.

Step 1: Determine the lumens needed

Ambient lighting in the kitchen
With a minimum illuminance of 100 lux and an area of 12 m^2: 12 m^2 x 100 lux = 1200 lumens

Task lighting in the kitchen
The countertop measures 3m x 0.9m which makes an area of 2.7 square meters.
To get the number of lumens, the calculation is 2.7 x 500 = 1350 lumens

Step 2: Determine the number of lighting fixtures needed

Ambient lighting in the kitchen:
The aim is to install one or several fixtures that together would provide slightly more than 1200 lumens. The higher the number of lumens, the higher the lighting power, so it is important to not exceed a lot the value of 1200 lumens.

Thus, appropriate lighting fixture(s) should be selected based on luminous efficacy (for energy efficiency - cf credit E-4) and the lumen output.

For example, if T5 fluorescent tubes that emit 800 lumens each are available. One tube wouldn't be sufficient, but two tubes would give 1600 lumens which would be plenty for the 1200 lumen requirement. In such case, it might be interesting to find a different type of lighting fixture to exceed requirements by less than 400 lumens.

Task lighting in the kitchen:
If the project wants to use LEDs for the under the cabinet lighting and a LED bulb which gives out 350 lumens is found.

Number of bulbs needed: 1350/350 = 3.8 which means that a minimum of 4 of the bulbs is needed to light the countertop.

Submissions

Certification Stage
• Technical data of the lighting fixtures showing lumen output • Evidence showing that the lighting fixtures were installed such as photographs, invoices, etc.

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H-BPC-3 Acoustic Comfort

Intent

To provide a comfortable acoustic environment for occupants.

Requirements

Criteria	1 Point
Average reverberation time (T60) in the habitable spaces of the project should be lower than 0.6 seconds	1

Approach & Implementation

A reverberation is the overall effect of reflected sound and the time required for reflected sound to become inaudible.

The reverberation time (T_{60}) measures the reflectivity of a room and consequently a room's absorbance to sound waves. The higher the reflectivity of a room, the longer the reverberation time will be. The reverberation time is proportional to the volume of the space, and inversely proportional to the amount of sound absorbing material within the space.

The reflectivity is dependent on factors like: geometry, room fittings and the nature of sound source.

Reverberation time in the habitable spaces of the building should be lower than 0.6 seconds.

Calculation

The calculation could be made according to ISO 3382 Acoustics – Measurement of the reverberation time for rooms with reference to other acoustical parameters.

The reverberation time can also be calculated theoretically, at the design stage, using modelling software that includes an acoustic component.

Submissions

Certification Stage
• Results of the calculations of the reverberation time • Evidence showing that the materials used in the calculations were installed such as photographs, invoices, etc.

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LE-BPC-1 Composting

Intent

To reduce the amount of waste sent to landfills and to improve soil quality

Requirements

Credit	1 point
Install a compost bin to compost organic wastes	1

Approach & Implementation

Install a compost bin and compost organic wastes such as food scraps and garden waste.

The following steps should be followed to ensure a good composting:

1. Start your compost pile on bare earth. This allows worms and other beneficial organisms to aerate the compost and be transported to your garden beds.
2. Lay twigs or straw first, a few centimeters deep. This aids drainage and aerate the pile.
3. Add compost materials in layers, alternating moist and dry. Moist ingredients are food scraps, tea bags, seaweed, etc. Dry materials are straw, leaves, sawdust pellets, etc.
4. Add manure, green manure (clover, buckwheat, wheatgrass, grass clippings) or any nitrogen source. This activates the compost pile and speeds the process along.
5. Keep compost moist. Water occasionally, or let rain do the job.
6. Cover the compost bin. Covering helps retain moisture and heat, two essentials for compost. Covering also prevents the compost from being over-watered by rain. The compost should be moist, but not soaked and sodden.
7. Turn. Every few weeks give the pile a quick turn with a pitchfork or shovel. This aerates the pile. Oxygen is required for the process to work, and turning "adds" oxygen. You can skip this step if you have a ready supply of coarse material, like straw.

Once your compost pile is established, add new materials by mixing them in, rather than by adding them in layers. Mixing, or turning, the compost pile is key to aerating the composting materials and speeding the process to completion.

To meet the requirements of this credit, the compost produced should be used for the landscaping of the house or made available for other people to use it.

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Submissions

Certification Stage
• Photographs showing the compost bin and the compost being used for landscaping

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CM-BPC-1 LOTUS AP

Intent

To encourage the involvement of a qualified individual to manage these aspects through the design process and maintained during the construction stage.

Requirements

Criteria	1 point
Involve a LOTUS AP in the project team from design to completion of construction	1

Approach & Implementation

A qualified individual, internal or external, is appointed with direct responsibility to ensure that all sustainable aspects of the project are met and best practice is achieved throughout the project lifecycle. This individual will be known as a 'green consultant' and should be a LOTUS Accredited Professional (LOTUS AP) who has successfully been taken and passed the LOTUS AP Exam provided by the VGBC. The primary objective of the LOTUS AP is to ensure that reliable analysis tools are introduced early into the design process to enable integrated design decisions.

Submissions

Certification Stage
• Evidence showing the involvement of a LOTUS AP from design to completion of construction

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CM-BPC-2 Comprehensive Construction Management Plan

Intent

To improve the construction practices on development sites to improve the impact of construction on the local environment and surrounding land users.

Requirements

Criteria	1 point
Prepare and implement a Construction Management Plan covering all the strategies in credit CM-2 Construction Management	1

Approach & Implementation

A Construction Management Plan must contain, at a minimum, all the information listed in the credit CM-2 Construction Management.

Submissions

Certification Stage
No documentation needs to be submitted for this strategy.

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CM-BPC-3 Public Awareness Campaign

Intent

To promote general public awareness on sustainability and green buildings

Requirements

Criteria	1 point
Conduct at least two activities to promote general public awareness	1

Approach & Implementation

Promote general public awareness about LOTUS Homes and green building by conducting at least two of the following activities:

Hold an advertised, attended public open house that lasts at least four hours per day on at least two weekends, or participate in a green building exhibition or tour. Offer a guided tour that highlights green building features.

Publish a website with at least two pages that provides detailed information about the features and benefits of owning a certified LOTUS Homes.

Generate a newspaper article on the LOTUS Homes project.

Display LOTUS signage, on the exterior of the home or building.

Submissions

Certification Stage
• Evidence showing that at least 2 different activities to promote general public awareness have been conducted such as photographs, newspaper extracts, etc.

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Appendix B: Performance paths

E-2 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	4 points
Strategy A: U-values of walls and roof	
Average U-value of the walls and roof are 20% lower than VBEEC requirements.	1
Average U-value of the walls and roof are 40% lower than VBEEC requirements.	2
Strategy B: SHGC values of glazing	
SHGC values of glazing are 10% lower than VBEEC requirements.	1
SHGC values of glazing are 20% lower than VBEEC requirements.	2
Strategy C: Solar radiation on opaque surfaces	
Implement strategies to reduce the solar radiation absorbed by opaque surfaces	1

Approach & Implementation

Strategy A: U-values of walls and roof

To decrease the heat transfer through the walls and roof, 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 and roof assemblies
- Add air layers (ventilated or unventilated)

VBEEC requires U-value of external walls to be lower than 1.8 W/m^2.K and U-value of roofs to be lower than 1 W/m^2.K.

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Strategy B: SHGC values of glazing

Select glazing materials with SHGC values lower than the values in Table E.3 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 VBEEC where allowances (A coefficient) on maximum SHGC values are given based on the geometry of the sunshades installed.

For glazing areas shaded by vegetation, 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.3: Maximum SHGC values of glazing for different WWR and orientations
(*Source: Table 2.3 of QCVN 09:2013*)

WWR (%)	$SHGC_{max}$ on 8 main orientations			
	N	E or W	NE, NW or SE, SW	S
≤ 20	0.90	0.80	0.86	0.90
30	0.64	0.58	0.63	0.70
40	0.50	0.46	0.49	0.56
50	0.40	0.38	0.40	0.45
60	0.33	0.32	0.34	0.39
70	0.27	0.27	0.29	0.33
80	0.23	0.23	0.25	0.28
90	0.20	0.20	0.21	0.25
100	0.17	0.18	0.19	0.22

Strategy C: 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

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Submissions

Certification Stage
Strategy A: U-values of walls and roof
• Calculations of the U-values of external walls and roof • Drawings of the external wall and roof assemblies indicating materials used
Strategy B: SHGC values of glazing
• Technical data of the glazing systems installed indicating SHGC values • Evidence that the aforementioned glazing systems are installed such as photographs, invoices, etc.
Strategy C: Solar radiation on solid surfaces
• Plans and elevations indicating the types of solid surfaces • For surfaces with high solar reflectivity, technical data or evidence justifying the high solar reflectivity value.

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E-3 Home Cooling

Intent

To reduce the need for HVAC systems and increase natural air flow and to encourage the installation of energy efficient HVAC systems.

Requirements

Criteria	6 points
Strategy A: Natural cooling	
Strategy A1: Stack Ventilation Install a vent column or an effective rooftop turbine vent to create stack ventilation	1
Strategy A2: Cross ventilation 1 point for every 20% of the area in living rooms and bedrooms which are designed with effective cross ventilation (up to 80%)	4
Strategy B: Mechanical cooling with air-conditioning system	
Strategy B1: Variable speed compressors All air-conditioners are equipped with variable speed compressors (inverters)	1
Strategy B2: COP Improvement 1 point for every 10% improvement of the average COP of all the air-conditioners in comparison to VBEEC requirements (up to 30%)	3

Approach & Implementation

Strategy A: Natural cooling

Strategy A1: 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 A2: Cross ventilation

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

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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.

Strategy B: Mechanical cooling with air-conditioning system

Strategy B1: Variable speed compressors

Select air-conditioners systems that are equipped with variable speed compressors (often referred to as inverters for split-units) to ensure better part-load systems efficiency.

Strategy B2: COP Improvement

Select and install HVAC equipment whose COP values meet the minimum requirement values of Table E.4. Increasing COP Values result in an improvement of the efficiency of HVAC systems.

Calculations

Strategy A: Natural cooling

Strategy A2: Cross ventilation

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

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

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]

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Strategy B: Mechanical cooling with air-conditioning system

Strategy B2: COP Improvement

All air conditioning units in the building should be included in the calculation. Cooling capacity and COP values should be calculated using the rating conditions in accordance with the test procedures listed in tables E.4.

Table E.4: Minimum COP requirements for direct electric air conditioners (*Source: VBEEC Table 2.6*)

Equipment Type	Capacity	Minimum COP	Test procedures
Unitary air-conditioner	-	2.30	TCVN 7830:2012 and TCVN 6307:1997
Split air-conditioner	< 4.5 kW	2.60	
	≥ 4.5 kW and < 7.0 kW	2.50	
	≥ 7.0 kW and < 14.0 kW	2.40	
Air conditioners, air cooled	≥ 14.0 kW and < 19 kW	2.93	TCVN 6307:1997 or ARI 210/240
	≥ 19 kW to < 40 kW	3.02	ARI 340/360
	≥ 40 kW to < 70 kW	2.84	
	≥ 70 kW to < 117 kW	2.78	
	≥ 117 kW	2.70	
Air conditioners, water and evaporatively cooled	< 19 kW	3.35	ARI 210/240
	≥ 19 kW to < 40 kW	3.37	ARI 340/360
	≥ 40 kW to < 70 kW	3.32	
	≥ 70 kW	2.70	

The calculation of increased HVAC efficiencies for air conditioned spaces for average COP values should be calculated using the following formula:

$$\text{COP improvement compared to VBEEC [\%]} = \left(\frac{\sum_i (P_i \times Y_i)}{\sum_i (P_i \times Y_{Ei})} - 1\right) \times 100$$

P_i = Capacity of the air-conditioning unit i

Y_i = COP of the air-conditioning unit i

Y_{Ei} = VBEEC minimum COP for a unit of the same type and capacity as the proposed unit i

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Submissions

Certification Stage
Strategy A: Natural cooling
Strategy A1: Stack ventilation • Plans showing the vent column or the rooftop turbine vent with the dimensions • Photographs showing the vent column or the rooftop turbine vent
Strategy A2: Cross ventilation • Elevations marking all wall openings with their size • Plans showing the air flow paths and the distances between openings
Strategy B: Mechanical cooling with air-conditioning system
Strategy B1: Variable speed compressors • Technical data and/or photographs showing that the units feature inverter technology • Evidence of the air-conditioning units were installed such as photographs, invoices, etc.
Strategy B2: Energy labelled air conditioners • Technical data and/or photographs showing the cooling capacity and power input of the air-conditioning systems installed • Evidence of the air-conditioning units were installed such as photographs, invoices, etc.

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E-4 Artificial Lighting

Intent

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

Requirements

Criteria	3 points
Installed light power density of the project is lower than 8 W/m^2	1
Installed light power density of the project is lower than 7 W/m^2	2
Installed light power density of the project is lower than 6 W/m^2	3

Approach & Implementation

Power associated with the use of artificial lighting systems can be reduced in the following way:

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

QCVN 09:2013/BXD sets the maximum light power density (LPD) for residential buildings at 8 W/m^2. Install less artificial lighting power (i.e. install less lighting fixtures or install lighting fixtures with higher luminous efficacies) to earn points following the performance path.

Calculation

Designers must demonstrate that the light power density in the project space surpasses the requirements of the VBEEC with the following method.

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

$$I_D[\mathrm{W/m2}] = \frac{P_L}{GFA_L}$$

I_D = Design Lighting Power Density of the project space [W/m^2]

P_L = Total power required to provide artificial lighting in the project space [W]

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

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Submissions

Certification Stage
• Floor plans showing the location of the lighting fixtures • Evidence of the lighting fixtures installed such as photographs, invoices, receipts, etc.

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W-1 Water Efficient Fixtures

Intent

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

Requirements

Criteria	5 points
Reduce domestic water consumption through fixtures by 20% in comparison to a baseline model	1
1 point for every additional 5% reduction of the domestic water consumption through fixtures (Up to 40%)	5

Approach & Implementation

The following strategies can be used to reduce the demand for domestic water:

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

Calculations

The aim of this calculation is to compare the building's water consumption through fixtures to a baseline model. The baseline annual water use should be calculated using values in Tables W.1 and W.2. The LOTUS Water Calculation Tool contains these calculations embedded into the tool and can be used instead of manually performing the calculations.

Table W.1: Baseline daily fixture uses (*Source: Default Fixture Uses, LEED Reference Guide for Green Building and Construction, 2009*)

Fixture	Daily Fixture Uses per Resident	Duration of Use (flow fixtures)
WC - Single Flush	4	-
WC - Dual flush	1 full-flush / 3 half-flushes	-
Lavatory Faucet	7	60 sec.
Shower	1	480 sec.
Kitchen Sink	4	60 sec
Clothes washer	1 use for the whole house	-

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Table W.2: Baseline fixtures water use (*Source: UPC and IPC Standards*)

Fixture	Fixtures Water Use
WC (single/dual flush)	6.0 L per flush (Lpf)
Faucet (conventional)	0.14 L/s
Showerheads	0.16 L/s
Kitchen faucet	0.14 L/s
Clothes washer	120 L / typical load (8kg)

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

The gender ratio should be representative of the building occupancy, if this is not available, a ratio of one to one should be used

The number of daily fixture uses and flow fixture use durations (in baseline case) should follow values in Table W.1

Calculation of annual water consumption through fixtures:

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

F = Proportion of fixtures

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

n = Number of daily uses per person per fixture type

P = Number of building occupants

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

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

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

O = Number of operation days per year

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

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Example of calculation:

A house with an occupancy of 4 occupants (gender ratio: 1 to 1) is equipped with the water fixtures listed in Table W.3.

Table W.3: Example calculation - Building fixtures quantities and flow/flush rates

Fixtures in the house	Quantities of Fixtures	Fixtures Water Use
WC Dual flush	3	3.0 - 4.5 Lpf
Bathroom Faucet 1	2	0.12 L/s
Bathroom Faucet 2	1	0.1 L/s
Showerheads	2	0.14 L/s
Kitchen faucet	1	0.12 L/s
Clothes washer	1	60 L / load (7kg)

Table W.4: Example calculation - Daily water use through fixtures calculation for baseline case

Fixtures in the house	F	$Q_{\text{Flush/Flow}}$	Daily Uses (n)	Occupants (P)	Daily Water Use (L)
WC	1	6 Lpf	4	4	96
Bathroom Faucet	1	0.14 L/s (60 sec)	7	4	235.2
Kitchen faucet	1	0.14 L/s (60 sec)	4	4	134.4
Showerheads	1	0.16 L/s (480 sec)	1	4	307.2
Clothes washer	1	120 L	1	1	120
Total daily water use through fixtures					893
Baseline total annual water use through fixtures					325,872

Table W.5: Example calculation - daily water use through fixtures calculation for the design case

Fixtures in the house	F	$Q_{\text{Flush/Flow}}$	Daily Uses (n)	Occupants (P)	Daily Water use (L)
WC Dual flush	1	$\left(\frac{3}{4} \times 3 + \frac{1}{4} \times 4.5\right)$Lpf	4	4	54
Bathroom Faucet 1	2/3	0.12 L/s (60 sec)	7	4	134.4
Bathroom Faucet 2	1/3	0.1 L/s (60 sec)	7	4	56
Kitchen faucet	1	0.12 L/s (60 sec)	4	4	115.2
Showerheads	1	0.14 L/s (480 sec)	1	4	268.8
Clothes washer	1	$60 \times 8 / 7$ L	1	1	68.5
Total daily water use through fixtures					696.9
Design total annual water use through fixtures					254,368.5

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$$\text{Water Consumption Through Fixtures Reduction [\%]} = \left(1 - \frac{254{,}368.5}{325{,}872}\right) \times 100 = 21.9\%$$

The building finally achieves a 22% reduction of the domestic water consumption through fixtures in comparison to a baseline model so one point is awarded.

Submissions

Certification Stage
• Manufacturer's data for each water efficient fixtures installed showing the water usage of the fixture (flowrate, flush size and/or water use per load) • Evidence that the water efficient fixtures have been installed such as photographs, receipts, etc.

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W-2 Water Efficient Landscaping

Intent

To reduce potable water consumption on landscaping

Requirements

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

Approach & Implementation

The amount of domestic water used for irrigation can be reduced through a number of different strategies. In this credit applicants can demonstrate their reduction through any combination of the methods outlined in this section.

Xeriscape Landscape and Planting Native Species:

Practices in this area can include:

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

Water Efficient Irrigation:

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

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Examples include:

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

The following irrigation management principles should also be followed:

- Develop a precise watering plan based on the knowledge of all plants' properties in order to reduce the amount of water used in irrigation.
- Water at a rate so that it does not pond, pool or run off
- Do not water when the soil is already adequately moist to sustain plant growth
- Water in such a manner so that it does not fall on buildings or hard surfaces
- Do not water in windy conditions where the distribution pattern of the irrigation systems will be affected
- Only water gardens that are sufficiently mulched to reduce evaporation

Irrigation with Recycled/Reused Water and/or Harvested Rainwater:

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

Calculation

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

The total irrigation demand for the landscaped area can be calculated using the following equation. The demand should be calculated for each different type of vegetation within the landscape (e.g. lawn, shrubs, trees etc.) and then summed together. The LOTUS Water Calculation Tool contains these calculations embedded into the tool and can be used instead of manually performing the calculations.

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

$$\text{Irrigation Demand}_\mathrm{i}{}^{*}\left[\frac{\mathrm{m}^3}{\text{year}}\right] = \text{Area}_\mathrm{i} \times \sum_{m=1}^{12}\left(\frac{\mathrm{ET}_{0\,\mathrm{m}} \times \mathrm{Ks_i} \times \mathrm{Kd_i} \times \mathrm{Km_i}}{1000 \times \mathrm{IE_i}} - \frac{\mathrm{E}_{\text{rain m}}}{1000}\right)$$

* If the irrigation demand for any area or any month is less than zero, it must be taken as zero in the total irrigation demand calculation.

Where:

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

Irrigation demand $_\mathrm{i}$ = Irrigation demand for the soft landscape *i*

Area $_\mathrm{i}$ = Area of the soft landscape *i* (m^2),

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

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

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

Km_i = Microclimate factor specific for sub-area *i* (e.g. well shaded and sheltered area *Km* - “low”, area next to pavement or on roof - “high”)

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

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

Monthly effective rainfall of the month *m* (mm) = $\sum_d (Daily\ rainfall_d - 5) \times 0.75$
$Daily\ rainfall_d$ is the rainfall of the day d.
Where daily rainfall data is unavailable, monthly rainfall data can be divided by the number of rainy days to give an average daily rainfall to be used in this equation.
If the landscape *i* is sheltered or partly sheltered from rainfall, apply a percentage to lower the amount of effective rainfall for the landscape *i*.

Typical values for these parameters are included in Table W.6.

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Table W.6: Standard values for species, density and microclimate factors of vegetated areas
(*Source: LEED Reference Guide for Green Building and Construction, 2009*)

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

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

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

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

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

1. Determine soft landscape area
2. Determine annual irrigation demand per square metre of soft landscaped area, this can be demonstrated either by sub-metering or the irrigation demand calculation method
3. Calculate irrigation demand savings using the following equation:

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

Example of calculation

A building's landscape in Ho Chi Minh City (ET_0 and E_{rain} values as per Table W.7) includes a 60 m^2 area of native trees, a 60 m^2 area of native shrubs, a 40 m^2 area of native groundcover and a 40 m^2 of a non-native lawn with an average species factor. All the vegetation areas are irrigated by a drip system. For Ho Chi Minh City the annual effective rainfall is 854 mm.

Table W.7: Monthly ET_0 and E_{rain} values for Ho Chi Minh City

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

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Table W.8: Example calculation - standard values for species, density and microclimate factors of vegetated areas

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

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

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

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

Submissions

Certification Stage
• Landscape plan outlining the proposed landscape design with a list of all plants • If an efficient irrigation system is used: description of all proposed water saving irrigation fixtures and drawings showing location • If using water recycling, reuse or rainwater harvesting: schematic drawings of proposed reticulation network

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H-4 Daylighting

Intent

To encourage building designs which maximize the use of daylight.

Requirements

Criteria	3 Points
50% of the net habitable area achieves a daylight factor of 1% or greater	1
70% of the net habitable area achieves a daylight factor of 1% or greater	2
90% of the net habitable area achieves a daylight factor of 1% or greater	3

Approach & Implementation

Natural light promoting designs strategies include:

- Building atria
- Window arrangement
- Skylights
- Interior light shelves

Calculations

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

Calculations for this credit can be done using a daylight modelling software or using a spreadsheet. Spreadsheet calculations are suitable for simple, rectilinear buildings. More complicated buildings, such as curved or faceted buildings, cannot be assessed with this methodology and should be assessed using daylight modelling software.

Daylight modelling software:

Use daylight factor outputs from a daylight modelling software to justify average daylight factor values in the habitable spaces. The design day used for daylight factor calculations should be on the 21st of September at 12:00pm.

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Spreadsheet calculations:

The average DF for each habitable 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.4).

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.4)

t = Visible light transmission (Values of Table H.5 can be used if manufacturer's data is not available)

ρ = Average reflectance of surrounding room surfaces (recommended values in Table H.6 can be used)

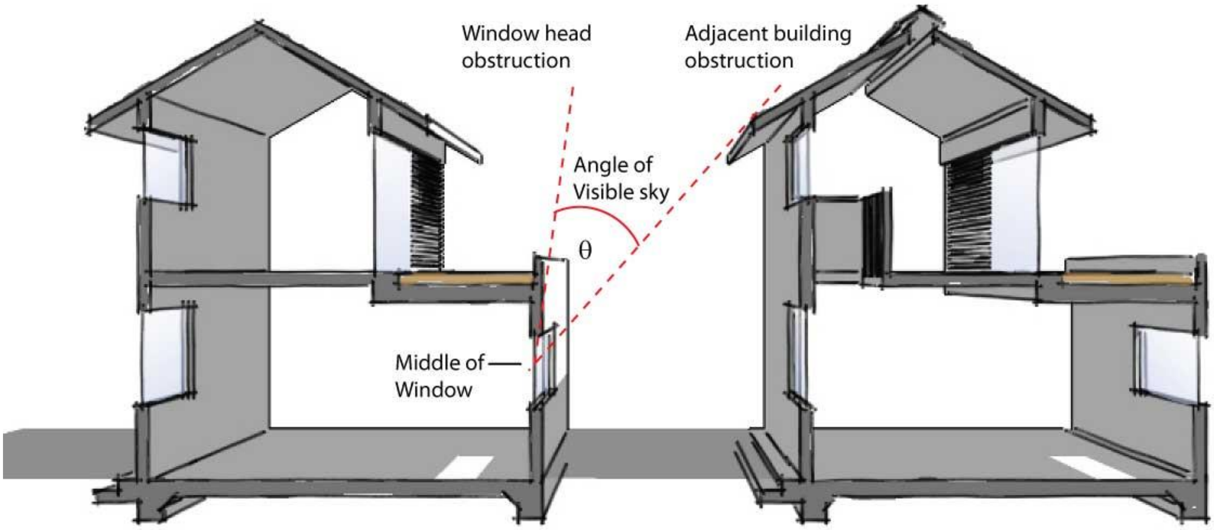

Figure H.4: Angle of visible sky from the mid-point of the window

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Table H.4: 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.5: 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.6: 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 calculations 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%
- 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:

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

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

A_O = Net habitable area [m^2]

Submissions

Certification Stage
• Plans and elevations outlining habitable spaces, daylit areas and indicating all glazing and its size

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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 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.

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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 achieved 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.

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 VGBC.

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 requirements that will be assessed for LOTUS Certification.

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LOTUS Submission Terms

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

Drawings - Two dimensional technical diagrams of a place or object.

Elevation - An elevation is a view of a building seen from one side, a 2D drawing of one facade of the building.

Floor 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.

Invoice/Receipt - A proof of purchase given from a supplier to a consumer.

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 (for example, in credit W-1, all low-flow toilets installed in the building should be photographed).

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.

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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.

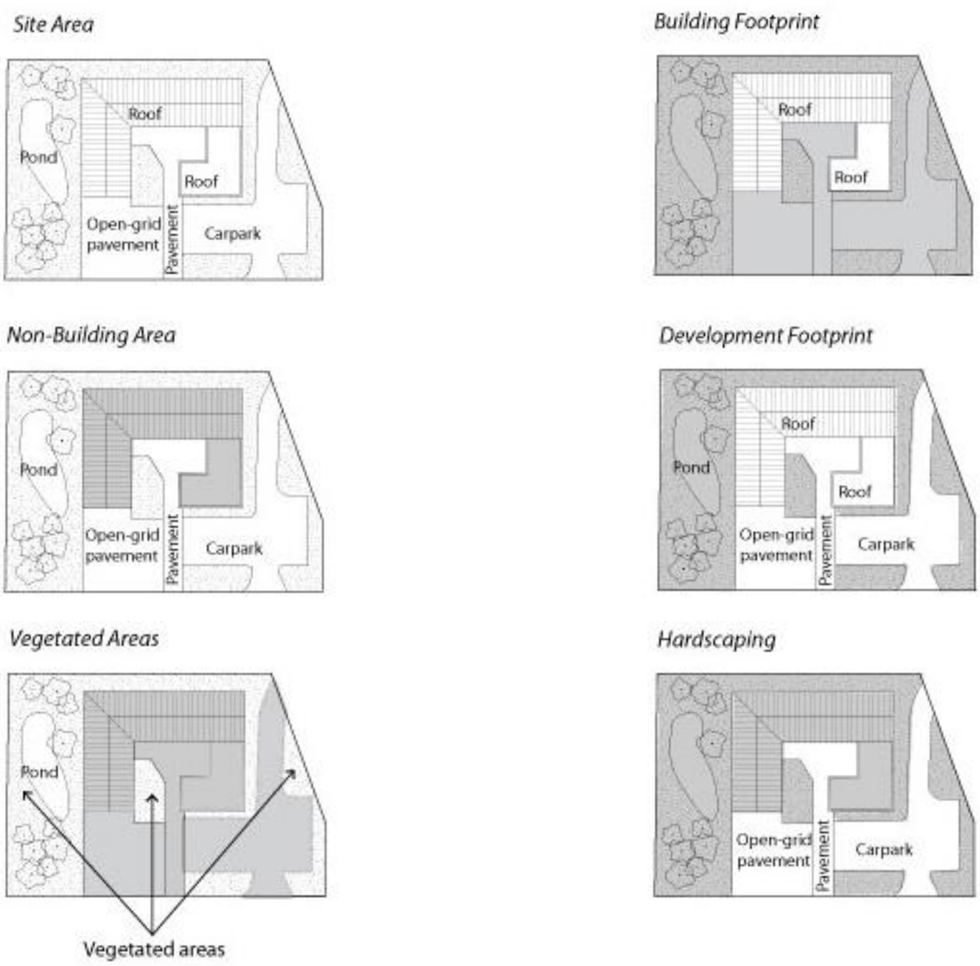

Figure G.1: Site area illustrations

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Technical Terms

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.

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.

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).

Gross Floor Area (GFA) - The sum of the fully enclosed covered floor area and the unenclosed covered floor area of a building at all floor levels. Some commercial and public authorities use variants of this definition. Parking areas are not to be included as GFA.

Global Warming Potential (GWP_{100}) - A value assigned to a refrigerant based on scientific measurements showing how much that refrigerant will contribute to global warming if released into the atmosphere. The reference datum is based on the effect of CO_2 in the atmosphere, which is assigned a GWP of 1. GWP is usually measure over a 100-year period and the lower the GWP of a refrigerant is the better or less harmful the refrigerant is for the environment.

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.

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HVAC (Heating, Ventilating and Air Conditioning) - The equipment, distribution network, and terminals that provides either collectively or individually the processes of heating, ventilating, or air conditioning to a building.

Illuminance - The density of the luminous flux incident on a surface. It is measured in lux or lm/m^2 and is equal to the luminous flux (lumen) divided by the area (m^2) of the surface when the latter is uniformly illuminated.

Lumen (Lm) - SI unit of luminous flux. Radio-metrically, it is determined from the radiant power. Photo-metrically, it is the luminous flux emitted within a unit solid angle (one steradian) by a point source having a uniform luminous intensity of one candela.

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.

Ozone Depletion Potential (ODP) - A value assigned to a refrigerant based on scientific measurements that show how destructive a refrigerant is to the ozone layer if released into the atmosphere. The reference datum is based on the effect of refrigerant R11, which is assigned an ODP of 1. The lower the value of ODP the better or less harmful the refrigerant is for the ozone layer and therefore the environment.

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.

Rapidly renewable materials - A rapidly renewable material is a source that can regenerate what has once been harvested within 10 years or less.

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Refrigerant - A refrigerant is a compound used in a heat cycle that reversibly undergoes a phase change from a gas to a liquid in a process of converting thermal energy to mechanical output.

Renewable energy - Energy generated from sources (sunlight, wind, rain, tides, and geothermal heat) that are replenished naturally and continually.

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.

VBEEC (Vietnam Building Energy Efficiency Code) – The Vietnam Building Energy Efficiency Code QCXDVN 09:2013/BXD is issued by the Ministry of Construction and is mandatory in Vietnam in order to help meet energy saving goals.

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.

Water efficient fixture - Water-based fixture that requires less amount of water to complete a designed task than most average fixtures

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

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