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

LOTUS Buildings in Operation V1

Technical Manual

June 2017

Vietnam Green Building Council LOTUS CERTIFIED ™

Vietnam Green Building Council LOTUS SILVER ™

Vietnam Green Building Council LOTUS GOLD ™

Vietnam Green Building Council LOTUS PLATINUM ™

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VGBC Members

The VGBC would also like to thank its generous and valuable members (as of June 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

LOTUS General Information

LOTUS Certification System is a set of voluntary 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, BEAM Plus, etc.) and aim at establishing standards and benchmarks to guide the local construction industry towards more efficient use of natural resources and more environmentally friendly practices.

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

LOTUS Rating Systems currently include (as of June 2017):

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

Further systems in development include:

- LOTUS Interiors
- LOTUS Small Interiors

LOTUS Accreditation for Professional Practitioners

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

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

LOTUS BIO Rating System

LOTUS BIO Scope

LOTUS BIO is intended to be used for all building types covered by LOTUS Non-Residential (LOTUS NR) and LOTUS Multi-family Residential (LOTUS MFR), including the following building types:

- Cultural buildings (library, cinema, museum, theatre, club, radio station, television station, exhibition center, community house)
- Educational buildings (nursery, elementary school, secondary and tertiary school, university, vocational school, college)
- Health care buildings (clinic, general hospital, specialist federal and local hospital, nursing home and temporary health care facility)
- Retail buildings (market, shop, shopping center, supermarket, restaurant, kiosk)
- Office buildings
- Hotels and guesthouse buildings
- Transport service buildings (train station, bus station, bus stop, information service center, post office)
- Communication station and towers
- Stadia and sports centers
- Residential buildings
- Factories and industrial buildings

LOTUS BIO Eligibility

In order for a building to be eligible for LOTUS BIO, the following criteria need to be fulfilled:

1. Building Control

In order to certify a building in operation, a certain degree of control over the whole building and site is required (whether the building has been previously certified or not). For this reason, LOTUS BIO is only applicable to whole buildings, not individual floors or tenancies.

2. Building Age

For a building to be eligible for LOTUS BIO it must have already been fully operational with at least 50% occupancy for a minimum of 2 years at the time of Certification.

3. Alterations and Additions

Alterations and additions are significant to LOTUS BIO Certification as they are common in the life cycle of a building, have the potential to affect the operations and performance of a building and could change a building significantly such that it can no longer be considered a "building in operation".

As such the following eligibility requirements must be complied with to be eligible for assessment under LOTUS BIO:

- An alteration shall not affect more than 50% of the Gross Floor Area (GFA) of the building at any one time during the Performance Period
- An alteration shall not disrupt the operations or relocate more than 50% of the building occupants during the Performance Period
- An addition shall not increase the GFA of the building by more than 30% during the Performance Period

In the case where alterations and/or additions exceed the above limits, the project should consider applying for LOTUS NR or LOTUS MFR certification.

LOTUS BIO Categories

LOTUS BIO is composed of 9 categories (plus "Innovation"*)*, each containing a varying number of credits. Against each credit, specific criteria have been set carrying individual scoring points.

It is important to note that prerequisite criteria have been set for few credits. All of these prerequisites are mandatory requirements and must be achieved in order to obtain LOTUS accreditation.

Energy (E) - To monitor, manage and reduce the energy consumption of a building through use of energy efficient equipment, natural ventilation, renewable energy generation and energy management systems.

Water (W) - To reduce the water consumption of a building through the use of water-efficient fixtures, rainwater harvesting, water reuse/recycling and effective monitoring and management of water consumption.

Sustainable Purchasing (SP) - To encourage the use of greener, healthier, and more sustainable products.

Ecology (Eco) - To protect the ecology of the building site and surrounding area, through management of the landscape and maximizing biodiversity.

Waste and Pollution (WP) - To reduce the pollution and waste produced during the operations of the building, as well as encourage extensive recycling practices.

Health and Comfort (H) - To ensure high indoor environmental quality, through maximizing daylight, external views and the monitoring and improvement of indoor air quality and occupant satisfaction.

Adaptation and Mitigation (A) - To ensure that the building reduces its impact on not only climate change itself, but also on the surrounding buildings and environment, while also being prepared for natural disasters and climate change related events.

Community (CY) - To promote the social integration of a building within its neighborhood through public awareness campaign and occupant behavior, and to facilitate access for persons with disabilities.

Management (Man) - To ensure that green targets are set and systems are in place so that occupants are aware of and can achieve these targets, as well as optimize the operation of the building to maximize efficiency.

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

LOTUS BIO Prerequisites

Table 1 summarizes the 9 prerequisites included in LOTUS BIO. Each prerequisite, whether stand-alone or included inside a credit, must be carried out as a minimum requirement for all projects applying for LOTUS BIO.

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

Table 1: LOTUS BIO Prerequisites

Prerequisite	Criteria
E-PR-1 Energy Audit	Perform a preliminary energy audit of the building
Eco-PR-1 Environment	Conduct a vegetation survey for the building site
WP-PR-1 Waste Management	Conduct a solid waste stream audit
H-PR-1 Occupant Comfort	Conduct building occupant survey and develop an action plan based on the responses
H-PR-2 Indoor Smoking	Prohibit smoking in the building in accordance with Decision 1315/QĐ-TTg
A-PR-1 Green Transport	Provide building occupants with information on the different collective transportation means available for travel to and from the site
CY-PR-1 Occupant Behavior	Provide a building user's guide to building occupants
Man-PR-1 Facility Audit	Perform a facility audit of the building
Man-PR-2 Maintenance	Provide a building operation and maintenance manual to the building management team

LOTUS BIO Credits

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

For some credits, requirements can encompass different strategies. A project can implement any of the proposed strategies inside a credit and cumulate points for the credit (while being restricted by the maximum number of points available for the credit).

Codes and Standards Referenced in LOTUS BIO

LOTUS BIO references 13 Vietnamese and 5 International Codes and Standards. These references are included in LOTUS BIO for their relevance to green building operation. VGBC recognizes that it has a responsibility to ensure that LOTUS certified buildings meet these mandatory minimum requirements as well as raise awareness of such codes in Vietnam. LOTUS achieves this by including many codes in prerequisite criteria, meaning evidence of compliance must be provided for a building to be LOTUS certified.

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

This list is intended to highlight the different codes and standards that LOTUS expects applicants to consider as a minimum. This is by no means a comprehensive list of all codes and standards to be applied to buildings in Vietnam. As such, VGBC does not intend this list to be used as a checklist for projects. While every care has been taken to provide the most current codes and standards at the time of publishing, it is the responsibility of the applicant to source the most current codes and standards for their project. Where a code or standard becomes out dated in LOTUS, the applicant will be expected to apply the most current version.

Table 2: Codes and Standards Referenced in LOTUS BIO

Category	Vietnamese/ International	Legislation or Standard
General	Vietnamese	QCVN 02:2009/BXD - Vietnam Building Code Natural Physical & Climatic Data for Construction
Energy	Vietnamese	QCVN 09:2013/BXD - Vietnam Building Energy Efficiency Code (VBEEC)
Water	Vietnamese	TCVN 6773: 2000 Water quality - Water quality guidelines for irrigation
		QCVN 02:2009/BYT - National technical regulation on domestic water quality
	International	NSF/ANSI Standard 350: On-site Residential and Commercial Water Reuse Treatment Systems (National Sanitary Foundation – USA)
Waste and Pollution	Vietnamese	QCVN 14:2008/BTNMT National Technical Regulation On Domestic Wastewater
		QCVN 10:2008/BTNMT National Technical Regulation On Coastal Water Quality
		QCVN 09-MT:2015/BTNMT National technical regulation on ground water quality
		QCVN 40:2011/BTNMT National technical regulation on Industrial Wastewater
		QCVN 28:2010/BTNMT National technical regulation on Health Care Wastewater
		TCVN 6980:2001 Water Quality - Standards For Industrial Effluents Discharged Into Rivers Using For Domestic Water Supply
		QCVN 13:2008/BTNMT National Technical Regulation On Effluent Of Textile Industry
Health and Comfort	Vietnamese	TCVN 5687:2010 - Ventilation - Air Conditioning, Design Standards
	International	CIBSE Guide B - Heating, Ventilating, Air conditioning and Refrigerant
		CIBSE Lighting Guide 7 Office Lighting
		ASHRAE Standard 62.1 (2007, 2010 & 2013) Ventilation for Acceptable Indoor Air Quality
		Australian Standard, AS 1668.
Community	Vietnamese	QCVN 10:2014/BXD - National Technical Regulation on Construction for Disabled Access to Buildings and Facilities

LOTUS BIO Weighting

Weighting of LOTUS BIO categories has been carefully considered through analysis of other green building rating systems and in response to environmental issues specific to building management practices and the changing climate of Vietnam. The number of points available per credit and per category (summarized in Table 3) has been set up to reflect this weighting.

Table 3: LOTUS BIO Weighting

Category	Maximum Points
Energy	33
Water	10
Sustainable Purchasing	4
Ecology	6
Waste & Pollution	8
Health & Comfort	12
Adaptation & Mitigation	11
Community	6
Management	10
Total	100

LOTUS BIO Certification Levels

There are 100 points available in LOTUS BIO, plus up to 8 bonus points available within the Innovation category. The first certification level for LOTUS BIO has been benchmarked at 40% (LOTUS Certified) of the total amount of 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.

Figure 1: LOTUS BIO Certification levels

LOTUS BIO for Multi-tenant Buildings

As specified in eligibility criteria 1, LOTUS BIO applies only to whole buildings. To achieve a LOTUS BIO Certification, Multi-tenant buildings (buildings that contain floor area under the ownership or tenancy of more than one entity) will require the commitment and cooperation of the majority of tenants in the building.

A number of prerequisites and credits considering systems, services and areas under building management control or considering permanent features of the building do not require cooperation from tenants. Such prerequisites and credits include: Eco-1 Vegetation, A-PR-1 Green Transportation, WP-1 Wastewater Treatment, CY-1 Public Space, Man-2 LOTUS AP, etc.

Depending on the lease terms, the management situation and the scope of tenants' fit-out works, some prerequisites and credits may or may not need the involvement of tenants:

- the credits related to HVAC systems (E-3, and WP-3), depending whether building management fully controls the HVAC systems serving tenants spaces or not
- W-3 Water Efficient fixtures, depending whether tenants have installed their own water fixtures or not

For credits and prerequisites requiring the involvement of tenants, in the situation where full cooperation cannot be achieved, the project should involve a minimum of 90% of the occupied GFA in order to be considered compliant. In this case, data and evidence will only need to be provided for those tenancies in cooperation for LOTUS BIO assessment.

Exception: To comply with the Health & Comfort Prerequisite 2 on Indoor Smoking, the whole building must meet the requirements of the prerequisite.

For all the credits where commitment and cooperation of tenants is necessary, project teams will have to determine which of these credits can be pursued based on the lease structure and management situation.

LOTUS BIO Certification Process

Introduction

LOTUS BIO Certification is a formal process to independently validate that a project has achieved the environmental performance specified in LOTUS BIO Rating System. Documentation-based submissions are provided to the Assessment Organization as evidence of this achievement.

LOTUS BIO Certification happens in three steps:

- LOTUS BIO Provisional Certification (optional)
- LOTUS BIO Full Certification
- LOTUS BIO Certification Renewal (required to maintain the LOTUS BIO certification)

LOTUS BIO Provisional Certification is an optional stage awarded after the completion of the Provisional Submission. Provisional Certification allows the Applicant to only make a guarantee that changes will be made in order to meet the requirements of some credits. If the building already has all necessary procedures and operations in place, the Applicant may wish to go directly to Full Certification. LOTUS BIO Provisional Certification is valid for 18 months.

LOTUS BIO Full Certification assesses the performance of the building in operation during the Performance Period. This assessment is similar to the Provisional Certification except that it requires all necessary operational procedures to be carried out and all strategies to be implemented during the whole Performance Period. Full Certification can also assess improvements from the historical performance of the building. LOTUS BIO Full Certification is valid for 5 years. During the 5 year validity period the Applicant will be required to submit operational data.

LOTUS BIO Certification Renewal assesses the performance of the building in operation during the period following LOTUS BIO Full Certification. This assessment is similar to the Full Certification except that it only requires projects to demonstrate that the performance has been maintained and that the operational procedures are still carried out. At the Certification Renewal stage, it is possible for projects to earn more points and reach a higher certification level by targeting more credits or by improving their performance further. It is also possible that projects earn less points and maybe lose the LOTUS BIO Certification if the performance of the building has decreased. The LOTUS BIO Certification Renewal is valid for 5 years and there is no limit in the number of renewals a project can get.

Performance Period

Initial Performance Period

The Initial Performance Period (that is referred to as Performance Period throughout the Technical Manual) is a continuous 12 month period that is used to assess the performance of the building at the Full Certification stage. All evidence supplied at the Full Certification stage must be relevant to the Performance Period, with the exception of historical data required for comparative purposes.

It is up to the applicant to specify the exact dates chosen for their Performance Period and provide evidence that data in all submissions for Full Certification was produced within this period.

The Performance Period should immediately precede the Full Certification submission.

Renewal Performance Period

The Renewal Performance Period is the whole period between the date on which previous LOTUS Certification (Full Certification or previous Certification Renewal) was awarded and the submission for the new Certification Renewal.

All evidence supplied at the Certification Renewal stage must be relevant to the Renewal Performance Period. Evidence should show that the performance of the building was maintained during the whole Renewal Performance Period and that the strategies implemented for previous LOTUS Certification have been kept in place.

LOTUS BIO Timeline

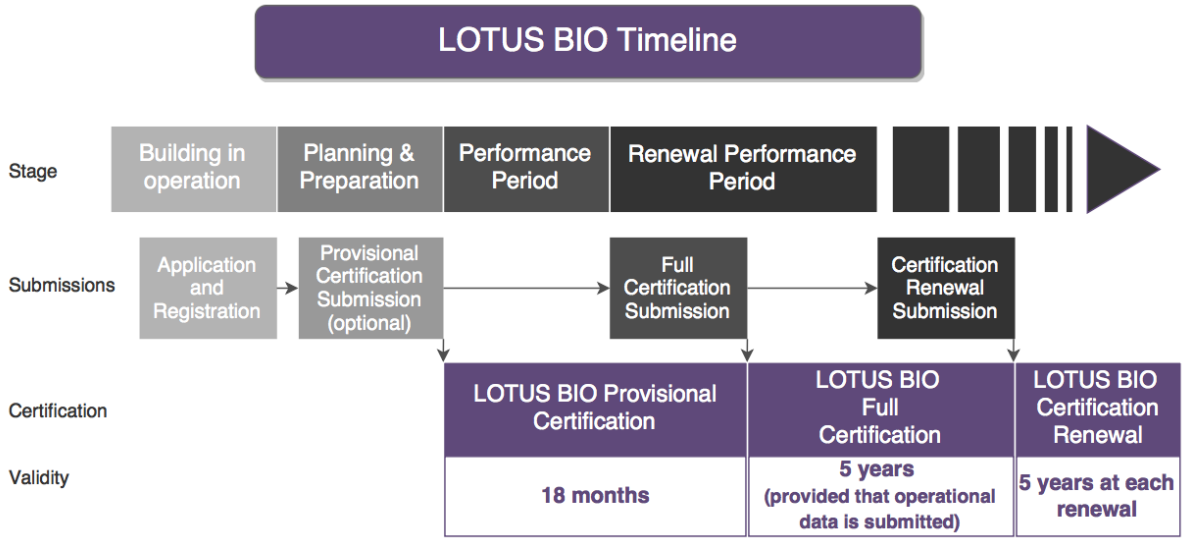


Figure 2: LOTUS BIO Timeline

The first step to gain LOTUS BIO certification is to apply and register the project. Ideally, this should be done before the project starts planning and preparing the implementation of "green" strategies to comply with LOTUS BIO, as once registered the project will receive support documents and resources.

During the planning and preparation stage, the Applicant may prepare the Provisional Certification Submission (optional), which should be submitted when the targets for certification have been set and the strategies to implement have been selected.
Based on the results of the assessment of the Provisional Certification Submission, a LOTUS BIO Provisional Certificate will be issued with a validity period of 18 months.

At the end of the Performance Period of 12 months, the Applicant should make a Full Certification Submission which aims to demonstrate the performance of the building during the Performance Period. Based on the results of the assessment of the Full Certification Submission, a LOTUS BIO Full Certificate will be issued with a validity period of 5 years.

In order to extend the validity of the LOTUS BIO Certification at the end of the 5 year period, the Applicant should make a Certification Renewal Submission which aims to demonstrate that the performance of the building has been maintained. Based on the results of the assessment of the Certification Renewal Submission, a LOTUS BIO Certificate Renewal will be issued with a validity period of 5 years.

Application and Registration

Registering a project declares the intent to pursue LOTUS BIO Certification and is the first step in the certification process.

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

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

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

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

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

Then, the project should request the Assessment Organization's Representative to invoice the Assessment Fee that has to be paid prior to any submission for Provisional or Full Certification.

Provisional Certification Stage

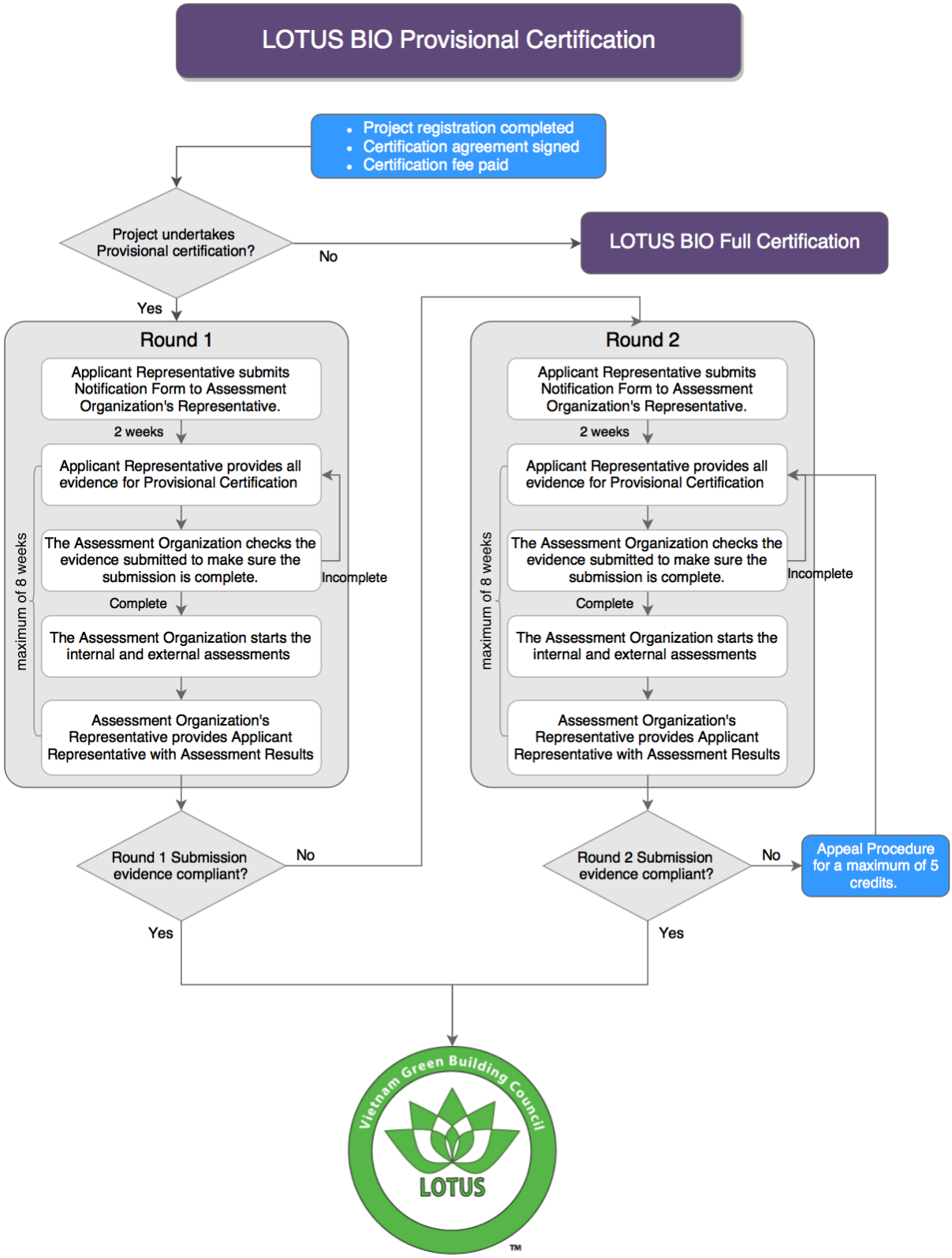


Figure 3: LOTUS BIO Provisional Certification Process

If the project decided to undertake LOTUS BIO Provisional Certification, the following process happening in 2 rounds should be followed. The timing of the submission for Provisional Certification is up to the Applicant but the VGBC recommends that the Applicant submits for Provisional Certification before the start of the Performance Period.

Round 1

Notification Form Submission

Once the Project Certification Team has compiled all evidence to be verified for Provisional Certification, the Applicant Representative must notify the Assessment Organization's Representative of the date when all evidence will be submitted. A minimum of two week notice must be provided.

Submission

The Applicant Representative submits all required evidence for Provisional Certification Assessment.

Scan of the submission

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

Assessment

The data supplied to the Assessment Organization Representative will be assessed by the Project Assessment Committee (PAC) and an assessment report providing the results of the round will be provided to the Applicant Representative within 8 weeks of the submission date.

At Provisional Certification, the assessment report will detail for each prerequisite and targeted credit if:

- The prerequisite/credit has been awarded for both Provisional Certification and Full Certification (meaning that, as long as no change occurs, no additional evidence will need to be submitted for Full Certification) ; or
- The prerequisite/credit has been awarded only for Provisional Certification (meaning that some additional evidence will need to be submitted for Full Certification) ; or
- The prerequisite/credit has not been awarded but compliance with the prerequisite/credit is pending (meaning that, with the submission of some additional evidence, the prerequisite/credit will be awarded) ; or
- The prerequisite/credit has not been awarded and is rejected

Round 2

If Round 1 submissions for any prerequisite is denied, or if the number of points achieved is not sufficient to be awarded LOTUS Provisional Certification, or if the Applicant would like the opportunity to score higher for some credits, a second round of submissions for re-assessment is available for projects. This second round should follow the same process as in Round 1.

Round 2 gives the possibility for the project to provide further evidence to demonstrate to the PAC that pending credits and/or prerequisites 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.

An assessment report detailing the results of the round will be provided to the Applicant Representative within 8 weeks of the submission date. In special cases further appeals and/or applications may be permitted, however these may generate additional fees.

Appeal Procedure

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

The following rules and conditions apply:

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

Provisional Certificate

At the end of the Round 1, Round 2 or after the appeal procedure, if all necessary evidence to demonstrate compliance with all the prerequisites and with a number of credits granting at least 40 points has been provided, LOTUS Provisional Certification can be awarded.

A Provisional Certification allows for marketing opportunities prior to completion of the Performance Period. The Provisional Certification of a project represents the intention of the project to be certified at Full Certification stage and shows that the project is on-track to achieve an anticipated level of certification at Full Certification stage. As such, no Certification Levels will be given to projects at Provisional Certification stage.

LOTUS Provisional Certification is valid for a maximum of 18 months.

Full Certification Stage

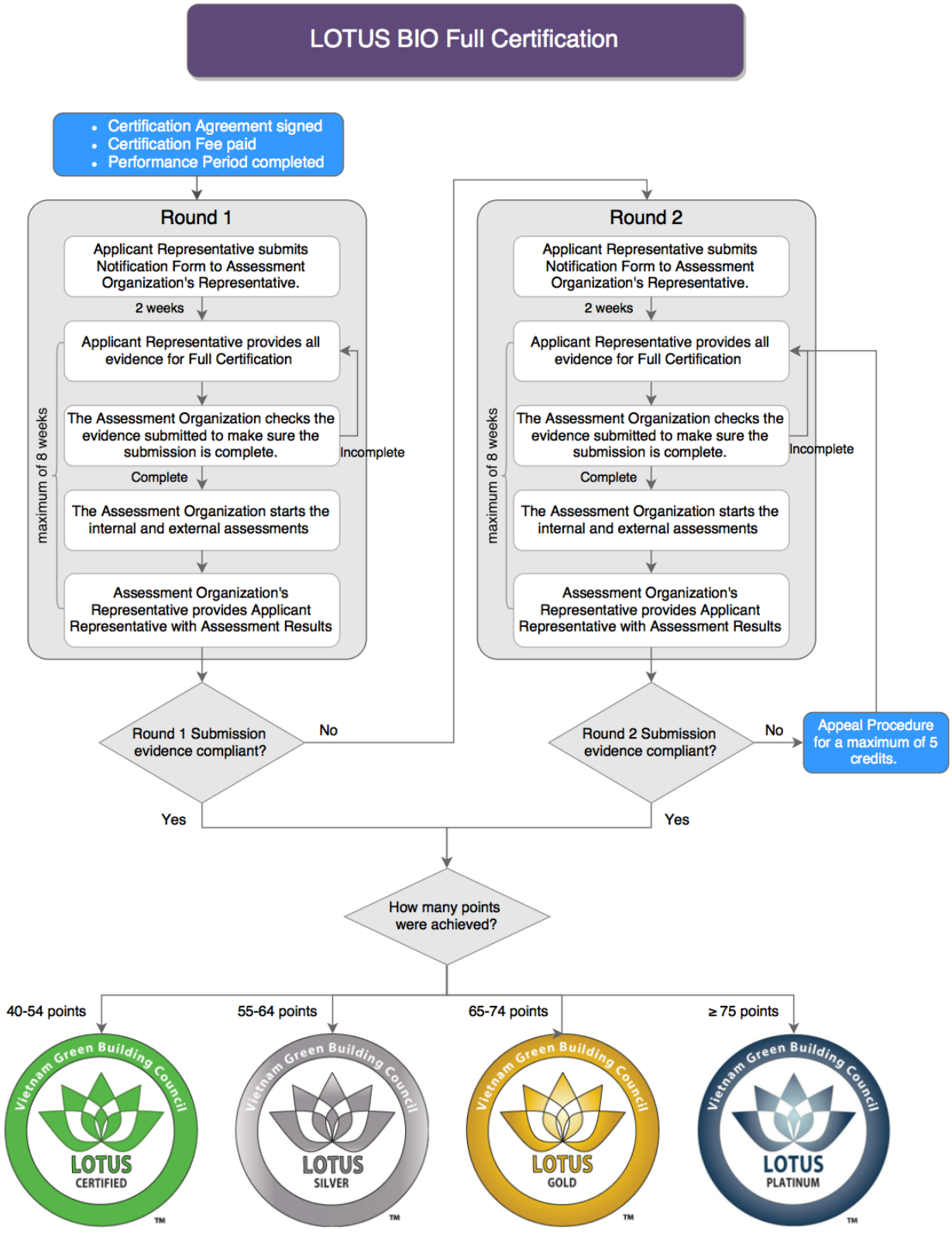


Figure 4: LOTUS BIO Full Certification Process

At the end of the Performance Period, for Full Certification, the building will be assessed through operational data and as-installed documentation.

As with the Provisional Certification assessment, the Applicant Representative is required to notify the Assessment Organization at least two weeks prior to the date of the final submission.

The assessment process for LOTUS Full Certification is the same as for LOTUS Provisional Certification and consists of two rounds of assessment and one potential appeal procedure. The difference is that instead of verifying provisional documentation that may include proposed equipment to install, and strategies/plans to implement, the LOTUS Full Certificate assessment verifies the final operational performance, as-installed evidence and the proper implementation of the strategies/plans.

The LOTUS Full Certificate will be issued by VGBC upon successful completion of this final assessment and is valid for 5 years. Projects will be issued with LOTUS Certified, LOTUS Silver, LOTUS Gold or LOTUS Platinum certificates depending on the number of points achieved. During the 5 year validity period the Applicant will be required to submit operational data.

Certification Renewal Stage

The Certification Renewal Stage should happen during the Renewal Performance Period which corresponds to the 5 years of validity of the LOTUS Full Certificate or the 5 years of validity of the previous LOTUS Certificate Renewal.

The building will be assessed through the operational data starting from the previous Certification date up to the Certification Renewal submission date.

As with the Provisional & Full Certification assessment, the Applicant Representative is required to notify the Assessment Organization at least two weeks prior to the date of the Certification Renewal submission.

The assessment process for LOTUS Certification Renewal is the same as for LOTUS Full Certification and consists of two rounds of assessment and one potential appeal procedure. The LOTUS Certification Renewal assessment will verify that the operational performance of the building has been maintained through over the period of validity of previous Certification.

At the Certification Renewal stage, by targeting more credits or by improving their performance further, it is possible for projects to earn more points and reach a higher certification level compared to Full Certification stage. It is also possible that projects earn less points and maybe lose the LOTUS BIO Certification if the performance of the building has decreased.

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

The LOTUS BIO Certification Renewal is valid for 5 years and there is no limit in the number of renewals a project can get.

All the details regarding the Certification Renewal Stage (including the list of submittals required) will be provided in separate guidelines that will be handed out to projects at Full Certification. Evidence to submit at the Certification Renewal Stage are similar to the evidence to submit at the Full Certification stage but should cover the Renewal Performance Period instead of the Initial Performance Period.

LOTUS BIO Submissions

Types of Submissions

There are four different types of submissions in LOTUS BIO Certification:

- Provisional Certification Submissions
- Full Certification Submissions
- Operational stage Submissions
- Certification Renewal Submissions

Provisional Certification Submissions

The list of all submittals to be provided for Provisional Certification is given in the Submissions sections at the end of each prerequisite and credit. The structure of this submission should follow the description provided in section Submission Process.

Unless otherwise specified, submissions for Provisional Certification should encompass existing (i.e. already installed at the time of submissions) and proposed (i.e. to be installed after submissions, prior or during the Performance Period) systems, equipment and materials.

Full Certification Submissions

The list of all submittals to be provided for Full Certification is given in the Submissions sections at the end of each prerequisite and credit. The structure of this submission should follow the description provided in section Submission Process.

Unless otherwise specified, submissions for Full Certification should encompass all the installed systems, equipment and materials and should cover the whole performance period.

Where, in the Submissions sections of prerequisites and credits, the sentence “If it had not been awarded at Provisional Certification or if there is any change:” is written, all the submittals listed below that sentence do not need to be submitted if all of the following is true:

- The submittals have been provided for Provisional Certification
- The assessment report at Provisional Certification shows that the submittals have been accepted by the Assessment Organization
- No change impacting the credit has occurred since the submittals have been provided

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

Operational Stage Submissions

During the 5 year validity period of the LOTUS Certificate, the Applicant will be required to submit operational data.

Operational data is real data that is collected during the operation of the building. It includes energy and water consumption data (from bills or from metering data when available) and renewable energy generation.

Certification Renewal Submissions

The list of all submittals to be provided for Renewal Certification will be given in separate guidelines that will be handed out to projects at Full Certification.

This list will be similar to the list of submittals for Full Certification, the only difference being that the submittals should cover the Renewal Performance Period which lasts 5 years whereas the Initial Performance Period used for Full Certification lasts 12 months.

For buildings that did not undergo any renovation, only credits linked to operations will need to be re-submitted at Renewal Certification, and where operational practices have been maintained, only documents such as records, reports, photographs, etc. showing that the operational practices were well implemented throughout the Renewal Performance Period will need to be submitted.

The structure of the Certification Renewal submission should follow the description provided in section Submission Process.

Submission Process

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

When any change or deviation happens between different submissions, it should be brought to the attention of the Assessment Organization, and complete updated information encompassing any changes should be provided.

Once payment for Registration Fee has been received and the certification agreement has been duly signed, the Assessment Organization Representative provides the Applicant Representative with a complete package of documentation that includes a pre-arranged submission folder and a resources folder.

Project Submission Folder

The project submission folder is the main folder provided that, upon completion, will be returned to the Assessment Organization Representative for assessment. The project submission folder contains 10 sub-folders for the LOTUS BIO categories and a general information folder.

The Applicant Representative must use the folder structure as detailed below.

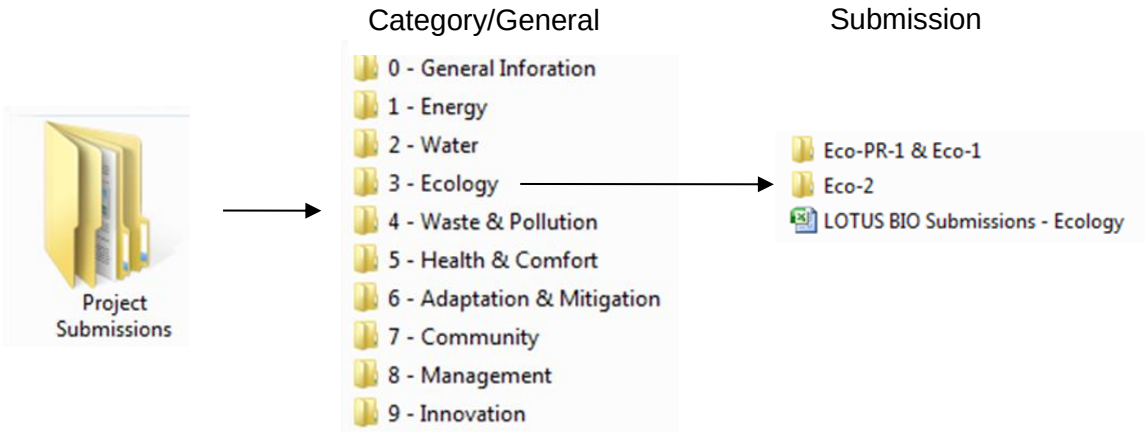


Figure 5: Project Submission Folder

General Information Folder

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

1. The completed LOTUS BIO Project General Information spreadsheet. This file provides the Assessment Organization with important information about the project, including:
   - Project location
   - Performance Period dates
   - List of consultants involved in the building renovation and/or certification
   - General information on building and site including a breakdown of spaces
   - Summary of all of the credits targeted by the project and the status of the submittals
2. Any critical correspondence between the Applicant Representative and the Assessment Organization Representative that may impact the project assessment.
3. Energy and water consumption data (from bills and/or metering data) starting at a minimum from the beginning of the Performance Period.

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

Category Folder

Within each category folder there will be one Category Submission Template file and a credit folder for each credit.

Credit Folder

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

Category Submission Template

The Category Submission Forms aim to provide a template for the Applicant to describe the strategies implemented and to submit all the evidence required. In order to make the assessment work easier and quicker, Category Submission Forms have been formatted to refer to the submissions section of each credit.

For each credit being targeted, including all mandatory prerequisites, the following sections that must be completed:

- Points: Tick the box corresponding to the number of points claimed for each credit
- Approach and Implementation: Insert a summary to explain how the credit requirements have been complied with; intent, solutions found, methodology used, main features, results and challenges (maximum of 2000 characters)
- Documents submitted: Complete the table by:
    - Adding the exact name of the electronic file(s) submitted in “File(s) Name”
    - Adding a “Reference” which will be used to guide the reviewer when assessing long or complicated documents which only partly address credit requirements (e.g. page 10, section 3.4, table 4.3)

Resources Folder

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

- LOTUS BIO V1 Management tool: a tool that can be helpful to manage the project, select appropriate pathways, track progression, set targets, etc. The Applicant Representative can use this tool at their own discretion.
- LOTUS Water Calculation Tool: a tool that can perform all the calculations necessary for the Water credits. VGBC strongly encourages the use of this tool as a submission document for the calculations of the Water Credits.
- LOTUS Water Calculation Tool - User Manual
- LOTUS Technical Queries Guidelines
- LOTUS Submissions Notification Form
- And, additional calculators/templates that can be used for a number of different credits.

LOTUS BIO Credit List

Credit	Title	Points
ENERGY		33 points
E-PR-1	Energy Audit	Energy Prerequisite 1
E-1	Energy Audit	2
E-2	Energy Use Intensity	15
E-3	Natural Ventilation and Air-conditioning	5
E-4	Artificial Lighting	4
E-5	Energy Monitoring and Management	3
E-6	Sustainable Energy Solutions	4
WATER		10 points
W-1	Water Audit	1
W-2	Water Efficient Fixtures	3
W-3	Water Metering and Leak Prevention	2
W-4	Sustainable Water Solutions	4
SUSTAINABLE PURCHASING		4 points
SP-1	Low-carbon purchasing	2
SP-2	Healthy purchasing	2
ECOLOGY		6 points
Eco-PR-1	Vegetation	Ecology Prerequisite 1
Eco-1	Vegetation	3
Eco-2	Sustainable Landscape Management	2
Eco-3	Pest Management	1
WASTE & POLLUTION		8 points
WP-1	Wastewater Treatment	2
WP-PR-1	Solid Waste Management	W&P Prerequisite 1
WP-2	Solid Waste Management	3
WP-3	Refrigerants	2
WP-4	Light Pollution Minimization	1

HEALTH & COMFORT		12 points
H-PR-1	Occupant Comfort	H&C Prerequisite 1
H-1	Occupant Comfort	3
H-PR-2	Indoor Smoking	H&C Prerequisite 2
H-2	Indoor Smoking	1
H-3	Fresh Air Supply	2
H-4	CO_2 monitoring	1
H-5	Daylighting	2
H-6	External Views	2
H-7	Green Cleaning	1
ADAPTATION & MITIGATION		11 points
A-1	Disaster Resilience	3
A-2	Storm Water Runoff	2
A-3	Heat Island Effect	2
A-PR-1	Green Transportation	A&M Prerequisite 1
A-4	Green Transportation	4
COMMUNITY		6 points
CY-1	Access for People with Disabilities	2
CY-PR-1	Occupant Behavior	CY Prerequisite 1
CY-2	Occupant Behavior	2
CY-3	Public Awareness Campaign	2
MANAGEMENT		10 points
Man-PR-1	Facility Audit	Man Prerequisite 1
Man-1	LOTUS Certified Building	1
Man-2	LOTUS AP	1
Man-3	Commissioning	4
Man-PR-2	Maintenance	Man Prerequisite 2
Man-4	Maintenance	2
Man-5	Green Management	2
INNOVATION		8 bonus points
Inn-1	Exceptional Performance Enhancement	8
Inn-2	Innovative techniques/initiative	

Energy

As urbanization is accelerating 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 (GHG) emissions.

For developing countries like Vietnam, while fast economic growth and urbanization rates are improving living conditions, they are also leading to an increasing demand for energy. It is expected that between 2010 and 2025 there will be a 10% increase in energy demand each year and that by 2025 demand will be triple the 2010 demand.

Moreover, as Vietnam's energy is mainly generated from non-renewable fossil fuels which are the main sources of GHG emissions, increased energy demand also means worsening global warming.

However, since buildings, 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 and operations, buildings can potentially reduce their energy consumption by up to 50% compared to a typical building, significantly reducing GHG emissions.

With this target in mind, LOTUS BIO rewards efforts taken to reduce a building's energy consumption through improving the efficiency of the existing systems, adding new green design features and ensuring a good management of the building.

Energy		33 points
Item	Criteria	Points
E-1	Energy Audit	2 points
	Perform a preliminary energy audit of the building	Energy Prerequisite 1
	Perform a general energy audit of the building	1
	Perform a detailed investment-grade energy audit of the building	2
E-2	Energy Use Intensity	15 points
	Strategy A: Benchmarking	
	1 point for energy use intensity lower than the benchmark and 1 point for every additional 2.5% of energy use intensity reduction compared to the benchmark	15
	Strategy B: Self-improvement	
	Reduce the energy use intensity of the building in comparison to the historical performance (up to 5 points)	5
E-3	Natural Ventilation and Air-conditioning	5 points
	Strategy A: Natural Ventilation	
	10 % of occupied areas are naturally ventilated	1
	1 point for every additional 20% of occupied areas that are naturally ventilated (up to 90%)	5
	Strategy B: COP of air-conditioning system	
	COP values of air-conditioning systems surpass VBEEC requirements	1
	1 point for every 10% improvement of COP for direct electric air-conditioners AND 5% improvement of COP for water-chilling systems in comparison to VBEEC requirements	5
	Strategy C: Variable speed controls	
	Use variable speed controls on all the air-conditioning systems	1
	Strategy D: Optimization of HVAC systems	
	1 point for every 2 measures effectively implemented to reduce energy consumption of the HVAC systems	2

E-4	Artificial Lighting	4 points
	Strategy A: Reduction of Light Power Density	
	Lighting Power Density surpasses EEBC requirements by 15%	1
	1 additional point for every further 15% of reduction of the installed LPD compared to VBEEC requirements (up to 45%)	3
	Strategy B: Lighting controls for building spaces	
	Install lighting control devices for the building spaces	1
	Strategy C: Lighting controls for daylit areas	
	Install lighting control devices for the lighting fixtures located in potentially daylit areas.	1
E-5	Energy Monitoring and Management	3 points
	Power sub-meters measure all the major energy uses	1
	A Power Monitoring System monitors all the major energy uses	2
	A Building Management System monitors and controls the building's electrical and mechanical equipment	3
E-6	Sustainable energy solutions	4 points
	Strategy A: Renewable Energy	
	For 1 point, 0.5% of the total energy used in the building is produced on-site from a renewable source	1
	1 point for every further 1% of the total energy used in the building that is produced on-site from a renewable source (up to 2.5%)	3
	Strategy B: Peak Electricity Demand	
	Reduce the percentage of energy consumed during the peak periods by 10% compared to the baseline	1
	Reduce the percentage of energy consumed during the peak periods by 20% compared to the baseline	2
	Strategy C: Service Water Heating	
	Heat recovery or solar thermal system or heat pump water heater contributes to at least 50% of the total hot water demand	1
	Heat recovery or solar thermal system or heat pump water heater contributes to 100% of the total hot water demand	2

E-PR-1 and E-1 Energy Audit

Intent

To identify and evaluate opportunities to optimize the energy use of the building.

Requirements

Criteria	2 Points
Perform a preliminary energy audit of the building	Energy Prerequisite 1
Perform a general energy audit of the building	1
Perform a detailed investment-grade energy audit of the building	2

Overview

An energy audit is an inspection, survey and analysis of the different energy usages in a building. The aim is to understand the status of the energy consumption of the building, identify the main energy saving opportunities and evaluate the benefits that can be obtained from adjustments, upgrades or the installation of new equipment. An energy audit is the best starting point to take appropriate decisions in the area of energy management.

Approach & Implementation

Energy Prerequisite 1

The preliminary energy audit should involve brief interviews with site operating personnel, a review of the building's utility bills and other operating data, and a careful walk-through of the building.

General energy audit

The scope of the audit should include at least the following:

- Heating, Ventilation, and Air Conditioning (HVAC)
- Lighting
- Hot water systems
- Pumping systems
- Any other significant energy consuming equipment/systems (greater than 20 kW)

The energy auditor conducting the audit should be qualified with either a certificate of energy auditor or at least 2 years of experience in energy auditing.

The audit should start with a preliminary stage as described above for the preliminary energy audit. This preliminary audit aims to familiarize the audit team with the building activities, identify the main energy usage areas and define the procedures necessary to carry out the general audit.

Then, the general energy audit should evaluate the building energy systems in detail to provide a comprehensive analysis of the energy use of the building and define a variety of potential energy-savings opportunities.

The audit should result in a report and briefing with the owner and management team. The report should contain the following:

- An overview of the building's energy profile
- A description of the different energy using systems
- The findings on the performance of these systems
- A list of energy-savings opportunities
- The expected energy savings, costs and paybacks for the different opportunities
- Some recommendations on the implementation of the energy-savings solutions

Detailed investment-grade energy audit

The detailed investment-grade energy audit aims to extend the general energy audit by providing a more thorough and detailed understanding of the benefits, costs and performance expectations. Its purpose is to give building owners a high level of confidence before upgrading or retrofitting some building systems that will require significant investments.

This audit must rely on a complete engineering study that includes a dynamic energy simulation of both the existing building and all the energy-savings measures identified.

More detailed data will need to be collected and analyzed, including:

- sub-metering of individual energy consuming systems within the building
- monitoring of energy consuming systems operating characteristics
- analysis of specific situations that cause load profile variations in energy use.

All these data should be used to calibrate a model of the existing building that will provide a realistic baseline against which to compute operating energy savings from proposed measures.

Submissions

Provisional Certification Stage
Energy Prerequisite 1
If no general or detailed energy audit report for Energy Credit 1 is submitted: • Preliminary energy audit report
General energy audit
• General energy audit report
Detailed investment-grade energy audit
• Detailed investment-grade energy audit report including all the elements of the general audit report and an energy simulation report showing inputs, assumptions and results.

Full Certification Stage
Energy Prerequisite 1
If no energy audit report for Energy Credit 1 is submitted and if the prerequisite had not been awarded at Provisional Certification or if there is any change: • Preliminary energy audit report
General energy audit
If the credit had not been awarded at Provisional Certification or if there is any change: • General energy audit report
Detailed investment-grade energy audit
If the credit had not been awarded at Provisional Certification or if there is any change: • Detailed investment-grade energy audit report including all the elements of the general audit report and an energy simulation report showing inputs, assumptions and results.

E-2 Energy Use Intensity

Intent

To encourage buildings in operation to minimize their energy consumption.

Requirements

Criteria	15 Points
Strategy A: Benchmarking	
1 point for energy use intensity lower than the benchmark and 1 point for every additional 1.5% of energy use intensity reduction compared to the benchmark	15
Strategy B: Self-improvement	
Reduce the energy use intensity of the building in comparison to the historical performance	5

Overview

Energy consumption within buildings is a major source of energy demand in Vietnam. Unabated, Vietnam's energy consumption stands to outweigh production and may result in more frequent energy shortages. Additionally, this escalating consumption will have an increasing contribution to climate change as a large portion of energy produced in Vietnam is derived from coal and gas. Buildings already in operation represent a significant proportion of the buildings that will exist in the near future; cutting down their energy use is the best strategy to relieve energy demand pressure in Vietnam.

Approach & Implementation

Many solutions can be employed to improve a building's energy performance. The most relevant energy savings opportunities will be highlighted in the energy audit conducted for Credit E-1. Clearly, inefficient buildings will have more opportunities to reduce their energy use intensity and will have shorter payback periods, but even efficient buildings can make improvements, especially in operations and maintenance.

Energy savings strategies for buildings in operation can include:

- Replacing inefficient equipment (lighting fixtures, air-conditioning units, water heaters etc.)
- Retrofitting the building envelope
- Installing variable speed drives for pumps and fans
- Improving the management and maintenance of the building's energy consuming systems
- Improving occupant behavior patterns

Calculations

The building energy use intensity, measured in kWh/m^2/year, is the total energy consumption of the building during one year (kWh/year) divided by the Net Floor Area (NFA) of the building (m^2). It can be calculated using utility bills (for electricity and any other types of fuel used) or energy metering data for the building. The energy produced on site from renewable sources should be deducted from the total energy consumption.

To convert the fuel consumption (e.g. gas, diesel, oil - usually in volume or weight of fuel) into an energy consumption in kWh, the net calorific value (or lower heating value) of the fuel should be used.

Strategy A: Benchmarking

In this strategy, the building energy use intensity at Performance period should be compared to a benchmark value that represents the typical energy use of a building comparable to the project.

The reduction of the building energy use intensity compared to the benchmark should be calculated using the following formula:

$$\text{Energy Intensity Use Reduction } [\%] = \left(1 - \frac{\text{Energy Use Intensity of the Building}}{\text{Benchmark Energy Use Intensity}}\right) \times 100$$

Two methods are proposed to projects to set the benchmark energy use intensity value.

Method 1: General benchmarks

Benchmark values in Table E.1 can be used for office, hotel, residential and retail buildings. To make the comparison between the building energy use intensity and the benchmark values, the building energy use intensity should be adjusted to match typical operational hours as a means to standardize results. As indicated in Table E.1, typical operational hours to consider are 52 hours per week for office buildings and 84 hours per week for retail buildings. Other types of buildings don't have a reference value for operational hours and actual energy intensity should be used for the calculations.

Table E.1: Benchmark energy use intensity and operational schedule for different building types

Building Type	Benchmark Energy Intensity (kWh/m^2/year)	Operational Hours (hours/week)
Office	150	52
Hotel	250	-
Residential	60	-
Retail	300	84

Method 2: Peer group of comparable buildings benchmark

As benchmark values set in Table E.1 may not be adapted for all buildings (building types that are not included such as hospitals, schools, factories; buildings with high quality ratings such as Grade A offices, 5 stars hotels; buildings with specific needs; etc.) another method can be used to set an acceptable benchmark value. This method consists in making a comparison with a group of buildings which share similar characteristics to the project building.

Guidelines explaining in details how to select the peer group of comparable buildings and how to adjust the building energy use intensity values will be provided to projects.

Strategy B: Self-improvement

In this strategy, the building energy use intensity at Performance period should be compared to the building energy use intensity at Historical period.

The reduction of the building energy use intensity during the Performance Period compared to the Historical period should be calculated using the following formula:

$$\text{Energy Use Intensity Reduction } [\%] = \left(1 - \frac{\text{Energy Use Intensity of the Building During Performance Period}}{\text{Energy Use Intensity of the Building During Historical Period}}\right) \times 100$$

Points in strategy B will be allocated to projects following Table E.2.

Table E.2: Points allocation for energy use intensity reduction compared to the Historical period

Building EUI at Performance Period	Points allocated
Building EUI value is higher than benchmark value	1 point every 3% of energy use intensity reduction compared to the historical baseline
Building EUI value is less than 10% lower than benchmark value	1 point every 2% of energy use intensity reduction compared to the historical baseline
Building EUI value is more than 10% lower than benchmark value	1 point every 1% of energy use intensity reduction compared to the historical baseline

Example of calculation combining both strategies:

An office building with a GFA of 3000 m^2 has a total electricity consumption of 510,000 kWh/year during the historical baseline period. After implementing energy saving strategies, the total electricity consumption is reduced to 420,000 kWh/year during the Performance Period. The building operates for 56 hours per week.

- Calculation of the building energy use intensity for the Historical Period and Performance Period:

$$\text{Historical Building EUI } = \frac{455{,}000}{3{,}000} = \text{ 151.6 kWh/m}^2\text{/year}$$

$$\text{Performance Period Building EUI} = \frac{420{,}000}{3{,}000} = 140.0 \text{ kWh/m}^2\text{/year}$$

- Calculation of the building energy use intensity reduction compared to benchmark:

Using method 1 to set the benchmark value, according to Table E.1, for an office building, the Benchmark Energy Intensity is equal to 150 kWh/m^2/year with an operation of 52 hours/week.

First, the building energy use intensity needs to be adjusted to match the operational hours:

$$\text{Standardized Performance Period Building EUI } = 140.0 \times \frac{52 \text{ hrs/week}}{56 \text{ hrs/week}} = 130 \text{ kWh/m}^2\text{/year}$$

Then, the reduction of the building energy use intensity compared to the benchmark is calculated:

$$\text{Benchmark Energy Use Reduction [\%]} = \left(1 - \frac{130}{150}\right) = 13.3\%$$

- Calculation of the building energy use intensity reduction compared to Historical Period:

$$\text{Historical Energy Use Reduction [\%]} = \left(1 - \frac{140}{151.6}\right) = 7.7\%$$

- Calculation of the number of points achieved:

A 13.3 % benchmark reduction corresponds to more than 8 times a reduction of 1.5%. 9 points will be granted for the benchmark reduction (1 point for being lower than the benchmark and 1 point for every additional 1.5%).

A 17.6% historical baseline reduction corresponds to more than 7 times a reduction of 1%. Only 5 points will be granted as it is the upper limit for self-improvement.

A total of 14 points would be awarded for such a building in LOTUS BIO.

Submissions

Provisional Certification Stage
• Utility bills (electricity and other types of fuel) -AND/OR- energy metering data for at least the previous 12 months
If new energy efficiency strategies are to be implemented: • Estimation of the energy savings expected from the implementation of new energy efficiency strategies in the building
Strategy A: Benchmarking
• Calculation of the expected reduction of the building energy use intensity during the Performance Period compared to the selected benchmark
If using the peer group of comparable buildings benchmark: • Calculation of the benchmark following the peer group of comparable buildings method • All relevant information on the peer group of buildings to establish the benchmark
Strategy B: Self-Improvement
• Calculation of the expected reduction of the building energy use intensity during the Performance Period compared to the Historical Period
If historical baseline period is different from the previous 12 months: • Utility bills (electricity and other types of fuel) -AND/OR- energy metering data covering the historical baseline period

Full Certification Stage
• Utility bills (electricity and other types of fuel) -AND/OR- energy metering data covering the whole Performance Period
Strategy A: Benchmarking
• Calculation of the actual reduction of the building energy use intensity during the Performance Period compared to the selected benchmark
If the strategy had not been awarded at Provisional Certification or if there is any change: If using peer group of comparable buildings benchmark: • Calculation of the benchmark following the peer group of comparable buildings method • All relevant information on the peer group of buildings to establish the benchmark
Strategy B: Self-Improvement
• Utility bills (electricity and other types of fuel) -AND/OR- energy metering data covering the historical baseline period • Calculation of the actual reduction of the building energy use intensity during the Performance Period compared to the Historical Period

E-3 Natural Ventilation and Air-conditioning

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	5 points
Strategy A: Natural Ventilation	
10% of occupied areas are naturally ventilated	1
1 point for every additional 20% of occupied areas that are naturally ventilated (up to 90%)	5
Strategy B: COP of air-conditioning system	
COP values of air-conditioning systems surpass VBEEC requirements	1
1 point for every 10% improvement of COP for direct electric air-conditioners AND 5% improvement of COP for water-chilling systems in comparison to VBEEC requirements	5
Strategy C: Variable controls	
Use variable controls on all suitable HVAC systems	1
Strategy D: Optimization of HVAC systems	
1 point for every 2 measures effectively implemented to reduce energy consumption of the HVAC systems	2

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.

Strategy A: Natural Ventilation

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). As buildings may not be able to wholly rely on natural means, ventilation systems such as mechanically assisted natural ventilation or mixed-mode ventilation can be introduced where possible in order to minimize HVAC demand.

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 requires proper building orientation, as well as the appropriate size, number and placement of wall and roof openings.

The second method, stack ventilation, depends on the density differences between air of different temperatures. As air is warmed, either by internal heat loads, or within a thermal chimney, it begins to rise due to its lower relative density. In a structure designed to take advantage of the stack effect, 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.

A combination of both the methods is also possible and will give the most effective results when the internal flow paths inside the building are considered.

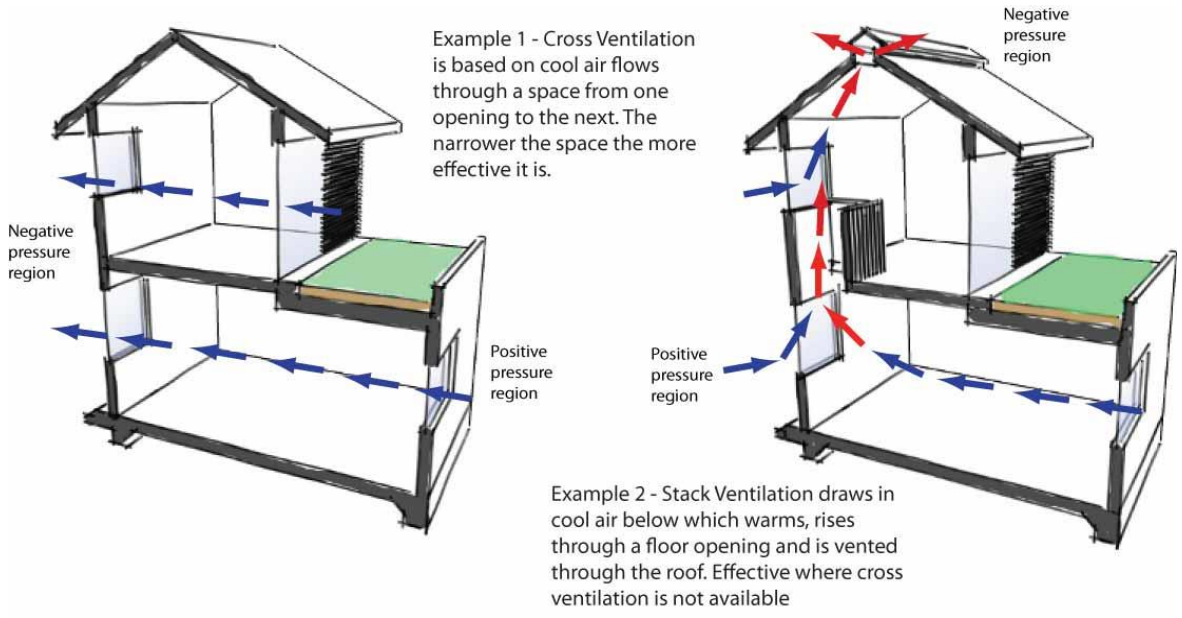


Figure E.1: Two methods of natural ventilation: wind driven ventilation and stack ventilation

Strategy B, C and D

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.

Energy efficient HVAC systems can result in energy and financial savings over the life of a building. Older HVAC systems in buildings may be inefficient and by replacing these existing systems with new HVAC systems with a higher Coefficient of Performance (COP), or by optimizing them, significant energy savings can be made.

Approach & Implementation

Strategy A: Natural Ventilation

The inclusion of natural ventilation as a major source of ventilation and cooling should preferably be investigated early in the design process. For an existing building, technologies and strategies which can promote natural ventilation include:

- Properly chosen window types and ventilation openings to ensure natural airflows are maximized
- Methods to enhance natural ventilation mechanisms like trickle vents, wing walls or thermal chimneys
- Adaptation of internal partitions to improve flow paths inside the building
- Computational Fluid Dynamics (CFD) modelling or wind tunnel testing to identify airflows and to increase the efficiency of the layout to promote natural ventilation

Strategy B: COP of air-conditioning system

Use air-conditioning systems whose COP values meet the minimum requirement values of tables E.3 and E.4 from VBEEC. Increasing COP Values results in an improvement of the HVAC systems efficiencies.

Table E.3: Minimum COP requirements for direct electric air conditioners (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	
Condensing Units, Air-Cooled	≥ 40 kW	2.96	ARI 365
Condensing Units, Water or evaporatively cooled	≥ 40 kW	3.84	

Table E.4: Minimum COP Requirements for chillers (VBEEC Table 2.7)

Equipment Type	Capacity	Minimum COP	Test procedures
Air cooled, with or without condenser, electrically operated	All Capacities	3.10	ARI 550/590
Water cooled, electrically operated, positive displacement (reciprocating)	All capacities	4.20	ARI 550/590
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	< 528 kW	4.45	
	>= 528 kW to <1055 kW	4.90	
	>= 1055 kW	5.50	
Water Cooled, Electrically Operated, Centrifugal	< 528 kW	5.00	
	>= 528 kW to <1055 kW	5.55	
	>= 1055 kW	6.10	
Air-cooled absorption chiller, single effect	All Capacities	0.60	ARI 560
Absorption, Single Effect, Water Cooled	All Capacities	0.70	
Absorption, Double Effect, Indirect Fired	All Capacities	1.00	
Absorption, Double Effect, Direct-Fired	All Capacities	1.00	

Strategy C: Variable controls

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

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

Strategy D: Optimization of HVAC system

Implement effective measures to reduce energy consumption of the HVAC systems. The list of measures below is not exhaustive and, in any case, the effectiveness of implemented measures will have to be demonstrated and will be subject to the Assessment Organization approval.

For chillers:

- If more than one chiller is installed, optimize the distribution of the cooling load among the chillers to minimize total chiller plant energy use. The distribution of the cooling load should take into account the efficiency of the different chillers, their part-load efficiency and their auxiliary equipment energy use (pumps, cooling towers).
- Optimize the operating chilled water and condenser water temperatures:
    - Keeping the chilled water supply temperature as high as possible will help to save energy in the chillers. The maximum chilled water supply temperature should be determined by compromising with fan power, pump power and cooling load.
    - Keeping the condensing temperature as low as possible can also reduce energy use of chillers. Optimizing condensing temperature is not as simple as optimizing the chilled water temperature, and calculating the optimum condensing temperatures should be done carefully. The following factors should be considered: energy use for heat rejection (which will increase), efficiency of the chiller at low condensing temperature (which might decrease when the temperature is too low), and the minimum required entering condenser water temperature of the chillers.
- Optimize Condenser and Evaporator Heat Transfer Efficiency:
    - Clean Condenser and Evaporator Tubes
    - Adjust the blowdown rate to maintain proper water conditions
- Optimize the performance of the Heat Rejection Equipment:
    - Clean heat rejection units at appropriate intervals.
    - In crossflow (gravity-flow) cooling towers, ensure proper water distribution
    - Modulating fan output in heat rejection units to follow the cooling load is not rewarded in Strategy D as it is already included in Strategy B.

For air handling systems:

- Turn off air handling systems when they are not needed
- Adjust fresh air intake
- Install an exhaust air heat recovery system
- Install and adjust thermostatic controls
- Adjust temperature setpoints depending on time of day and day of the year

For air-conditioners:

- Minimizing Equipment Operation
    - Provide signs with instructions for users on a proper use of air-conditioners
    - Assign responsibility for turning conditioning units on and off
- Clean and repair air conditioners at regular intervals
- Provide separate thermostatic control for each area with distinct heating requirements

Calculations

Strategy A: Natural Ventilation

Only net occupied areas are to be included and must be consistent across all calculations for this credit.

For locations where the average maximum temperature during the hottest month is below 30°C, a space shall be considered naturally ventilated where the total operable opening area is no less than 4% of the floor area.

For locations where the hottest month average maximum temperature is above 30°C, a space shall be considered to be naturally ventilated if it meets at least one of the following two requirements.

1. The space meets all of the following specifications:

- The total effective area of operable openings to the outside is no less than 4% of the floor area. The effective area of a window is defined as the physical area of the window open to the outdoors (this can be calculated using simple geometry). These openings shall be readily accessible to the occupants and must provide a direct path to the outside through openings of equal or greater area
- The total effective area of operable openings through the ceiling or opposite wall from the source of outside air is no less than 4% of the floor area.
- The net exhaust area must be no less than the sum of the required net ventilation areas

2. Using CFD or wind tunnel testing, it is justified that the weighted average air speed within the space is greater than the values in Table E.5. The CFD simulation should be conducted in accordance with the CFD simulation methodology set by the VGBC which will be provided upon request.

Table E.5: Minimum air speed requirements for naturally ventilated spaces

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

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

The total naturally ventilated occupied area of the building is calculated using the following formula:

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

Strategy B: COP of air-conditioning system

All air conditioning units and water chilling packages 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.3 and E.4.
Calculations of the improvement of air conditioning efficiencies compared to VBEEC should be performed using the two following formulas:

$$\text{Direct electric AC COP Improvement [\%]} = \left(\frac{\sum_i (P_i \times Y_i)}{\sum_i (P_i \times Y_{Ei})} - 1\right) \times 100$$

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

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

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

$$\text{Chiller COP Improvement [\%]} = \left(\frac{\sum_c (P_c \times Y_c)}{\sum_c (P_c \times Y_{Ec})} - 1\right) \times 100$$

P_c = Capacity of the chiller unit c

Y_c = COP of the chiller unit c

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

Submissions

Provisional Certification Stage
Strategy A: Natural Ventilation
• Elevations and plans marking all existing and/or proposed operable wall and roof openings • Window schedule indicating the number, location and size of all existing and/or proposed operable wall and roof openings or room data sheets that indicate area and window specifications (glazing type, size and whether the window is operable). • Calculations demonstrating that existing and/or proposed naturally ventilated occupied spaces conform to the requirements • Calculation showing the percentage of the net occupied area which is/will be naturally ventilated
If CFD simulation has been conducted to determine air speed within the building: • Report following the requirements of the CFD simulation methodology set by the VGBC
If the building includes spaces with mixed-mode ventilation: • Report explaining the operation of the mixed-mode ventilation system and how it can reduce HVAC energy consumption

Strategy B: COP of air-conditioning system
• Schedule of all existing and/or proposed HVAC equipment indicating cooling capacity and COP • Schematic drawings/sketches of the HVAC systems indicating location of all HVAC equipment • Inventory report from facility audit indicating cooling capacity, electrical power and/or COP values of all existing HVAC equipment. • Calculations demonstrating improvement on the VBEEC requirements
If any proposed HVAC equipment are to be installed: • Manufacturer's published data - AND/OR - Specification extracts on all proposed HVAC equipment, indicating cooling capacity, electrical power and/or COP values.
Strategy C: Variable controls
• Schedule of all existing and/or proposed HVAC systems showing that all systems are using variable controls to ensure better part-load systems efficiency • Evidence showing that the variable controls are installed such as inventory report from facility audit, photographs, drawings, commissioning reports, etc.
If any proposed variable controls are to be installed: • Manufacturer's published data - AND/OR - Specification extracts of all proposed variable controls to be installed
Strategy D: Optimization of HVAC system
For each measure to be implemented or already implemented: • Description of the measure, the energy saving potential, the issues to consider to ensure a good performance

Full Certification Stage
Strategy A: Natural Ventilation
If the strategy had not been awarded at Provisional Certification or if there is any change: • Elevations and plans marking all operable wall and roof openings • Window schedule indicating the number, location and size of all operable wall and roof openings or room data sheets that indicate area and window specifications (glazing type, size and whether the window is operable). • Calculations demonstrating that naturally ventilated occupied spaces conform to the requirements • Calculation showing the percentage of the net occupied area which is/will be naturally ventilated If CFD simulation has been conducted to determine air speed within the building: • Report following the requirements of the CFD simulation methodology set by the VGBC If the building includes spaces with mixed-mode ventilation: • Report explaining the operation of the mixed-mode ventilation system and how it can reduce HVAC energy consumption

Strategy B: COP of air-conditioning system
If new air-conditioning equipment have been installed after Provisional Certification: • Manufacturer's published data of all new HVAC equipment, indicating cooling capacity, electrical power and/or COP • Evidence of the new HVAC equipment installed, such as photographs, receipts, as-built documentation, commissioning report, material approval request, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Inventory of all HVAC equipment indicating cooling capacity and COP • Schematic drawings/sketches of the HVAC system indicating location of all HVAC equipment • Inventory report from facility audit indicating cooling capacity, electrical power and/or COP values of all existing HVAC equipment. • Calculations demonstrating improvement on the VBEEC requirements
Strategy C: Variable controls
If any proposed variable controls have been installed after Provisional Certification: • Manufacturer's published data of all proposed variable controls to be installed • Evidence of the new variable controls installed, such as photographs, receipts, as-built documentation, commissioning report, material approval request, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Schedule of all HVAC systems showing that all systems are using variable controls to ensure better part-load systems efficiency • Evidence showing that the variable controls are installed such as inventory report from facility audit, photographs, drawings, commissioning reports, etc.
Strategy D: Optimization of HVAC system
• Evidence showing that the measures have been properly implemented during the Performance Period such as photographs, maintenance records, contracts, etc. • Evidence showing the effectiveness of the measure implemented (when possible) such as energy metering data, measurements, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Description of the measures implemented, the energy saving potential, the issues to consider to ensure a good performance

E-4 Artificial Lighting

Intent

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

Requirements

Criteria	4 Points
Strategy A: Reduction of Light Power Density	
Installed Lighting Power Density (LPD) surpasses VBEEC requirements by 15%	1
1 additional point for every further 15% of reduction of the installed LPD compared to VBEEC requirements (up to 45%)	3
Strategy B: Space lighting controls	
Install lighting control devices for the building spaces	1
Strategy C: Daylighting controls	
Install lighting control devices for the lighting fixtures located in potentially daylit areas	1

Overview

Artificial lighting contributes significantly to a building's overall energy consumption. The application of appropriate lighting contributes to occupant well-being, worker performance and building aesthetics. Upgrading lighting systems to energy efficient lamps, luminaires and ballasts can be a cost-effective way of reducing the energy consumption of a building, potentially having a short payback period.

Approach & Implementation

Strategy A: Reduction of Light Power Density

The VBEEC stipulates maximum light power densities for different building types (Table E.6). Lighting power associated with the use of artificial lighting systems can be reduced in the following way:

- Retrofit existing lighting with high efficiency lighting fixtures (fluorescent T5, LED...)
- Use efficient ballasts with low watt losses and with appropriate ballast factors
- Optimize the lighting system 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

Table E.6: Maximum LPD Values for different types of building
(*Source: VBEEC Table 2.12*)

Type of Buildings	Maximum LPD (W/m^2)
Office	11
Hotel	11
Hospital	13
School	13
Retail	16
Residential	8
Enclosed, in-house, basement car parks	3
Outdoor or open (roofed only) car parks	1.6
Other types of buildings	13

Strategy B: Space lighting controls

Meet the following requirements (adapted from VBEEC Section 2.3.3 Lighting controls 1) Lighting controls for different building spaces):

- All separate spaces (any space enclosed with ceiling-height partitions) must have at least one lighting control device (actuated manually or by automatic sensor).
- Each control device must cover a maximum floor area of 100 m^2
- Following spaces must have occupancy or vacancy sensors to control the lighting system:
    - Conference rooms in office buildings and hotels,
    - Passageways in office buildings, hotels, schools and residential buildings,
    - In-house parking lots in schools and residential buildings
- A device to shutoff lighting in all spaces must be installed. It can be a master main switch located adjacent to the main staff entry for the premises enabling the last person to turn off all the lighting systems when leaving or it can be an automatic control device (scheduling control, occupant sensor, etc.)

The device to shutoff lighting in all spaces, the occupancy sensors and the vacancy sensors shall not be connected to the exit lighting and security lighting systems.

Strategy C: Daylighting lighting controls

For each potentially daylit area, comply with at least one of the three following requirements:

- install photosensors to automatically dim lights depending on the level of natural illuminance received.
- install photosensors to automatically switch lights off when natural light measured by the sensors is beyond the standard preset level for the occupant space (e.g. 300 lux for offices)
- install a manual switch to control the lights independently of the general area lighting

Potentially daylit areas are the sidelit daylit areas and skylit daylit areas as defined below:

- 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.

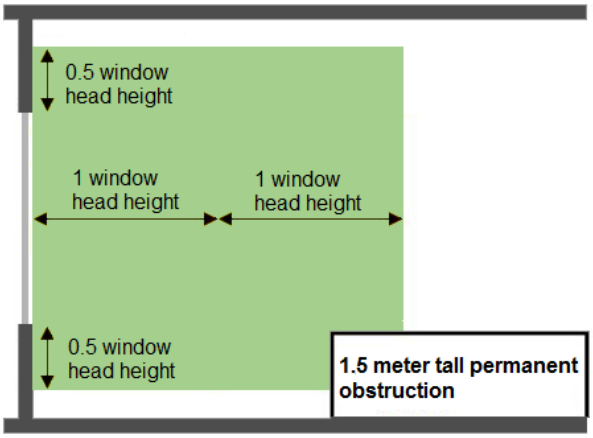


Figure E.2: Measurement of the sidelit daylit area (top view)

- 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 exist

  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 (e.g. for a rectangular skylight the skylit daylit zone plan area shall be rectangular).

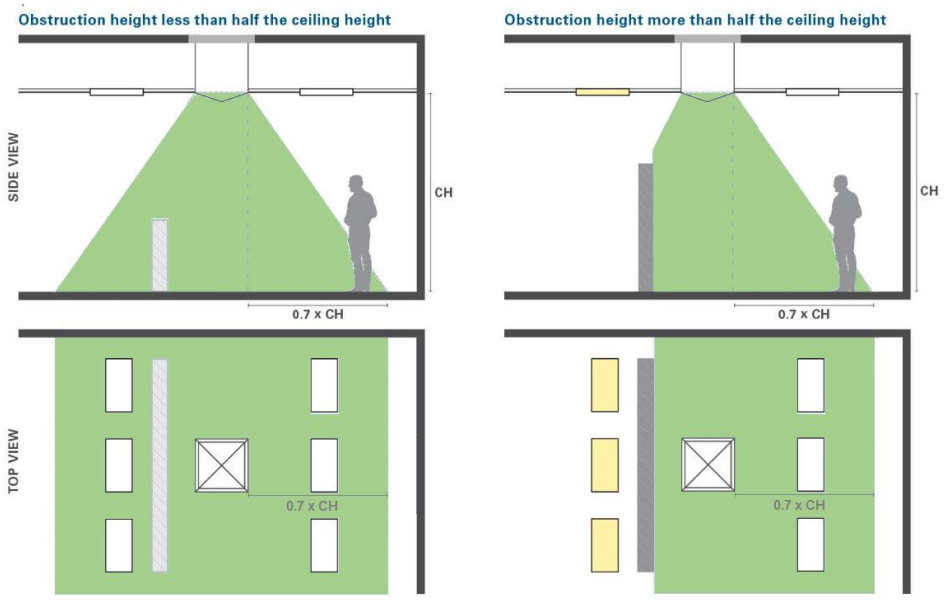


Figure E.3: Measurement of the skylit daylit area

Calculations

Strategy A: Lighting power density reduction

The calculation demonstrating that the average Lighting Power Density of all artificially lit areas of the building surpasses the requirements of the VBEEC should be calculated using 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 building including parking spaces. The calculation must include the power used by lamps and ballasts. Current regulators and control devices don't have to be included.

$$\text{LPD}_{\text{building}}\,[\text{W/m2}] = \frac{P_L}{GFA_L}$$

$LPD_{building}$ = Lighting Power Density of the building [W/m^2]

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

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

$$P_L[\text{W}] = \sum(\text{lamp wattage} \times \text{number of lamps} \times \text{ballast factor}) + \text{ballast losses}$$

Ballast factor (BF) is the measured ability of a particular ballast to produce light from the lamp(s) it powers. Ballast factor is not a measure of energy efficiency. A lower ballast factor reduces lamp lumen output and consumes proportionally less input power. As such, careful selection of a lamp-ballast system with a specific ballast factor allows designers to better minimize energy use by "tuning" the lighting levels in the space.
For example, in new construction, high ballast factors are generally best, since fewer luminaires will be required to meet the light level requirements. In retrofit applications or in areas with less critical visual tasks, such as aisles and hallways, lower ballast factor ballasts may be more appropriate.

Ballast losses correspond to the power or energy dissipated in the ballast as heat and not converted to lamp energy.

- Calculate the average baseline LPD for the building including parking spaces with the following formula:

$$LPD_{baseline}[\text{W/m2}] = \frac{\sum_i (LPD_i \times GFA_{L\,i})}{\sum_i GFA_{L\,i}}$$

$LPD_{baseline}$ = Maximum Lighting Power Density for the building [W/m^2]

LPD_i = Maximum Lighting Power Density for the building type i from the VBEEC [W/m^2]

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

- Calculate the average reduction in Lighting Power Density with the following formula:

$$\text{LPD Reduction } [\%] = \left(1 - \frac{LPD_{building}}{LPD_{baseline}}\right) \times 100$$

Example of calculation:

A retail building includes the following areas and lighting power installed (Table E.7).

Table E.7: Example of LPD reduction calculation for a mixed-use project

Building types	GFA of lighted spaces [m²]	Total artificial lighting power installed [W]	Maximum Lighting Power Density for the building type (VBEEC) [W/m²]
Retail	5,000	45,000	16
Office	300	1,800	11
Outdoor car parks	1,000	1,500	1.6
Enclosed car parks	2,000	6,000	3
Total	GFA_L = 8,300 m²	P_L = 54,300 W	

$$LPD_{building}[W/m2] = \frac{P_L}{GFA_L} = \frac{54{,}300}{8{,}300} = 6.5\ W/m^2$$

$$LPD_{baseline}\left[\frac{W}{m2}\right] = \frac{\sum_i (I_{E\,i} \times GFA_{L\,i})}{\sum_i GFA_{L\,i}} = \frac{5{,}000 * 16 + 300 * 11 + 1{,}000 * 1.6 + 2{,}000 * 3}{8{,}300}$$
$$= 11.0\ W/m2$$

$$LPD\ Reduction\ [\%] = \left(1 - \frac{I_D}{I_E}\right) \times 100 = 40.3\%$$

This retail building can be granted 2 points with more than 30% of LPD reduction achieved.

Submissions

Provisional Certification Stage
Strategy A: Reduction of Light Power Density
• Schedule of all the existing and/or proposed lighting fixtures in the building, including the ballasts • Calculations demonstrating the percentage of LPD reduction achieved • Evidence showing the lighting fixtures installed such as inventory report from facility audit, photographs, drawings, invoices, etc.
If any proposed lighting fixtures are to be installed: • Specification extracts - AND/OR - Manufacturer's published data for all proposed lighting fixtures, including the ballasts

Strategy B: Space lighting controls
• Schedule showing all the existing and/or proposed sensors/controls in each spaces • Evidence showing the installation and location of all the sensors and controls such as inventory report from facility audit, electrical drawings, photographs, receipts, etc.
If any proposed space lighting sensors/controls are to be installed: • Specification extracts -AND/OR- Manufacturer's published data for all proposed space lighting sensors/controls to be installed
Strategy C: Daylighting controls
• Schedule showing all the existing and/or proposed daylighting sensors/controls • Evidence showing the installation and location of all the daylighting sensors/controls such as inventory report from facility audit, electrical drawings, photographs, receipts, etc.
If any proposed sensors/controls for daylit areas are to be installed: • Specification extracts -AND/OR- Manufacturer's published data for all the proposed daylighting sensors/controls for daylit areas to be installed

Full Certification Stage
Strategy A: Reduction of Light Power Density
If new lighting fixtures have been installed after Provisional Certification: • Manufacturer's published data of all the new artificial lighting devices, including the ballasts
If the strategy had not been awarded at Provisional Certification or if there is any change: • Schedule of all the lighting fixtures in the building, including the ballasts • Calculations demonstrating the percentage of LPD reduction achieved • Evidence showing the lighting fixtures installed such as inventory report from facility audit, photographs, drawings, receipts, etc.
Strategy B: Space lighting controls
If new space lighting sensors/controls have been installed after Provisional Certification: • Manufacturer's published data of all the new space lighting sensors/controls
If the strategy had not been awarded at Provisional Certification or if there is any change: • Schedule showing all the sensors/controls installed in each spaces • Evidence showing the installation and location of all the space lighting sensors/controls such as inventory report from facility audit, electrical drawings, photographs, receipts, etc.
Strategy C: Daylighting controls
If new daylighting sensors/controls have been installed after Provisional Certification: • Manufacturer's published data of all the new daylighting sensors/controls
If the strategy had not been awarded at Provisional Certification or if there is any change: • Schedule showing all the sensors/controls installed for daylit areas • Evidence showing the installation and location of all the daylighting sensors/controls such as inventory report from facility audit, electrical drawings, photographs, receipts, etc.

E-5 Energy Monitoring and Management

Intent

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

Requirements

Criteria	3 Points
Power sub-meters measure all the major energy uses	1
A Power Monitoring System monitors all the major energy uses	2
A Building Management System monitors and controls the building's electrical and mechanical equipment	3

Overview

Power sub-metering involves the installation of measurement equipment to meter building energy use. It helps to track energy consumption of major building uses and other end-use applications (e.g. by building systems or individual floors). Separate metering should be put in place to monitor all major power uses and floors/tenancies.

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

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

Approach & Implementation

Power sub-metering

To meet the requirements for sub-metering, individual power meters should be installed for all the following:

- Separate tenancies
- Separate floors (when appropriate)
- HVAC equipment such as chillers, air handling units, air-conditioners and pumps
- Artificial Lighting
- Any equipment with a rated power greater than 20 kW (including lifts and escalators)

Power Monitoring System

The power monitoring system should centralize the data from all the power meters installed following requirements for sub-metering. The data from the PMS should be used to analyze the consumption of the different energy-using areas and to create monthly and annual summaries.

Building Management System

The building management system should meet the requirements for power monitoring system and it should monitor and control at least the following systems:

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

The BMS should be used to optimize the performance of the systems by determining appropriate adjustments of the operational parameters (temperature setpoints, air flowrates, damper control, etc.) in order to achieve energy savings. Access to the BMS should be restricted to trained staff that have the ability to analyze the data and make relevant adjustments to the systems in order to improve energy performance.

Submissions

Provisional Certification Stage
For all strategies:
• Schedule of all the existing and/or proposed power meters indicating their location, type and the water usage metered • Report indicating how the meters are/will be employed, including: responsible staff, training provided and types of outputs generated • Existing and/or proposed electrical schematic drawings showing location, type, number of power meters and the usage served by those meters • Inventory report from facility audit indicating all existing meters and/or BMS controls
Power Monitoring System:
• Existing and/or proposed schematics of the communication interface between the software and the meters
Building Management System:
• Report indicating how the building management system is/will be employed, including: responsible staff, training provided, types of outputs generated and adjustments of operational parameters • Existing and/or proposed BMS control schematic drawings showing systems operated by the BMS • Existing and/or proposed electrical schematic drawings showing location, type and number of sensors and controls showing their usage • Details on existing and/or proposed user interface, central monitoring and control equipment

Full Certification Stage
For all strategies:
• Monthly outputs from the power meters during the Performance Period
If new power meters have been installed after Provisional Certification: • Evidence showing the new power meters installed such as receipts, invoices, photographs, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Schedule of all the power meters indicating their location, type and the water usage metered • Report indicating how the meters are employed, including: responsible staff, training provided and types of outputs generated • Electrical schematic drawings showing location, type, number of power meters and the usage served by those meters • Inventory report from facility audit indicating all the existing meters and/or BMS controls
Power Monitoring System:
If the strategy had not been awarded at Provisional Certification or if there is any change: • Schematics of the communication interface between the software and the meters
Building Management System:
• Report indicating how the building management system has been employed during the Performance Period, including: responsible staff, training provided, types of outputs generated and adjustments of operational parameters
If new BMS controls have been installed after Provisional Certification: • Evidence showing the new BMS controls installed such as receipts, invoices, photographs, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • BMS control schematic drawings showing systems operated by the BMS • As-installed electrical schematic drawings showing location, type and number of sensors and controls showing their usage • Details on user interface, central monitoring and control equipment used

E-6 Sustainable energy solutions

Intent

To implement sustainable energy solutions in order to generate energy from renewable sources, reduce electricity consumption during peak hours and reduce energy consumption for service water heating.

Requirements

Criteria	4 Points
Strategy A: Renewable Energy	
For 1 point, 0.5% of the total energy used in the building is produced on-site from a renewable source	1
1 point for every further 1% of the total energy used in the building that is produced on-site from a renewable source (up to 2.5%)	3
Strategy B: Peak Electricity Demand	
Reduce the percentage of energy consumed during the peak periods by 10% compared to the baseline	1
Reduce the percentage of energy consumed during the peak periods by 20% compared to the baseline	2
Strategy C: Service water heating	
Heat recovery or solar thermal system or heat pump water heater contributes to at least 50% of the total hot water demand	1
Heat recovery or solar thermal system or heat pump water heater contributes to 100% of the total hot water demand	2

Overview

Strategy A: Renewable Energy

The use of renewable energy reduces the demand for traditional power. It also serves to reduce the environmental impact due to the emission of GHGs. The term renewable energy generally refers to electricity supplied from renewable energy sources such as wind and solar power, geothermal, hydropower and various forms of biomass. These energy sources are considered renewable sources because their fuel sources are continuously replenished. Using renewable energy sources can help to reduce the overall energy consumption, environmental impacts and GHG emissions of a building. The application of renewable energy strategies in buildings are presently uncommon in Vietnam and should be promoted.

It is possible to incorporate renewable energy into buildings in operation. Such examples include installing solar panels or small wind turbines on roofs.

Strategy B: Peak Electricity Demand

Electricity consumption in buildings can fluctuate over daily, weekly and yearly cycles. The periods of time in these cycles where energy consumption is highest is known as peak electricity demand. As Vietnam has a high ratio of peak to off peak demand, in 2009 Electricity Vietnam (EVN) introduced a time-based pricing system for electricity in Vietnam. The peak period has been set between 9:30 a.m. and 11:30 a.m. and between 5 p.m. and 8 p.m. Monday to Saturday, while the off-peak period has been set between 10 p.m. and 4 a.m. Monday to Sunday. The remaining time is the partial peak period. The Monday to Saturday pricing schedule is shown in Figure E.4.

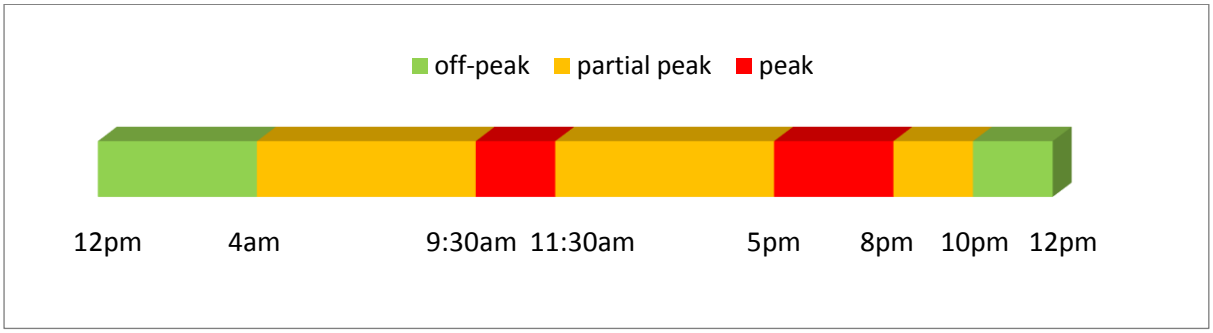


Figure E.4: EVN electricity pricing schedule Monday to Saturday

High peak electricity demand requires a lot of seldom used electricity generation capacity. In order to supply this increased capacity, significant costs are borne in the upgrade of electricity distribution networks. As the network struggles to supply peak energy demands, brown/black-outs occur, especially in hot periods, which can result in significant economic losses due to equipment down time and damaged goods. In order to mitigate such losses many buildings run backup diesel or single stage gas turbines. These are not only costly to run, but also have negative environmental impacts from the burning of fossil fuels, inefficiency and noise pollution.

By reducing the peak electricity demand, less investment will be required in electricity generation and distribution networks and less brown/black-outs will occur. As a result this will allow thermal power plants to be retired and will reduce the need for backup generators. Reducing peak energy demand can also save occupants money, by consuming electricity during partial peak and off peak periods when it is charged at a lower tariff.

Strategy C: Service water heating

Service water heating corresponds to the supply of hot water for purposes other than space heating. The following solutions can help to significantly reduce energy consumption for service water heating:

- Solar thermal systems which convert sunlight into heat using a solar thermal collector.
- Heat recovery systems where an energy recovery heat exchanger recovers waste heat (from condensers of cooling/refrigeration systems, boilers, etc.) to generate hot water.
- Heat pump systems which use electricity to move heat from the ambient air to the water instead of generating heat directly. Such systems can be two to four times more energy efficient than conventional electric resistance water heaters.

Approach & Implementation

Strategy A: Renewable Energy

Installing and operating sources of power which produce energy on-site from a renewable source can achieve points within this credit. Valid forms of renewable energy include:

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

Power meters should be installed to monitor the production of energy from renewable sources and optimize the operation of the energy production systems.

Strategy B: Peak Electricity Demand

There are a number of methods that can be used to lower a building's peak energy demand, these include:

- Continuous on-site energy generation systems (e.g. photovoltaics, cogeneration, microturbines, fuel cells etc.)
- Energy and thermal storage systems (e.g. batteries, ice storage etc.)
- Behavior changes by users to reduce their peak demand using strategies such as:
    - Turn off unneeded electrical devices during peak demand periods (e.g. don't use washing machines during peak periods)
    - Operate water heaters during off-peak demand periods
    - Set thermostats to reduce heating and cooling demands during peak demand periods
    - Monitor energy consumption in real time in order to react to any sudden demand increases.

Stand-by generators do not qualify for this credit. Stand-by generators are not designed for peak energy demand reduction, but are primarily for risk management purposes in times of brown/black-outs.

Strategy C: Service water heating

All of the following technologies and strategies are compliant under Strategy C and can be used to cover service water heating demand:

- Application of pre-heating from waste or recovered heat
- Solar water heaters
- Heat pump hot water system

Calculations

Strategy A: Renewable Energy

The following calculation shall be performed to indicate the total contribution to the building's energy use from renewable sources for a period of one year. In the Full Certification submission this period must be the Performance Period.

$$\text{Renewable Energy Contribution } [\%] = \frac{\text{Renewable Energy Produced During One Year}}{\text{Total Energy Use During One Year}} \times 100$$

The total energy use should correspond to all energy used on site whether it comes from the electrical grid, fuel or renewable source. The renewable energy produced and total energy use data must come from the same period of time.

Strategy B: Peak Electricity Demand

From electricity bills or electricity metering data, the proportion of electricity consumed during peak periods can be calculated as the ratio between electricity consumed during peak periods and total electricity consumed.

This proportion should be calculated using the sum of the consumption during the months of March, April, May and June which are the four months with the most critical electricity shortages in Vietnam.

Two different baselines can be set:

- Historical baseline: values of the historical period are used to set the baseline
- Estimated baseline: in case a peak demand reduction technology was already installed during the historical period, the baseline should be estimated assuming that the technology wasn't operating.

Calculation of the reduction of the proportion of energy consumed during the peak periods compared to the baseline:

$$\text{Peak Period Energy Demand Reduction (\%)} = \left(1 - \frac{\text{Operation Proportion of the Electricity Consumed During Peak Periods}}{\text{Baseline Proportion of the Electricity Consumed During Peak Periods}}\right) \times 100$$

Example of Calculation:

In order to limit the electricity consumption during peak hours, an ice storage system has been implemented in a building. Below is the electricity consumption of this building during the months of March, April, May and June for both the historical period (prior to the installation of the system) and the Performance Period.

Table E.7: Example of electricity consumption during historical period and Performance Period

Period of consumption	Historical consumption period (kWh)	Performance Period consumption (kWh)
Peak	36 295	30 647
Partial-peak	85 127	86 245
Off-peak	16 474	24 631
Total	137 897	141 523

Calculation of the proportion of energy being consumed during peak periods:

Table E.8: Example calculation, reduction in proportion of energy consumed during peak periods

Period of consumption	Historical period consumption	Performance Period consumption	Reduction in the proportion of energy consumed at peak hours
Peak period	36 295 / 137 897 = 26.3%	30 647 / 141 523 = 21.6%	1 - (21.6 / 26.3) = 18%

With a reduction in the percentage of energy consumed during peak periods of 18% compared to the historical baseline, such a project would be awarded 1 point.

Strategy C: Service water heating

Calculations are only necessary if the water heating systems compliant with Strategy C (heat recovery system, solar thermal system and heat pump system) installed in the building contribute to less than 100% of the total hot water demand. A project only using such types of systems to produce hot water will be considered as compliant without having to perform any calculations.

Designers are responsible for demonstrating the percentage of hot water production covered by the compliant types of water heating systems using the following formula:

$$\text{Compliant hot water production } [\%] = \frac{\text{Annual Domestic Hot Water Produced by compliant water heating systems}}{\text{Total Annual Domestic Hot Water Demand}} \times 100$$

The total annual domestic hot water demand shall be based on actual metering data from the building or shall be calculated using the following methodology:

- Calculate the domestic water consumption of the fixtures connected to the hot water system as per the methodology given in Credit W-3 or by using metering data
- Define the mixed temperature desired for the different fixtures
- Based on the cold water and hot water temperatures, calculate the ratio of hot water to be used in the different fixtures using the following formula:

$$\text{Ratio of Hot Water } (\%) = \frac{\text{Mixed Water T°C} - \text{Cold Water T°C}}{\text{Hot Water T°C} - \text{Cold Water T°C}} \times 100$$

- For each fixture, the hot water demand is equal to the domestic water consumption multiplied by the ratio of hot water

Submissions

Provisional Certification Stage
Strategy A: Renewable Energy
• Report describing the implementation of the existing and/or proposed renewable energy production system (photovoltaic, solar thermal, wind, etc.). For solar and wind sources, outline the weather data used. For biomass based systems, outline the origin of the biomass used and estimated quantities required to run the system over a period of a year • Description of the calculations or simulations performed to estimate the production of energy from renewable sources • Schedule of all existing and/or proposed energy production equipment • Inventory report from facility audit -OR- Manufacturer´s published technical data for all energy production equipment • Calculations indicating the recorded and/or estimated percentage of renewable energy contribution to the predicted annual energy consumption of the building and any assumptions made
If new energy production equipment are to be installed: • Specification extracts on all proposed energy production equipment
Strategy B: Peak Electricity Demand
• Electricity bills or meter records showing the historical consumption during peak periods • Description of each of the existing and/or proposed strategies and calculation of the reduction in the proportion of electricity consumed during peak periods achieved or predicted

If the baseline has been estimated:

- Description of the calculations including explanations on all the assumptions taken

If behavior changes will be encouraged:

- Report showing which strategies will be implemented and how they will be enforced and quantifying the peak demand reduction achieved by each measure

Strategy C: Service water heating

- Schedule of all existing and/or proposed water heating systems on the project
- Inventory report from facility audit -OR- Manufacturer's published data on all water heating systems listed in the schedule
- Calculations indicating the percentage of total domestic hot water demand that will be covered by the compliant types of water heating systems

If new water heating equipment are to be installed:

- Specification extracts on all proposed water heating systems

If solar water heaters are to be installed:

- Description of the solar thermal system, including technical description of the system, indication on the location within the site and calculation of the production of domestic hot water

Full Certification Stage

Strategy A: Renewable Energy

- Energy metering data showing the production of energy from renewable sources during the Performance Period

If the strategy had not been awarded at Provisional Certification or if there is any change:

- Final report describing the implementation of the renewable energy production system (photovoltaic, solar thermal, wind, etc.). For solar and wind sources, outline the weather data used. For biomass based systems, outline the origin of the biomass used and estimated quantities required to run the system over a period of one year
- Schedule of all energy production equipment
- Manufacturer's published technical data for all energy production equipment installed
- Final calculations indicating the percentage of renewable energy contribution to the annual energy consumption of the building during the Performance Period. Consumption values should come from utility bills or energy metering data
- Evidence showing the renewable energy equipment installed such as photographs, invoices, receipts, etc.

Strategy B: Peak Electricity Demand

- Electricity bills or meter records showing the total electricity consumption and the electricity consumption during peak periods for a one year period during both the historical period and Performance Period
- Description of each of the strategies implemented and calculation of the reduction in the proportion of electricity consumed during peak periods achieved
- Where technologies are installed, supply proof of installation such as as-built drawings, photographs, receipts etc.

If the strategy had not been awarded at Provisional Certification or if there is any change: • If the baseline has been estimated, provide details of the calculation and explain any assumptions
Strategy C: Service water heating
• Schedule of all water heating systems installed on the project • Manufacturer's published data -OR- Inventory report from facility audit on the water heating systems of the building • Evidence that all water heating systems listed are installed such as photographs, invoices, receipts, commissioning reports, etc.
If solar water heaters have been installed after Provisional Certification: • Description of the solar thermal system, including technical description of the system, indication on the location within the site and calculation of the production of domestic hot water

Water

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

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

As clean water becomes less readily available within Vietnam, the cost of domestic water supply is bound to increase in the 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 sewerage systems in urban areas of Vietnam.

Understanding the circumstances, LOTUS prioritizes the reduction of water consumption and emphasizes this in the requirements of the Water category. Credits within this category encourage strict monitoring of water consumption, water-efficient fixtures, water reuse/recycling, rainwater collection and water efficient landscaping.

Water		10 Points
Item	Criteria	Points
W-1	Water Audit	1 point
	Perform a water audit of the building	1
W-2	Water Efficient Fixtures	3 points
	Reduce water consumption through fixtures by 10% in comparison to a baseline model	1
	1 point for every additional 10% reduction of water consumption through fixtures (up to 30%) in comparison to a baseline model	3
W-3	Water Metering and Leak Prevention	2 points
	Strategy A: Water metering	
	Install permanent water meters for all major water uses	1
	Strategy B: Water Leak Prevention	
	Develop and implement a water leak prevention plan	1
W-4	Sustainable Water Use Solutions	4 points
	Strategy A: Water recycling/reuse/harvest	
	Recycled water, reused water or harvested rainwater contributes 5% of the building's total water consumption	1
	1 point for every 5% of the building's total water consumption covered with recycled water, reused water or harvested rainwater (up to 15%)	3
	Strategy B: Water Efficient Landscaping	
	Reduce domestic water used for landscaping by 50% compared to benchmark consumption	1
	Reduce domestic water used for landscaping by 80% compared to benchmark consumption	2
	Strategy C: Cooling Tower Water Use	
	The cooling tower operates at a minimum of 6 cycles of concentration	1
	The cooling tower operates at a minimum of 8 cycles of concentration	2

W-1 Water Audit

Intent

To identify and evaluate opportunities to optimize the building's water use.

Requirements

Criteria	1 Point
Perform a water audit of the building	1

Overview

A water audit is an important first step to understand water consumption in a building and on its site and identify opportunities to make savings. A water audit typically involves an inspection, survey and analysis of the different water uses in a building and on its site. The aim is to understand where water is consumed in a building, identify the main water saving opportunities and evaluate the benefits that can be obtained from adjustments, upgrades or the installation of new fittings and fixtures.

A comprehensive water use audit will examine the major areas in which a facility uses water, including sanitation, maintenance, mechanical systems, building processes and irrigation. For each of those areas the water audit will provide a breakdown of the how, when and where of water use.

Approach & Implementation

A water audit should follow the following methodology:

- Meet with building management to discuss the operation of the building and water consuming operations and request to make an on-site inspection
- Request water bills and/or water meter readings for at least the previous 3 years
- Conduct an on-site investigation to quantify water usage by each of the following:
    - Water fixtures – toilets, taps, showers, urinals, kitchen fittings
    - Air conditioning systems and cooling towers
    - Cleaning
    - Irrigation and grounds maintenance
    - Fire services
    - Other water using fixtures and equipment
- During on-site inspection check for any leaks
- Inspect water services, meters, pumps, tanks and fixtures throughout the building/site

- Inspect relevant water services plans
- Complete water balance assessment which breaks down water uses (desktop)
- Identify potential water savings and quantify estimated savings in terms of both water and money and calculate estimated payback periods (desktop)
- Complete a clear and concise report

The water audit report should cover the following points:

- Review of historical water use of building and site and make a comparison with a relevant benchmark
- Review of water hardware and fixtures within the building and site
- Estimated breakdown of water uses within the building and site
- Any noted existing or potential leaks at the site
- List and discussion of any potential water savings measures and their associated savings (both water and money) and payback periods
- Description of current hydraulic system and identification of any deficiencies
- Review of water management techniques

Submissions

Provisional Certification Stage
• Water audit report

Full Certification Stage
If the credit had not been awarded at Provisional Certification or if there is any change: • Water audit report

W-2 Water Efficient Fixtures

Intent

To reduce the consumption of water in buildings through water fixtures.

Requirements

Criteria	3 Points
Reduce water consumption through fixtures by 10% in comparison to the baseline	1
1 point for every additional 10% reduction of water consumption through fixtures (up to 30%) in comparison to the baseline	3

Overview

One of the most effective ways to reduce building water consumption is to install efficient water fixtures such as dual flush WCs, low flow or waterless urinals, low flow showerheads and low flow kitchen and bathroom taps. These fixtures can be retrofitted into buildings in operation and are typically installed in kitchens and bathrooms.

Approach & Implementation

The following water efficient fixtures can be used to reduce the demand for water within a building:

- Dual-flush WCs with low-flow
- Low-flow or waterless urinals
- Low-flow shower heads
- Low-flow kitchen and bathroom taps

Another solution to reduce the water consumption through the existing taps and shower heads without having to replace them is to install flow aerators or flow restrictors. They are easy-to-fit devices that limit flowrate without reducing pressure.

Calculation

The aim of this calculation is to compare the building's water consumption through fixtures to a baseline model. The baseline annual water use should be calculated using values in tables W.1 to W.5. It is strongly advised to perform the calculation using the LOTUS Water Calculation Tool that is provided to all registered projects.

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

Fixture	Daily Fixture Uses		Duration of Use (flow fixtures)
	Full Time Occupants	Visitors	
WC - Single Flush (female)	3	0.5	-
WC - Dual flush (female)	1 full-flush / 2 half-flush	0.1 full-flush / 0.4 half-flush	
WC - Single Flush (male)	1	0.1	-
WC - Dual flush (male)	1 full-flush	0.1 full-flush	
Urinal	2	0.4	-
Lavatory Faucet	3	0.5	15 sec; 12 sec with auto-control
Shower	0.1	0	300 sec
Kitchen Sink	1	0	15 sec

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

Fixture	Daily Fixture Uses Per Occupant			Duration of Use (flow fixtures)
	Residents / Hotel Guests	Full Time Occupants	Visitors	
WC - Single Flush (female)	4	3	0.5	-
WC - Dual flush (female)	1 full-flush / 3 half-flush	1 full-flush / 2 half-flush	0.1 full-flush / 0.4 half-flush	
WC - Single Flush (male)	4	1	0.1	-
WC - Dual flush (male)	1 full-flush / 3 half-flush	1 full-flush	0.1 full-flush	
Urinal	0	2	0.4	-
Lavatory Faucet	7	3	0.5	Residents: 60 sec. Others: 15 sec or 12 sec with auto-control
Shower	1	0.1	0	Residents: 480 sec. Others: 300 sec
Kitchen Sink	4	1	0	Residents: 60 sec. Others: 15 sec
Clothes washer	1 / living unit	0	0	

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

Fixtures	Daily Fixture Uses Per Occupant				
	Students (kindergarten and primary education	Students (secondary & post/secondary education)	Full Time Occupants	Visitors	Duration of Use (flow fixtures)
WC - Single Flush (female)	3	1.5	3	0.5	-
WC - Dual flush (female)	1 full-flush / 2 half-flush	0.5 full-flush / 1 half-flush	1 full-flush / 2 half-flush	0.1 full-flush / 0.4 half-flush	
WC - Single Flush (male)	1	0.5	1	0.1	-
WC - Dual flush (male)	1 full-flush	0.5 full-flush	1 full-flush	0.1 full-flush	
Urinal (male)	2	1	2	0.4	-
Lavatory Faucet	3	1.5	3	0.5	15 sec; 12 sec with auto-control
Shower	0	0	0.1	0	300 sec
Kitchen Sink	0	0	1	0	15 sec

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

Fixture	Daily Fixture Uses Per Occupant			Duration of Use (flow fixtures)
	Retail Customers	Full Time Occupants	Visitors	
WC - Single Flush (female)	0.2	3	0.5	-
WC - Dual flush (female)	0.1 full-flush / 0.1 half-flush	1 full-flush / 2 half-flush	0.1 full-flush / 0.4 half-flush	
WC - Single Flush (male)	0.1	1	0.1	-
WC - Dual flush (male)	0.1 full-flush	1 full-flush	0.1 full-flush	
Urinal (male)	0.1	2	0.4	-
Lavatory Faucet	0.2	3	0.5	15 sec; 12 sec with auto-control
Shower	0	0.1	0	300 sec
Kitchen Sink	0	1	0	15 sec

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

Fixture Type	Fixture Water Use
WC (single/dual-flush)	6.0 L per flush (Lpf)
Urinal (flush)	3.79 Lpf
Faucet (conventional)	0.14 L/s
Showerheads	0.16 L/s
Kitchen faucet	0.14 L/s
Clothes washer	120 L/load

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

- The gender ratio should be representative of the building occupancy, if this is not available, a ratio of one to one should be used
- The number of daily fixture uses and flow fixture use durations (in baseline case) should follow values in tables W.1 to W.4 according to the building type
- The fixture water uses values (in baseline case) should follow values in tables W.5
- In case no urinals are available in the building, daily uses values for WCs (female) shall be considered for the male occupants.
- Full-time occupants are employees/staff in the building and their number should be calculated based on a daily occupancy of 8 hours. Part-time occupants should be given an equivalent 'full-time occupants' value based on the number of hours they spend in the building per day divided by 8
- In buildings with multiple shifts, use the number of full-time occupants from all shifts.

Calculation of annual water consumption through fixtures:

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

F = Proportion of fixtures

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

n = Number of daily uses per person per fixture type

P = Number of building occupants

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

$$\text{Water Consumption Through Fixtures Reduction [\%]} =$$

$$\left(1 - \frac{\text{Annual Water Consumption Through Fixtures (Proposed Case)}}{\text{Annual Water Consumption Through Fixtures (Baseline Case)}}\right) \times 100$$

Example of calculation:

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

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

Fixtures Present in the Building	Quantities of Fixtures	Fixtures Water Use
Urinal (flush)	3	3 Lpf
WC Dual flush (male)	15	3.0 - 4.5 Lpf
WC Single flush (male)	5	5 Lpf
WC Dual flush (female)	18	3.0 - 4.5 Lpf
WC Single flush (female)	6	5 Lpf
Faucet	20	0.12 L/s
Faucet with auto-control	5	0.12 L/s
Showerheads	1	0.15 L/s

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

Fixtures Present in the Building	F	$Q_{Flush/Flow}$	Number of Daily Uses (n)	Number of Building Occupants (P)	Daily Water Use Through Fixtures (L)
Urinal (flush)	1	3.79 Lpf	2	250	1895
WC (male)	1	6 Lpf	1	250	1500
WC (female)	1	6 Lpf	3	250	4500
Faucet	20/25	0.14 L/s (15 sec)	3	500	2520
Faucet with auto-control	5/25	0.14 L/s (12 sec)	3	500	504
Showerheads	1	0.16 L/s (300 sec)	0.1	500	2400
Total daily water use through fixtures (liters)					13,319
Baseline total annual water use through fixtures (liters)					4,861,435

Table W.8: Example calculation - daily water use through fixtures calculation for the proposed case

Fixtures Present in the Building	F	Q Flush/Flow	Number of Daily Uses (n)	Number of Building Occupants (P)	Daily Water use Through Fixtures (L)
Urinal (Flush)	1	3 Lpf	2	250	1500
WC Dual flush (male)	15/20	4.5 Lpf	1	250	844
WC Single flush (male)	5/20	5 Lpf	1	250	312.5
WC Dual flush (female)	18/24	$\left(\frac{2}{3}\times 3+\frac{1}{3}\times 4.5\right)$Lpf	3	250	1969
WC Single flush (female)	6/24	5 Lpf	3	250	937.5
Faucet	20/25	0.12 L/s (15 sec)	3	500	2160
Faucet with auto-control	5/25	0.12 L/s (12 sec)	3	500	432
Showerheads	1	0.15 L/s (300 sec)	0.1	500	2250
Total daily water use through fixtures (liters)					10,405
Proposed total annual water use through fixtures (liters)					3,017,305

$$\text{Water Consumption Through Fixtures Reduction } [\%] = \left(1-\frac{3017305}{3912535}\right)\times 100 = 23\%$$

The building finally achieves a 23% reduction of the domestic water consumption through fixtures in comparison to a baseline model, so 3 points are awarded.

Submissions

Provisional Certification Stage
• Schedule of all the existing and/or proposed water fixtures (highlighting any fixtures that will be replaced) indicating their flush/flow rates • Calculations demonstrating compliance with the requirements (it is advised to submit the completed LOTUS Water Calculator Tool) • Hydraulic plans or schematics indicating the existing and/or proposed types of water fixtures (highlighting any fixtures that will be replaced) • Evidence showing the existing water fixtures installed such as inventory report from facility audit, photographs, commissioning records, etc.
If any proposed water fixtures are to be installed: • Specification extracts for new fixtures -OR- Manufacturer's published data of all water fixtures proposed indicating their flush/flow rates

Full Certification Stage
If any new water fixtures have been installed after Provisional Certification: • Manufacturer's published data of all the new water fixtures installed after Provisional Stage indicating their flush/flow rates • Evidence showing the new water fixtures installed such as invoices, receipts, photographs etc.
If the credit had not been awarded at Provisional Certification or if there is any change: • Schedule of all the water fixtures indicating their flush/flow rates • Hydraulic plans or schematics indicating the types of water fixtures • Calculations demonstrating compliance with the requirements (it is advised to submitted the completed LOTUS Water Calculator Tool) • Evidence showing the existing water fixtures installed such as inventory report from facility audit, photographs, commissioning records, etc.

W-3 Water Metering and Leak Prevention

Intent

To monitor water uses so that water consumption can be regulated and water leaks can be detected.

Requirements

Criteria	2 Points
Strategy A: Water metering	
Install permanent water meters for all major water uses	1
Strategy B: Water Leak Prevention	
Develop and implement a water leak prevention plan	1

Overview

Strategy A: Water metering

In order to reduce water consumption in buildings in operation it is important to have accurate, up to date information on water consumption. Water meters and sub-meters that cover major water uses within buildings and their sites are simple to install and provide valuable information to building managers. Sub-meters allow building managers to have a better understanding of the breakdown of water consumption in the building which enables them to identify potential water savings.

Strategy B: Water Leak Prevention

Leaks in fixtures and pipes are known to consume as much as 30% of domestic water in buildings. By conducting regular inspections and monitoring data from water meters, building managers can identify leaks within the building as they will be represented by spikes in water consumption. When leaks are suspected within the building it is important that swift action is taken to identify the exact location of the leak and make necessary repairs. This will not only save water but will also prevent water damage to the building and prevent the development of unhygienic conditions.

Approach & Implementation

Strategy A: Water metering

Water meters should be installed for all the major water uses in the project.

What is defined as a major water use will depend on the building type, however this will typically include:

- Indoor plumbing fixtures and fittings separated for each floor or major occupancy
- Irrigation
- Process water (e.g. industrial processes, swimming pools, cooling towers etc.)

More advanced water monitoring systems may be linked to a central display indicating real time water consumption. Water meters can also be connected to automated monitoring and control systems (e.g. BMS).

Buildings in operation should have a system in place where the outputs from water meters are frequently monitored and are reported monthly. Water consumption reports should be reviewed by building management and where appropriate, provided to tenants. Water consumption reports should include the following information:

- Monthly water consumption divided into sub-meters corresponding to different uses
- Comparison of water consumption with previous and corresponding periods
- Identification of any spikes in water consumption that may be caused by leaks, mismanagement or poor occupant behavior.

Strategy B: Water Leak Prevention

The building should develop and implement a water leak prevention plan that will help to identify and repair leaks quickly and effectively.

The water leak prevention plan leak should include at a minimum:

- Information on the building water consumption (from water bills or water metering data) of the last 12 months
- Description of methods to identify water leaks, such as:
    - Weekly visual inspections of every water fixtures of the building with a staff trained on what to look for when doing an inspection (for example, valves that feel damp to the touch, or have white calcium around them, are potential future leaks),
    - Reading of water meters at the end of the night and start of the following morning (if the building is vacant during the night but water is still consumed, it is most likely to be caused by a leak),
    - Use of leak detectors, such as: acoustic detectors, pressure detectors, infra-red detectors, etc.
- A water leak response plan for when leaks are suspected or identified which includes:
    - List of preferred leak detection and plumbing contractors
    - Maximum allowable response time after leak is detected

Submissions

Provisional Certification Stage
Strategy A: Water metering
• Schedule of all the existing and/or proposed water meters indicating their location, type and the water usage metered • Existing and/or proposed hydraulic plans and/or schematic drawings showing water meters • Description of the water monitoring and reporting strategy • Evidence showing the existing water meters installed such as inventory report from facility audit, receipts, photographs, commissioning records, etc.
Strategy B: Water Leak Prevention
• Water leak prevention plan

Full Certification Stage
Strategy A: Water metering
• Monthly water consumption reports covering the whole Performance Period and including all water meter readings
If new water meters have been installed after Provisional Certification: • Evidence showing the new water meters installed such as receipts, invoices, photographs, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Inventory of all the water meters indicating their location, type and the water usage metered • Hydraulic plans and schematic drawings showing location, type and number of water meters as well as the usage served by those meters • Description of the water monitoring and reporting strategy • Evidence showing the existing water meters installed such as inventory report from facility audit, receipts, photographs, commissioning records, etc.
Strategy B: Water Leak Prevention
• Evidence that the water leak prevention plan has been followed during the Performance Period, such as maintenance records, photographs, invoices, receipts, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Water leak prevention plan

W-4 Sustainable Water Use Solutions

Intent

To encourage water recycling, reuse and rainwater harvesting, to limit the use of water for irrigation and to reduce the water consumption for heat rejection in cooling towers.

Requirements

Criteria	4 Points
Strategy A: Water recycling/reuse/harvest	
Recycled water, reused water or harvested rainwater contributes 5% of the building's total water consumption	1
1 point for every 5% of the building's total water consumption covered with recycled water, reused water or harvested rainwater (up to 15%)	3
Strategy B: Water Efficient Landscaping (Only sites with a landscaped area which is greater than 100 m^2 are eligible for this strategy)	
Reduce domestic water used for landscaping by 50% compared to benchmark consumption	1
Reduce domestic water used for landscaping by 80% compared to benchmark consumption	2
Strategy C: Cooling Tower Water Use	
The cooling tower system operates at a minimum of 6 cycles of concentration	1
The cooling tower system operates at a minimum of 8 cycles of concentration	2

Overview

Strategy A: Water recycling/reuse/harvest

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

Rainwater harvesting refers to the collection and storage of rain. Collection is usually from rooftops and channeled to storage tanks (Figure W.2) which can range from a simple barrel at the bottom of a down pipe to multiple tanks with pumps and controls.

Water recycling and rainwater harvesting saves the amount of domestic water used for toilet flushing, irrigation or heat rejection (cooling towers) and reduces the amount of wastewater delivered to water treatment facilities. The importance of using non-domestic water is that it reduces demand for domestic water, which should be saved for drinking and bathing.

Strategy B: Water Efficient Landscaping

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

Xeriscaping is the preferred approach and has the following advantages:

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

Strategy C: Cooling Tower Water Use

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

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

All the water that is lost from the cooling tower is replaced by make-up water.

Approach & Implementation

Strategy A: Water recycling/reuse/harvest

Gray Water Recycling and Reuse:

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

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

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

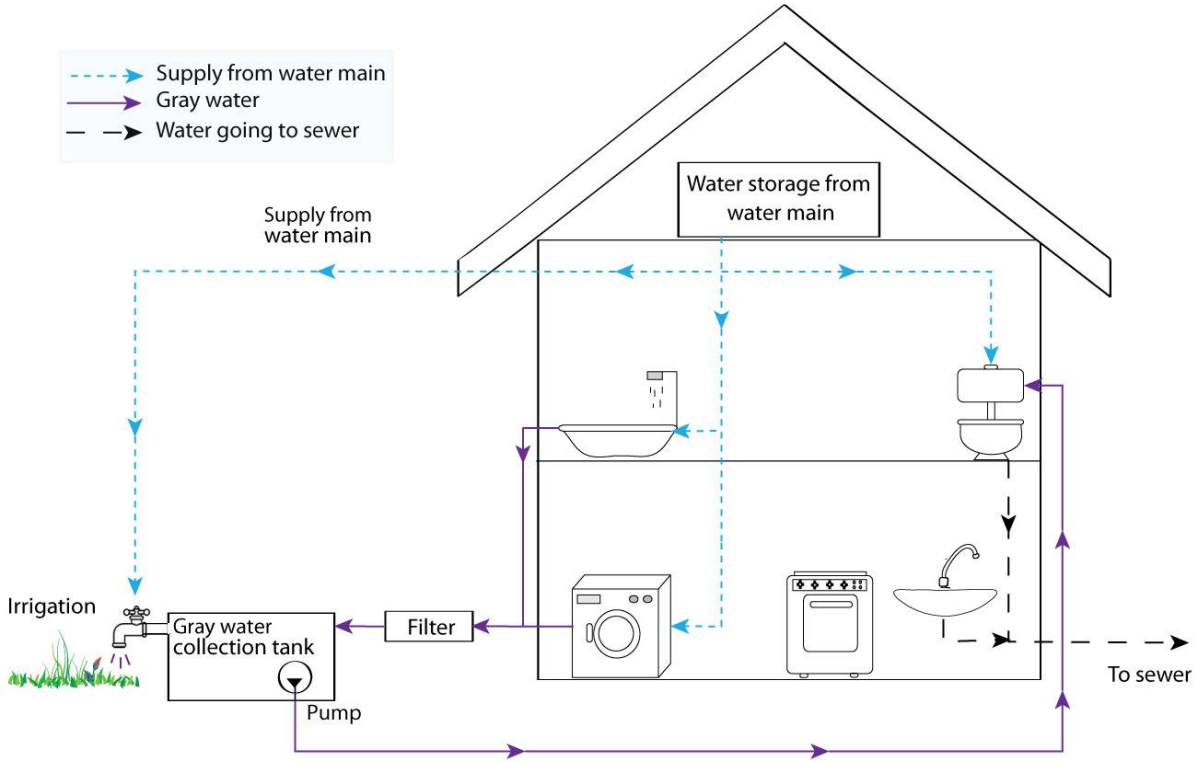


Figure W.1: Example of a gray water collection system

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

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

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

Black Water Recycling and Reuse:

Black water is more difficult 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

Rainwater Harvesting:

Rainwater can be collected from impervious surfaces to reduce rainwater runoff and control infrastructure demands. Where average precipitation is greater than 254 mm a year, rooftop rainwater collecting systems are recommended as the most economical systems. Rainwater can be stored in storage tank(s) for non-potable use. Air pollution can contaminate rainwater with pollutants which can potentially damage storage tanks and plumbing systems. In this case, rainwater should be filtered before entering the tanks. Instead of a filtration system, a mechanism where the initial water flow is sent to waste by a diverter can be used to minimize contamination of storage supply, since airborne pollutants and pollutants on the collection surface are usually washed away by the initial rainfall. In such case, simple but regular inspection and maintenance of the mechanism is necessary.

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

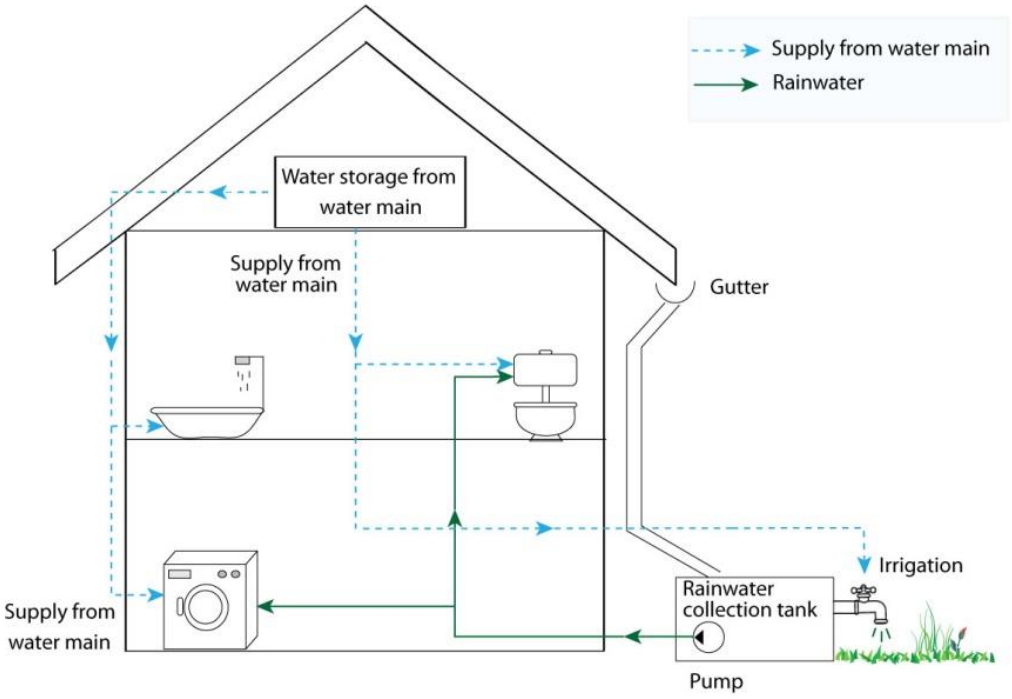


Figure W.2: Rainwater harvesting system

Water Recycling/Reuse and rainwater harvesting:

To ensure that the uses associated with treated gray water, treated black water and rainwater 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 water, reused water and harvested water must comply at the point of delivery with minimum quality requirements of national or international standards (non-exhaustive list):

- TCVN 6773: 2000 Water quality - Water quality guidelines for irrigation
- QCVN 02:2009/BYT - National technical regulation on domestic water quality
- NSF/ANSI Standard 350: On-site Residential and Commercial Water Reuse Treatment Systems – 2011 (National Sanitary Foundation – USA)

Strategy B: Water Efficient Landscaping

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 3 methods outlined in this section.

1. Xeriscape Landscape and Planting Native Species

Practices in this area can include:

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

2. Efficiency of Water Irrigation

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

- Conduct a vegetation survey for the building site (Ecology PR-1). Based on the outcomes of the survey and knowledge of all plants' properties, a watering plan can be developed in order to reduce the amount of water used in irrigation. A precise watering schedule will help to reduce total water consumption.
- Water at a rate so that it does not pond, pool or run off
- Do not water when the soil is already adequately moist to sustain plant growth, whether as a result of rain or other watering
- Water in such a manner so that it does not fall on buildings or hard surfaces
- Do not water in windy conditions where the distribution pattern of the irrigation systems will be affected
- Water gardens that are sufficiently mulched to reduce evaporation

3. Irrigation with Recycled/Reused Water and/or Harvested Rainwater

Recycled/reused water and/or rainwater collection systems can 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.

Strategy C: Cooling Tower Water Use

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

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

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

First step to maximize the number of cycles of concentration is to determine the maximum cycles of concentration the cooling tower system can safely achieve. Then different operation, maintenance and retrofit strategies can be used to allow and to maintain the system running at higher cycles of concentration (non-exhaustive list):

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

Calculations

Strategy A: Water recycling/reuse/harvest

The volume of harvested rainwater, recycled water and reused water can either be measured by metering or estimated using reasonable assumptions. The LOTUS Water Calculation Tool contains these calculations embedded into the tool and can be used instead of manually performing the calculations.

- Water Recycling and Reuse:

If the volume of recycled and reused water is estimated, the calculation should be the same as the calculation of the annual domestic water use in Credit W-3, except that only the fixtures connected to gray or black water collection system are included in the calculation.

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

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

F = Proportion of fixtures

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

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

P = Number of building occupants

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

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

t_{flow} = Time of use of flow type fixture [s] = Number of operation days during the year

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

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

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

- Rainwater Harvesting:

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

To estimate the amount of harvested rainwater that will be reused, applicants can use either the LOTUS Water Calculation Tool or their own method that shall be subject to the Assessment Organization approval.

- Total Water recycling/reuse/harvest:

In order to calculate the proportion of total water consumption supplied by harvested rainwater, recycled water or reused water this value should be compared to the total water consumption of the building based on water bills or sub-metering data (as submitted for Credit W-2).

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

Where Annual Water Consumption = Water bill or water meter data + Recycled, reused and harvested rainwater used.

Strategy B: Water Efficient Landscaping

The irrigation demand of the landscape area can either be demonstrated using a full year of irrigation consumption records from water metering or from irrigation demand calculations.

The total irrigation demand for the landscaped area can be calculated using the following equations. 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.

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

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

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

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

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

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

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

Km_i = Microclimate factor specific for sub-area *i* (e.g. well shaded and sheltered area *Km* - “low”, area 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*. Monthly rainfall data can be found in QCVN 02:2009/BXD.

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

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

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

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

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

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:

- Determine the soft landscape area
- Determine annual irrigation demand per square meter of soft landscaped area, this can be demonstrated either by water metering or the irrigation demand calculation method
- Calculate irrigation demand saving using the following equation:

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

Example of calculation:

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

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

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

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

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

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

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

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

Strategy C: Cooling Tower Water Use

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

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

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

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

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

Submissions

Provisional Certification Stage
Strategy A: Water recycling/reuse/harvest
• Report describing and detailing the existing and/or proposed strategy of gray/black water recycling/reuse and/or rainwater harvesting including collection, distribution and storage • Hydraulic plans and schematics of the existing and/or proposed gray and black water system and/or rainwater harvesting system, including collection, distribution and storage • Calculations, estimations or metering data indicating the existing and/or proposed total recycled/reused water and/or harvested rainwater used • Calculations, estimations of the contribution of the recycled/reuse water and/or harvested rainwater to the building's annual water consumption (it is advised to submit the completed LOTUS Water Calculator Tool) • Evidence showing main existing equipment and existing components installed for water recycling/reuse or rainwater harvesting such as photographs, commissioning records, etc.
Strategy B: Water Efficient Landscaping
• Landscape plan outlining the existing and/or proposed landscape design • List of all plants (with picture, name, information about watering patterns, information about whether species is native, locally adapted or introduced and estimated number of individuals per species (trees) and/or coverage (grasses - m^2) • Metering records for water used for irrigation -OR- Calculations estimating landscape irrigation demand • Calculation of the existing and/or proposed irrigation demand reduction (it is advised to submit the completed LOTUS Water Calculator Tool)
If using water efficient irrigation equipment: • Description of all existing and/or proposed water saving irrigation fixtures • Evidence of all existing water efficient irrigation fixtures installed such as photographs, plans, commissioning reports, etc.
If using water recycling, reuse or rainwater harvesting: • Schematic drawings of existing and/or proposed reticulation network • Water balance showing amount of irrigation demand that can be met by recycled, reused water or harvested rainwater
Strategy C: Cooling Tower Water Use
• Narrative describing the existing and/or proposed strategies to maximize the cycles of concentration of the cooling tower
If strategies to maximize the cycles of concentration are already implemented: • Flow measurements of the water makeup and water blowdown -OR- chemical measurements of the tower water and makeup water along with water sampling records • Calculations of the number of cycles of concentration

Full Certification Stage
Strategy A: Water recycling/reuse/harvest
• Calculations indicating the total recycled/reused water and/or harvested rainwater used and the contribution of the recycled/reused water and/or harvested rainwater to the building's annual water consumption during Performance Period
If the strategy had not been awarded at Provisional Certification or if there is any change: • Report describing and detailing the strategy of gray/black water recycling/reuse and/or rainwater harvesting including collection, distribution and storage • Hydraulic plans and schematics of the gray and black water system and/or rainwater harvesting system, including collection distribution and storage • Calculations indicating the total recycled/reused water and/or harvested rainwater used and the contribution of the recycled/reused water and/or harvested rainwater to the building's annual water consumption (it is advised to submit the completed LOTUS Water Calculator Tool) • Evidence showing main equipment and components installed for water recycling/reuse or rainwater harvesting such as photographs, commissioning records, etc.
Strategy B: Water Efficient Landscaping
• Metering records for water used for irrigation during Performance Period -OR- Calculations of the landscape irrigation demand during Performance Period If using water recycling, reuse or rainwater harvesting: • Water balance showing amount of irrigation demand that met by recycled, reused water or harvested rainwater during the Performance Period
If the strategy had not been awarded at Provisional Certification or if there is any change: • Landscape plan outlining the landscape design • List of all plants (with picture, name, information about watering patterns, information about whether species is native, locally adapted or introduced and estimated number of individuals per species (trees) and/or coverage (grasses - m^2) If using water efficient irrigation equipment: • Description, including flow rates and installation locations, of all existing and/or proposed water saving irrigation fixtures and flow rates • Evidence of all water efficient irrigation fixtures installed such as photographs, invoices, plans, commissioning records, etc. If using water recycling, reuse or rainwater harvesting: • Schematic drawings of existing and/or proposed reticulation network
Strategy C: Cooling Tower Water Use
• Flow measurements during Performance Period of the water makeup and water blowdown -OR- chemical measurements during Performance Period of the tower water and makeup water along with water sampling records
If the strategy had not been awarded at Provisional Certification or if there is any change: • Narrative describing the strategies to maximize the cycles of concentration of the cooling tower • Calculations of the number of cycles of concentration

Sustainable Purchasing

Sustainable purchasing is an effort to buy greener, healthier, and more sustainable products. It is based on the simple concept that every single purchase has hidden human health, environmental, and social impacts and that it is possible to reduce adverse impacts by buying better products.

The Sustainable Purchasing Category of LOTUS BIO includes two main goals which are to increase the use of materials and products associated with a low-carbon footprint (low energy use, low use of virgin natural resources used, recyclable, etc.) and to increase the use of healthier materials and products (low-VOC, low-formaldehyde, chlorine free, etc.).

Sustainable Purchasing		4 points
Item	Criteria	Points
SP-1	Low-carbon purchasing	2 points
	Adopt a Low-carbon Purchasing Policy including procurement of at least 2 types of low-carbon products	1
	Adopt a Low-carbon Purchasing Policy including procurement of at least 4 types of low-carbon products	2
SP-2	Healthy purchasing	2 points
	Adopt a Healthy Purchasing Policy including procurement of at least 2 types of healthy products	1
	Adopt a Green Purchasing Policy including procurement of at least 4 types of healthy products	2

SP-1 Low-carbon purchasing

Intent

To encourage the purchase of low-carbon products that have less environmental impacts during the operations of the building.

Requirements

Criteria	2 Points
Adopt a Low-carbon Purchasing Policy including procurement of at least 2 types of low-carbon products	1
Adopt a Low-carbon Purchasing Policy including procurement of at least 4 types of low-carbon products	2

Overview

Green Purchasing refers to the procurement of products that have a reduced effect on human health and the environment when compared with other similar types of products. Through the adoption of a Green Purchasing Policy, LOTUS encourages purchasing practices that promote the use of green products in building operations, maintenance and renovation.
Green (or environmentally friendly) products can be of many types and can consider raw materials acquisition, manufacturing, packaging, pollutants, disposal of the product, etc.

Approach & Implementation

Prepare and adopt a Low-carbon Purchasing Policy (LCPP). The policy should include low-carbon purchasing plans and procedures endorsed by top management and should cover at least the product (ongoing consumables and/or durable goods) purchases within the building and site management's control.

Procurement of low-carbon products as described in Tables SP.1 and SP.2 (in a non-exhaustive list) may be included in the LCPP.

The LCPP should show the commitment to use only the low-carbon products identified in the procurements whenever possible.

The Low-carbon Purchasing Policy can be included with the Healthy Purchasing Policy together into a Green Purchasing Policy.

To score points at Full Certification, the project should show evidence that a number of green products have been purchased during the Performance Period in accordance with the LCPP.

Table SP.1: Example of low-carbon ongoing consumables

Products	Green attributes
Batteries	Rechargeable
Toilet paper	- FSC Certified or equivalent - With recycled content
Plastic bags	Biodegradable
Printing paper	- FSC Certified or equivalent - Paper from Khan-na - With recycled content
Toner cartridges	Refillable

Table SP.2: Example of low-carbon durable goods

Products	Green attributes
Furniture	- reused furniture - made from rapidly renewable materials
Electrical appliances (IT equipment)	Energy Star label or equivalent
Electrical appliances (Other equipment)	With energy label (at least 4 stars under VNEEP labelling scheme)

Submissions

Provisional Certification Stage
• Low-carbon Purchasing Policy signed by top management and showing procurement plans of healthy products

Full Certification Stage
• List of all the low-carbon products purchased during the Performance Period • Manufacturer's published data showing that the products purchased are low-carbon • Invoices, receipts or purchase orders for all the low-carbon products purchased
If the credit had not been awarded at Provisional Certification or if there is any change: • Low-carbon Purchasing Policy signed by top management and showing procurement plans of green products

SP-2 Healthy purchasing

Intent

To encourage the purchase of healthy products that have less harmful impacts to occupants during the operations of the building.

Requirements

Criteria	2 Points
Adopt a Healthy Purchasing Policy including procurement of at least 2 types of healthy products	1
Adopt a Green Purchasing Policy including procurement of at least 4 types of healthy products	2

Overview

Green Purchasing refers to the procurement of products that have a reduced effect on human health and the environment when compared with other similar types of products. Through the adoption of a Green Purchasing Policy, LOTUS encourages purchasing practices that promote the use of green products in building operations, maintenance and renovation.
Green (or environmentally friendly) products can be of many types and can consider raw materials acquisition, manufacturing, packaging, pollutants, disposal of the product, etc.

Approach & Implementation

Prepare and adopt a Healthy Purchasing Policy (HPP). The policy should include healthy purchasing plans and procedures endorsed by top management and should cover at least the product (ongoing consumables and/or durable goods) purchases within the building and site management's control.

Procurement of healthy products as described in Tables SP.3 and SP.4 (in a non-exhaustive list) may be included in the HPP.

The HPP should show the commitment to use only the green products identified in the procurements whenever possible.

The Healthy Purchasing Policy can be included with the Low-carbon Purchasing Policy together into a Green Purchasing Policy.

To score points at Full Certification, the project should show evidence that a number of green products have been purchased during the Performance Period in accordance with the HPP.

Table SP.3: Example of healthy ongoing consumables

Products	Healthy attributes
Toilet paper	Chlorine free (PCF, TCF or ECF)
Printing paper	Chlorine free (PCF, TCF or ECF)

Table SP.4: Example of healthy durable goods

Products	Healthy attributes
Paints and coatings	low-VOC content
Adhesives and sealants	low-VOC content
Furniture	Solid wood or low-formaldehyde content
Carpets	low-VOC content
Plastics	BPA free and phthalate free

Submissions

Provisional Certification Stage
• Healthy Purchasing Policy signed by top management and showing procurement plans of healthy products

Full Certification Stage
• List of all the healthy products purchased during the Performance Period • Manufacturer's published data showing that the products purchased are healthy • Invoices, receipts or purchase orders for all the healthy products purchased
If the credit had not been awarded at Provisional Certification or if there is any change: • Healthy Purchasing Policy signed by top management and showing procurement plans of green products

Ecology

In the 21st century, the world has witnessed the boom of large cities with populations of over 10 million across Asia. Following this trend, Vietnam's urbanization rate is rapidly increasing together with a rise in the country's GDP. While this raises the general standard of living, the fast but difficult to manage rate of urbanization poses a great threat to the existence of various ecosystems. As virgin land quickly turns into urban areas, habitats are disappearing together with the species living within them.

Sites of buildings in operation consume the majority of space within urban areas, this means that at some stage they have displaced native plant and animal species. By including vegetated areas populated by native species on the sites of buildings in operation these negative impacts can be mitigated. This is achieved by improving the general biodiversity of the urban area, providing a better living environment for human and co-habitating species. It is important that landscaped areas are managed in a sustainable way to prevent any negative environmental impacts caused by excessive irrigation, chemical fertilizer and pesticide use.

Recognizing the importance of vegetation within urban areas, the Ecology category of LOTUS BIO awards points to buildings that have vegetation on a significant portion of their site. LOTUS BIO also recognizes that an important first step is to understand the characteristics of the landscape and rewards the sustainable management of these areas.

Ecology		6 points
Item	Criteria	Points
Eco-1	Vegetation	3 points
	Conduct a vegetation survey for the building site	Ecology Prerequisite 1
	Strategy A: Vegetated Area	
	10% of the total site area is vegetated	1
	1 point for every additional 10% of the total site area that is vegetated (up to 30%)	3
	Strategy B: Quality of the Vegetation	
	Improve the quality of the vegetation on site	1
Eco-2	Sustainable Landscape Management	2 points
	Implement a landscape management plan	2
Eco-3	Pest Management	1 point
	Implement an Integrated pest management system	1

Eco-PR-1 and Eco-1 Vegetation

Intent

To maximize the amount of vegetation on site and ensure building managers are familiar with the vegetation and its needs.

Requirements

Only sites with a landscaped area which is greater than 100 m^2 are eligible for credit Eco-1.

Criteria	3 Points
Conduct a vegetation survey for the building site	Ecology Prerequisite 1
Strategy A: Vegetated Area	
10% of the total site area is vegetated	1
1 point for every additional 10% of the total site area that is vegetated (up to 30%)	3
Strategy B: Quality of the Vegetation	
Improve the quality of the vegetation on site	1

Overview

Site vegetation improves the site's microclimate, ventilation and scenery. Moreover, vegetation can lead to the restoration of topsoil and prevention of erosion. Site vegetation preservation also conserves 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.

Having a significant portion of a site vegetated not only improves/maintains site biodiversity but also the size of the carbon sink and the ability of the area to absorb CO_2. Vegetation of any kind helps to mitigate the effects of emissions from the building's operation. For these reasons, maximizing the area covered by vegetation is encouraged.

Approach & Implementation

Ecology Prerequisite 1

The quantity and quality of the site vegetation shall be outlined in a vegetation survey. The vegetation survey should cover the whole site and shall include any green roofs present.

The vegetation survey should include the following information:

- List of species name (Latin and Vietnamese name), number of individuals or coverage (m^2) per species, with specific note for native species
- Landscape plan showing the position on the site of each plant except grass and small vascular plants (for sites less than or equal to 2 ha), or each plant cluster of the same species (sites greater than 2 ha)
- List of plants greater than 50 years old
- List of plants of particular ecological and/or spiritual value
- Photos showing existing site vegetation

Strategy A: Vegetated Area

Maximize the vegetated area to have a significant portion of a site vegetated. In instances where additional vegetation is being planted to increase the vegetated area of the site, it is encouraged to follow the strategies given in Strategy B to improve the quality of the vegetation.

Strategy B: Quality of the Vegetation

To increase the quality of the vegetation on site, the following strategies should be considered:

- Replace plants with low/negligible value (such as grasses and small vascular plants that have colonized naturally) with native and/or climate-adapted plant species which are better adapted to the local conditions and have more ecological value
- Consider the light and water demands of species when deciding where to plant them (particularly for shaded areas)
- Increase the number of plant species on site to improve biodiversity

A point can be achieved where:

- a minimum of 100 m^2 or 50%, whichever is smaller, of the existing vegetated area with low/negligible ecological value has been improved by replacing existing plant species with native and/or climate-adapted plant species.

  - OR-
- the overall number of plant species on site has been increased by 3 species

Calculations

Strategy A: Vegetated Area

The percentage of vegetated area can be calculated by the following method:

- Quantify area of vegetated area using the following classifiers:
  - Grasses and small vascular plants that have colonized naturally cannot be counted towards vegetated coverage (trees planted among grass areas can be counted)
  - Low-lying vegetation and shrubs: overall area coverage as if seen from above
  - Trees: vegetated area should be average coverage across year as seen from above. If coverage is unknown standard set coverage of 1 m^2 can be applied
  - If a green roof is installed then the area of this can be included in the vegetated area, regardless of what species or type of vegetation is planted
- Calculate the proportion of vegetated area using the following formula:

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

A_V = Total Vegetated Area [m^2]

A_S = Site area [m^2]

Strategy B: Quality of the Vegetation

The percentage of improved vegetated area can be calculated by the following method:

- Quantify area of existing vegetated area with low/negligible ecological value as follows overall vegetated area coverage as if seen from above
- Calculate the percentage of improved vegetated using the following formula:

$$\text{Improved Vegetated Area } [\%] = \left(\frac{A_I}{A_L}\right) \times 100$$

A_I = Vegetated Area that has been improved [m^2]

A_L = Existing vegetated area with low/negligible ecological value [m^2]

The number of plant species on site can be calculated by the following method:

- Quantify area of each different type of vegetation plot within the landscape (e.g. grasses, shrubs, trees, ground covers, etc.)
- Quantify number of plant species present within each type of vegetation plot
- Calculate the number of plant species

$$\text{Overall number of plant species on site} = \frac{\sum_i A_i \times S_i}{A_S}$$

A_i = Area of the vegetation plot type i [m^2]

S_i = Number of plant species present within vegetation plot type i

A_S = Site area [m^2]

Example of calculation:

A project that had an initial vegetated area with limited biodiversity and decided to bring new plant species on site as shown in Table Eco.1.

Table Eco.1: Example of low-carbon ongoing consumables

Vegetation plot type	Initial vegetated area		Improved vegetated area	
	Number of different species	Area [m^2]	Number of different species	Area [m^2]
Trees	3	25	5	40
Shrubs	2	30	3	50
Groundcover (not grass)	1	40	5	75
Grass	1	100	0	0
Herbaceous perennial flowers	0	0	8	30

$$\text{Initial overall number of plant species on site} = \frac{3 \times 25 + 2 \times 30 + 1 \times 40 + 1 \times 100}{195} = 1.3$$

$$\text{Increased overall number of plant species on site} = \frac{5 \times 40 + 3 \times 50 + 5 \times 75 + 8 \times 30}{195} = 4.95$$

The overall number of plant species on site has been increased by more than 3 species and this project could be granted 1 point under Strategy B.

Submissions

Provisional Certification Stage
Ecology Prerequisite 1
• Site vegetation survey including landscape plan and photos showing existing site vegetation
For both strategies A and B:
If new vegetation is to be planted after the vegetation survey was realized, also provide: • Description indicating how on-site preservation will be undertaken -OR- A description indicating how on-site revitalization will be undertaken • Extracts from the landscape specification identifying plants to be introduced to the site For sites less than or equal to 2 ha: • Proposed landscape plan showing the position on the site of each plant (not including grass and small vascular plants) For sites greater than 2 ha: • Proposed landscape plan showing the position on the site of each plant cluster of the same species

Strategy A: Vegetated Area
• Calculation of the vegetated area indicating adherence to the credit requirements
Strategy B: Quality of the Vegetation
• Calculation of the improved vegetated area - AND/OR - • Calculation of the increase in the overall number of plant species on site

Full Certification Stage
Ecology Prerequisite 1
If the prerequisite had not been awarded at Provisional Certification: • Site vegetation survey including landscape plan and photos showing existing site vegetation
For both strategies A and B:
If new vegetation has been planted after the vegetation survey was realized: • Photographs showing all new plant species introduced
If the credit had not been awarded at Provisional Certification or if there is any change: • Description indicating how on-site preservation and revitalization have been undertaken • List of plant species that have been introduced to the site For sites less than or equal to 2 ha: • Landscape plan showing the position on the site of each plant (not including grass and small vascular plants) For sites greater than 2 ha: • Landscape plan showing the position on the site of each plant cluster of the same species
Strategy A: Vegetated Area
If the credit had not been awarded at Provisional Certification or if there is any change: • Calculation of the vegetated area indicating adherence to the credit requirements
Strategy B: Quality of the Vegetation
If the credit had not been awarded at Provisional Certification or if there is any change: • Calculation of the improved vegetated area - AND/OR - • Calculation of the increase in the overall number of plant species on site

Eco-2 Sustainable Landscape Management

Intent

To preserve ecological integrity, protect the environment and promote non-toxic landscaping.

Requirements

Criteria	2 Points
Implement a landscape management plan	2

Overview

An effective landscape management plan will ensure a healthy, well vegetated landscape whilst minimizing the use of water and chemical fertilizers. Healthy vegetation will also reduce soil erosion.

Landscape irrigation practices can consume large quantities of domestic water. Improved landscape management practices can significantly reduce and even eliminate irrigation needs. Maintaining healthy native vegetation on the site of a building promotes a self-sustaining landscape that requires minimal supplementary water, fertilizer and pesticides. Healthy vegetation also reduces soil erosion and can attract native fauna to the site promoting integration between the site and its natural surroundings.

Fertilizers used in landscaping have various impacts on the environment. Nitrate leaching through the soil can present a serious health hazard and contributes to soil acidification. Moreover, leakage to water bodies can cause eutrophication (the enrichment of water by the addition of nutrients), which results in rapid growth of algae that in turn may produce toxins poisonous to animals, including humans.

Approach & Implementation

The landscape management plan should cover ongoing maintenance of vegetated areas including soil management and appropriate selection of species.

Good landscape management should include the following principles:

- Know your plant species and irrigate according to their requirements – drip irrigation is preferred
- Conduct periodical monitoring and inspection of the condition of vegetation
- Keep records of landscape maintenance including irrigation, mulching, composting, fertilization, weeding and use of pesticides.

- Apply mulch and compost. Lawn clippings from the site and organic waste from the building can be used for this. Compost is preferred to synthetic fertilizers
- Select native species when replacing plants: they require less maintenance (watering, fertilizer, pest control) as they are adapted to the local environment. Site constraints should be considered when selecting plant species (e.g. shading, cover, etc.)
- Install temporary fencing e around any vegetation potentially affected by the activities when undertaking any construction, renovations or major maintenance. Fencing should be constructed of at least 1.2 m tall metal posts and bunting.

Specifically the landscape management plan should at a minimum address the following points:

- Review of building site's landscape areas: This should include a summary of landscape areas on the site and details of plant species and soil characteristics
- Inspection and records: A framework and commitment to maintain records of maintenance activities
- Sustainable landscape maintenance: Details of the landscape's maintenance needs and appropriate landscape practices. A commitment and schedule for actions such as mulching, composting, weeding, sweeping, pruning and removal of diseased plants
- Water conservation: Details of the landscape's irrigation methods and needs and a commitment to water only when necessary
- Chemical fertilizers and pesticides: Details of the landscape's chemical fertilizer needs (if any) and a commitment to prioritize the use of organic fertilizers and/or minimize the use of chemical fertilizers and pesticides
- Native plant species selection: A commitment to plant native species wherever practical

Submissions

Provisional Certification Stage
• Copy of the landscape management plan

Full Certification Stage
• Records of landscape management activities during the Performance Period in accordance with the landscape management plan including: irrigation, mulching, composting, fertilization, weeding and pest control in accordance with the landscape management plan
If the credit had not been awarded at Provisional Certification or if there is any change: • Copy of the Landscape management plan implemented during the Performance Period

Eco-3 Pest Management

Intent

To manage pests in a responsible way and minimize the use of chemical pesticides.

Requirements

Criteria	1 Point
Implement an Integrated pest management system	1

Overview

A large variety of pesticides designed to kill specific indoor and outdoor pests are used increasingly worldwide, those most commonly used are:

- Insecticides (for killing insects)
- Herbicides or weed-killers
- Fungicides (to kill mold or fungi)
- Rodenticides
- Fumigants; pesticides that exist as a gas or a vapor at room temperature. They are extremely toxic and can be used to kill every living organism

When a pesticide is applied directly to a target pest (plant or animal) the whole site is affected including plants, soil organisms and, potentially, humans and wildlife in the immediate area. This in turn can affect human health and cause serious loss of biodiversity. In addition, some pesticide is inherently lost to the air or to surface waters, due to storm water runoff or drift it may deposit on humans, wildlife, plants or soil. Pesticides may leak into groundwater and thus disturb wildlife and human health not only inside the building but also in surrounding areas (World Health Organization).

In many cases preventative and non-chemical treatments can be just as effective in minimizing pest levels. This can be achieved by implementing an integrated pest management system that ensures responsible management of pests with an emphasis on control rather than eradication and minimizing the use of chemical pesticides.

Approach & Implementation

An integrated pest management system is a systematic way to manage pests. It should cover the control of pests both inside and outside of the building.

An integrated pest management system can be developed by building management or by an independent pest control specialist. It typically involves the following basic components:

- Determine acceptable indoor and outdoor pest levels; beyond these levels building and landscape managers will take action according to the system. This emphasizes control rather than eradication and accepts that there will always be pests
- Preventative practices;
    - Indoors: Seal areas where pests may enter the building, empty rubbish bins regularly, remove water (e.g. fix leaking taps and don't let water accumulate anywhere inside) and ensure food is stored correctly
    - Outdoors: Select species best suited to local conditions (e.g. native species), ensure good storm water drainage to avoid standing water where insects can breed and maintain healthy vegetation (e.g. remove or prune diseased plants, etc.)
- Monitoring; conduct regular visual inspections of the building and landscape and keep records noting things such as insects, animal droppings, spore traps on plants, weeds etc.
- Mechanical controls; when pests reach an unacceptable level mechanical controls (e.g. weeding, erecting barriers and traps) should be considered first
- Biological controls; promote insects that eat target pests or use biological insecticides
- Responsible pesticide use; chemical pesticides should only be used as required – often only at specific times in a pest's life cycle

The integrated pest management system should be outlined in a plan which covers each of the following points:

- Acceptable indoor and outdoor pest levels
- Preventative practices (indoor and outdoor) that are in place with specific attention to those that need to be maintained
- Periodical monitoring strategy including recording method
- Mechanical controls (indoor and outdoor) that can be implemented when pests exceed acceptable levels
- Biological controls (indoor and outdoor) that can be implemented when pests exceed acceptable levels and mechanical controls fail
- Pesticide controls (indoor and outdoor) that can be implemented when pests exceed acceptable levels and mechanical and biological controls fail. This should include times within specific pests' life cycles when pesticides can be applied. Preferred pesticides should be identified along with acceptable application quantities

Submissions

Provisional Certification Stage
• Copy of the Integrated pest management system plan

Full Certification Stage
• Records of pest control activities and use of pesticides during the Performance Period in line with the integrated pest management system
If the credit had not been awarded at Provisional Certification or if there is any change: • Copy of the Integrated pest management system plan

Waste & Pollution

A building and its occupants produce various forms of waste and pollution. These include solid waste, sewer discharge, water pollution, light pollution, ozone depleting chemicals and greenhouse gases. Reducing these emissions should be a key aim of any green building.

In Vietnam the three largest cities have a combined domestic waste water discharge of 1.9 million m^3 per day, of which less than 10% is treated. This is due to outdated and undersized sewerage infrastructure and urban treatment plants. The release of this untreated domestic and industrial wastewater is a major concern which is causing Vietnam's waterways and natural aquifers to become increasingly polluted. As such it is vitally important that sewage discharged from a building meets minimum quality requirements in order to reduce the damage to downstream ecosystems.

Vietnam's urban areas generate over 8 million tonnes of solid waste pear 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.

Mitigating these trends is extremely important, as pollution prevention is always preferable to remediation, which is costly and inefficient. The credits within the Waste & Pollution category of LOTUS BIO encourage strategies and technologies which minimize the generation, and hence minimize the negative effects of a wide range of waste and pollutants. Proper equipment and specification for building systems, as well as good management procedures throughout the lifespan of the building, can reduce the overall waste and pollution generated by the built environment. In addition to reducing waste generation, systematic reuse and recycling programs can also significantly reduce the quantity of waste and pollution discharged from a building site.

Waste & Pollution		8 points
Item	Criteria	Points
WP-1	Wastewater Treatment	2 points
	Building complies with all relevant wastewater regulations and standards	2
WP-2	Solid Waste Management	3 points
	Conduct a solid waste stream audit	W&P Prerequisite 1
	Strategy A: Environmentally friendly solid waste management system	
	Implement an environmentally friendly solid waste management system	1
	Strategy B: Dedicated recycling storage area	
	Provide a dedicated recycling storage area for use by all building occupants	1
	Strategy C: Waste diversion performance	
	50% of the solid waste generated by the building is diverted from landfill	1
WP-3	Refrigerants	2 points
	Strategy A: Refrigerant Atmospheric Impact of Air-conditioning systems	
	Average Refrigerant Atmospheric Impact of all the air-conditioning systems installed in the building is below 13	1
	Average Refrigerant Atmospheric Impact of all the air-conditioning systems installed in the building is below 11	2
	Strategy B: Refrigerant management	
	Implement measures to reduce annual leakage of refrigerants	1
WP-4	Light Pollution Minimization	1 point
	Option A: Automatic lighting shutoff	
	Implement automatic lighting shutoff strategies for exterior lighting fixtures and interior lighting fixtures with a direct line of sight to any openings in the envelope	1
	Option B: Cutoff exterior lighting fixtures	
	All exterior lighting fixtures are either full cutoff, cutoff or semi-cutoff	1

WP-1 Wastewater Treatment

Intent

To encourage appropriate treatment of wastewater prior to discharge from the site

Requirements

Criteria	2 Points
Building complies with all relevant wastewater regulations and standards	2

Overview

Discharging untreated or inadequately treated wastewater result in the spreading of disease, fish kills, and destruction of other forms of aquatic life. The on-site treatment of wastewater is particularly important in Vietnam as only 10% of wastewater is treated at downstream wastewater treatment plants. On-site treatment in Vietnam typically involves a septic tank however, more advanced technologies such as filtration, biological treatment and disinfection can achieve superior results. The management and maintenance of wastewater treatment systems is particularly important to ensure optimal performance.

Approach & Implementation

It is the responsibility of the project team to identify and comply with all relevant wastewater regulations as they are regularly released and updated.

As a non-exhaustive guide, the following standards and regulations should be considered:

- QCVN 14:2008/BTNMT National technical regulation on domestic wastewater
- QCVN 10:2008/BTNMT National technical regulation on coastal water quality
- QCVN 09-MT:2015/BTNMT National technical regulation on ground water quality

Regulations and standards specific to industrial uses:

- QCVN 40:2011/BTNMT National technical regulation on Industrial Wastewater
- TCVN 6980:2001 Water quality – Standards for industrial effluents discharged into rivers using for domestic water supply
- QCVN 13-MT:2015/BTNMT National technical regulation on the effluent of textile industry

Standards specific to hospitals:

- QCVN 28:2010/BTNMT National technical regulation on Health Care Wastewater

Submissions

Provisional Certification Stage
• Report demonstrating that the wastewater treatment system meets/will meet the requirements of applicable wastewater regulations and standards • Hydraulic plans or schematics of the existing and/or proposed wastewater system If wastewater treatment system already meets the requirements of applicable wastewater regulations and standards: • Treated water test results in accordance with applicable regulations

Full Certification Stage
• Report demonstrating that the wastewater treatment system has met the requirements of applicable wastewater regulations and standards during Performance Period • Treated water test results performed during Performance Period
If the credit had not been awarded at Provisional Certification or if there is any change: • Hydraulic plans and schematics of the wastewater treatment system

WP-PR-1 and WP-2 Solid Waste Management

Intent

To understand the quantity and type of waste produced by the building and implement environmentally friendly solid waste management systems.

Requirements

Criteria	3 Points
Conduct a solid waste stream audit	WP Prerequisite 1
Strategy A: Environmentally friendly solid waste management system	
Develop and implement an environmentally friendly solid waste management system	1
Strategy B: Dedicated recycling storage area	
Provide a dedicated recycling storage area for use by all building occupants	1
Strategy C: Waste diversion performance	
50% of the solid waste generated by the building is diverted from landfill	1

Overview

Solid waste stream audits are a means of understanding the quantity and type of waste produced by a building, which allows the use and disposal of solid consumables to be better managed. By undertaking a solid waste stream audit and implementing an environmentally friendly solid waste management system, building owners and operators can identify opportunities to increase recycling and reuse and reduce disposal in landfills or incineration facilities.

Buildings in operation produce a considerable amount of waste that can be diverted from landfill for reuse and recycling. Good practice and the provision of separation facilities to allow for recycling is a simple way to reduce the amount of waste generated during building operation.

Approach & Implementation

Waste and Pollution Prerequisite 1

Conduct a solid waste stream audit to evaluate the building's solid waste stream and establish policies to divert materials from disposal in landfills or incineration facilities by encouraging the recycling and reuse of materials where possible.

A solid waste stream audit should cover all materials in the building's ongoing solid consumable waste stream.

The audit can be conducted prior to or during the Performance Period at a time when the building is fully occupied and may be conducted internally or by independent consultants. The audit should identify opportunities for recycling and reuse of items in the solid waste stream. The solid waste stream audit should separate solid waste into at least the following categories:

- Plastics
- Glass
- Paper, newspapers and cardboard
- Metals
- Food and organics
- E-waste

Strategy A: Environmentally friendly solid waste management system

An environmentally friendly solid waste management system should be developed on the basis of the findings of the solid waste stream audit.

The system, outlined in a manual, should be an ongoing commitment for which adequate resources are allocated. It should require the implementation of waste management practices (the below list of practices is indicative and non-exhaustive) regarding the 4 following aspects:

- Source waste reduction
    - Reduce the incoming waste streams (on packaging, printing, purchasing, etc.)
    - Purchase products in bulk.
    - Reduce (or eliminate) the use of hazardous waste
    - Use durable towels, tablecloths, napkins, dishes, cups, glasses, etc.
- Waste reuse
    - Reuse corrugated boxes, and office furniture and supplies
    - Donate unwanted supplies, excess products/materials, etc.
- Waste recycling
    - Install recycling containers and bins next to trash receptacles
    - Investigate external markets for recyclables and expand collection
- Management of hazardous waste
    - Demonstrate compliance with all current regulations with respect to the management and disposal of hazardous waste
    - Collect and sort potentially hazardous waste (such as batteries, light fittings, etc.)

To make sure the waste management practices will be properly implemented, the environmentally friendly solid waste management system should include measures to educate, advise and facilitate building users.

Strategy B: Dedicated recycling storage area

The building or building site should include a dedicated recycling storage area with recycling bins for the collection, separation and storage of recyclables.

The storage area must allocate storage space for at least the following recyclable materials:

- Paper (including newspaper)
- Corrugated cardboard
- Plastics
- Metals
- Glass

Other recyclable materials to be considered include:

- Fluorescent tubes
- E-waste (batteries, electronic devices, etc.)
- Food and organics (for composting)

The dedicated recycling storage area must be located in the basement, at ground level or outside the building near the main building entry/exit for convenient access by all building occupants and collection vehicles. The recycling area and the bins for each material should be clearly marked.

Strategy C: Waste diversion performance

Reduce the quantity of solid waste sent to landfill by following an environmentally friendly solid waste management system (Strategy A) or by directly implementing a number of waste management practices.

Calculations

Strategy B: Dedicated recycling storage area

The dedicated recycling storage area shall be sized based on the total gross floor area of the building in accordance with Table WP.1.

Where the GFA of the building falls between the figures in the table, linear interpolation shall be used to determine the appropriate percentage area for the dedicated recycling storage.

Projects with a GFA less than 500 m^2 shall have a minimum area of 7.5 m^2 and projects with a GFA more than 20,000 m^2 shall use 0.15%.

For projects with a dedicated recycling storage area over 50 m^2, a smaller percentage may be justified depending on the type of building and frequency of recycling pick-up, and can be judged on a case-by-case basis.

Table WP.1: Dedicated Recycling Storage Area Size Requirements
(Source: GREEN STAR office version 3-2008, Materials, Mat-1 Recycling Waste Storage)

Gross Floor Area (m^2)	Dedicated Recycling Area (% of GFA)
500	1.5%
1,000	0.80%
5,000	0.35%
10,000	0.25%
20,000	0.15%

Example of calculation:

The minimum dedicated recycling storage area of a building with a GFA of 17,000 m^2 should be calculated as follows:

- 10,000m^2 with 0.25 % equals 25 m^2
- 20,000m^2 with 0.15 % equals 30 m^2

$$\text{Minimum area } [\text{m}^2] = \ 25 + (30 - 25) \times \frac{17{,}000 - 10{,}000}{20{,}000 - 10{,}000} = 28.5$$

Strategy C: Waste diversion performance

Calculation is based on volume or weight.
The percentage of solid waste diverted must be calculated by the following method:

- Quantify the total amount of solid waste generated by the building
- Quantify the amount of solid waste diverted from landfill (e.g. waste sent to recycling, waste reused on site, waste donated or sold to be reused, waste composted, etc.)
- Gather data in a table similar to the example given in Table WP.2
- Calculate waste diverted from landfill using the following formula:

$$\text{Solid waste diverted from landfill } [\%] = \frac{\text{W}_\text{D}}{\text{W}_\text{G}} \times 100$$

W_D = Waste diverted from landfill [tons, kg or m^3]

W_G = Total waste generated by the building [tons, kg or m^3]

Table WP.2: Example calculation of waste diversion

Type of waste	Quantity (kg)	Disposal Option	Hauler or destination
Cardboard	15	Reuse	On site
Cardboard	60	Recycling	Recycling Facility
Paper	20	Recycling	Recycling Facility
Computers	25	Donated	Donated to employees
All other wastes	100	Landfill	Landfill
Total Waste	220		
Total Waste diverted	120		

$$\text{Solid waste diverted from landfill } [\%] = \frac{120}{220} \times 100 = 54.5\ \%$$

Note: It is preferable to apply the same unit (tons, kg or m^3) consistently across the entire credit to calculate the overall percentage of waste diverted. Projects that would use different units (volume and weight) for any reason will have to perform 2 calculations: the percentage of waste diverted by weight and the percentage of waste diverted by volume. Both these percentages must be higher than 50% to meet the requirements of Strategy C.

Submissions

Provisional Certification Stage
Waste and Pollution Prerequisite 1
• Report of the solid waste stream audit of the building
Strategy A: Environmentally friendly solid waste management system
• Copy of the environmentally friendly solid waste management system manual
Strategy B: Dedicated recycling storage area
• Plan/sketch indicating the existing or proposed location and size of the recycling storage area(s) • Description outlining: - how recycling materials will be sorted during the Performance Period, - the types of materials which will be recycled during the Performance Period, and - the access routes to the recycling storage area(s) for occupants and recycling contractors • Calculations indicating that the size of the recycling storage area complies with requirements
Strategy C: Waste diversion performance
• Estimations of the percentage of solid waste to be diverted during Performance Period based on the solid waste stream audit and on the waste management practices to be implemented
If no copy of an environmentally friendly solid waste management system manual is submitted for Strategy A: • Description of all the waste management practices to be implemented during the Performance Period

Full Certification Stage
Waste and Pollution Prerequisite 1
If the prerequisite had not been awarded at Provisional Certification or if there is any change: • Report of the solid waste stream audit of the building
Strategy A: Environmentally friendly solid waste management system
• Evidence showing the ongoing implementation of the solid waste management system during the Performance Period, such as photographs, receipts showing collection of recyclables, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Copy of the environmentally friendly solid waste management system manual
Strategy B: Dedicated recycling storage area
• Evidence such as photographs, receipts or narratives showing, during the Performance Period: - the recycling storage area, - how recycling materials have been sorted, and - the materials which have been recycled
If the strategy had not been awarded at Provisional Certification or if there is any change: • Plan/sketch indicating the location and size of the dedicated recycling storage area(s) and access routes to the recycling storage area(s) for building occupants and recycling contractors • Description outlining: - how recycling materials have been sorted, - the types of materials which have been recycled, and - the access routes to the recycling storage area(s) for building occupants and recycling contractors • Calculations indicating that the size of the recycling storage area complies with requirements
Strategy C: Waste diversion performance
• Calculations of the percentage of solid waste diverted during the whole Performance Period
If not submitted for Strategy A: • Evidence showing the ongoing implementation of the waste management practices during the Performance Period, such as photographs, receipts showing collection of recyclables, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change or no copy of an environmentally friendly solid waste management system manual is submitted for Strategy A: • Description of all the waste management practices implemented during the Performance Period

WP-3 Refrigerants

Intent

To encourage the selection and use of refrigerants that do not increase global warming or damage the ozone layer.

Requirements

Criteria	2 Points
Strategy A: Refrigerant Atmospheric Impact of Air-conditioning systems	
Average Refrigerant Atmospheric Impact of all the air-conditioning systems installed in the building is below 13	1
Average Refrigerant Atmospheric Impact of all the air-conditioning systems installed in the building is below 11	2
Strategy B: Refrigerant management	
Implement measures to reduce annual leakage of refrigerants	1

Overview

Common chemical refrigerants used in buildings such as Chlorofluorocarbons (CFCs) and Hydrochloroflourocarbons (HCFCs) are ozone depleting substances and greenhouse gases. These refrigerants have significant Ozone Depleting Potential (ODP) and Global Warming Potential (GWP), meaning they contribute to ozone layer depletion and global warming when emitted to the atmosphere.

HCFCs were being used as a transition chemical to aid the phase-out of CFCs due to their lower ODP compared to CFCs but under the 2007 Montreal Adjustment on Production and Consumption of HCFCs, Vietnam (Article 5 (developing country) Parties) committed to phase out the use of HCFCs (including R-22).

Other refrigerants such as HFCs have zero ODP (as they do not contain chlorine), thus they are the current preferred replacements. However, HFCs often have a high GWP (up to 12240). The use of new refrigerants with lower GWP and zero ODP such as HFOs or natural refrigerants (CO_2, hydrocarbons, etc.) is encouraged as they are the best choice to limit both ozone layer depletion and global warming.

It is important that in buildings where HVAC systems are being replaced that the existing systems are correctly disposed of in order to ensure that refrigerants are not emitted to the atmosphere where their ozone depleting and global warming potentials can be realized.

Approach & Implementation

To follow this credit, projects should meet the following requirements:

- From 12 months prior to the Performance Period, no equipment using CFC refrigerant or refrigerants with an ODP higher than 0.05 (including R-22) should be installed in the building.
- A phase-out of all CFC refrigerants and refrigerants with an ODP higher than 0.05 (including R-22) used in the building should be scheduled.
- Where old equipment using refrigerants are replaced, proper disposal methods should be employed.

Strategy A: Refrigerant Atmospheric Impact of Air-conditioning systems

Refrigerants that have a limited atmospheric impact such as those in Table WP.3 should be selected. In general, such refrigerants should have both low GWP_{100} values (under 2000) and ODP values of 0. The atmospheric impact of refrigerants can also be limited by using equipment which can ensure a lower leakage rate of the refrigerant (under 2% per year).

Table WP.3: List of some selected refrigerants that have a limited atmospheric impact (Source: Values from IPCC Fifth Assessment Report 2013)

Refrigerant	ODP	GWP_{100}
R134a	0	1,300
R407A	0	1,923
R407C	0	1,624
R410A	0	1,924
CO_2	0	1

Strategy B: Refrigerant management

Implement measures to properly operate and maintain the systems using refrigerants to reduce annual leakage of refrigerants and minimize the atmospheric impacts.

To meet the requirements of Strategy B, the project must:

- Maintain log books with records documenting dates, refrigerant charge amount and related information for equipment servicing and disposal.
- Implement measures to reduce leak potential.
  For example, the project can:
  - Replace system components with parts that are more leak-resistant or have a reduced number of potential leak sources

- Verify that the threaded and flared fittings are properly tightened
- Make sure caps and seals on all valves are installed to ensure leak tightness

- Implement a refrigerant leak detection strategy.

  For example, the project can:
  - install a permanent automated refrigerant leak detection system
  - conduct regular leak inspections
  - install liquid receivers and log the refrigerant level of the receiver (for chillers)

The list of above measures is not exhaustive and in any case, the effectiveness of implemented measures will have to be demonstrated and will be subject to VGBC approval.

Calculations

Strategy A: Refrigerant Atmospheric Impact of Air-conditioning systems

Using the following equation, the Refrigerant Atmospheric Impact of all the air-conditioning systems in the building should be calculated.

$$\text{Refrigerant Atmospheric Impact} = \frac{\sum_{\text{unit}} [(\text{LCGWP} + \text{LCODP} \times 10^5) \times \text{Q}_{\text{unit}}]}{\text{Q}_{\text{total}}}$$

Q_{unit} = Cooling capacity of an individual air-conditioning equipment (kW)

Q_{total} = Total cooling capacity of all air-conditioning equipment (kW)

LCGWP, the Lifecycle Global Warming Potential (kg CO_2/kW/Year) and LCODP, the Lifecycle Ozone Depletion Potential (kg CFC 11/kW/Year) are calculated as follows:

$$\text{LCGWP} = \frac{[\text{GWPr} \times (\text{Lr} \times \text{Life} + \text{Mr}) \times \text{Rc}]}{\text{Life}}$$

$$\text{LCODP} = \frac{[\text{ODPr} \times (\text{Lr} \times \text{Life} + \text{Mr}) \times \text{Rc}]}{\text{Life}}$$

GWPr = Global Warming Potential of Refrigerant (0 to 12,000 kg CO_2/kg r) coming from the IPCC Fifth Assessment Report (AR5) in 1995.

ODPr = Ozone Depletion Potential of Refrigerant (0 to 0.2 kg CFC 11/kg r) coming from the stratospheric ozone protection regulations at 40 CFR Part 82

Lr = Refrigerant Leakage Rate (0.5% to 2.0%; default of 2% unless otherwise demonstrated)

Mr = End-of-life Refrigerant Loss (2% to 10%; default of 10% unless otherwise demonstrated)

Rc = Refrigerant Charge (0.2 to 2.3 kg of refrigerant per kW of rated cooling capacity)

Life = Equipment Life (default based on Table WP.4, unless otherwise demonstrated)

Table WP.4: Recommended Lifetime values for different types of equipment
(Source: ASHRAE Applications Handbook, 2007)

Equipment type	Recommended Lifetime (years)
Window air-conditioning units and heat pumps	10
Unitary, split, and packaged air-conditioning units and heat pumps	15
Reciprocating compressors, scroll compressors and reciprocating chillers	20
Absorption chiller	23
Water cooled packaged air-conditioners	24
Centrifugal and screw chillers	25

Submissions

Provisional Certification Stage
Strategy A: Refrigerant Atmospheric Impact of Air-conditioning systems
• Schedule of all existing and/or proposed HVAC equipment indicating refrigerant types and refrigerant charge. • Calculation of the Refrigerant Atmospheric Impact of all the existing and/or proposed HVAC equipment in the building
For all the existing HVAC equipment: • Manufacturer's published data of all existing HVAC equipment, indicating refrigerant types and refrigerant charge. • Evidence of the existing HVAC equipment installed, such as inventory report from facility audit, photographs, receipts, as-built documentation, commissioning report, etc.
If some existing HVAC equipment are to be disposed: • Description outlining proposed disposal method and disposal location of refrigerant
If any proposed HVAC equipment are to be installed: • Manufacturer's published data -AND/OR- Specification extracts on all proposed HVAC equipment indicating refrigerant types and refrigerant charge
Strategy B: Refrigerant management
• Narrative explaining all the existing and/or proposed measures to reduce annual leakage and showing their effectiveness

Full Certification Stage
Strategy A: Refrigerant Atmospheric Impact of Air-conditioning systems
If some existing HVAC equipment have been disposed of after Provisional Certification: • Evidence showing that the existing equipment and existing refrigerant have been adequately disposed of such as receipts, contracts, photographs, etc.
If some new HVAC equipment have been installed after Provisional Certification: • Manufacturer's published data of all new HVAC equipment, indicating refrigerant types and refrigerant charge. • Evidence of the new HVAC equipment installed, such as photographs, receipts, as-built documentation, commissioning report, material approval request, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Inventory/schedule of all HVAC equipment indicating refrigerant types and refrigerant charge • Calculation of the Refrigerant Atmospheric Impact of all the HVAC equipment in the building • Inventory report from facility audit -OR- Manufacturer's published data all existing HVAC equipment, indicating refrigerant types and refrigerant charge • Evidence of the existing HVAC equipment installed, such as inventory report from facility audit, photographs, receipts, as-built documentation, commissioning report, etc.
Strategy B: Refrigerant management
• Evidence that the measures to reduce annual leakage have been implemented during the Performance Period such as maintenance records, log books, photographs, receipts, etc.
If the strategy had not been awarded at Provisional Certification or if there is any change: • Narrative explaining all the measures to reduce annual leakage and showing their effectiveness

WP-4 Light Pollution Minimization

Intent

To minimize light pollution into the night sky.

Requirements

Criteria	1 Point
Option A: Automatic lighting shutoff	
Implement automatic lighting shutoff strategies for exterior lighting fixtures and interior lighting fixtures with a direct line of sight to any openings in the envelope	1
Option B: Cutoff exterior lighting fixtures	
All exterior lighting fixtures are either full cutoff, cutoff or semi-cutoff	1

Overview

Light pollution is excessive or obtrusive artificial light, causing adverse effects such as sky glow, glare, light trespass, light clutter, decreased visibility at night and energy waste. Like any form of pollution (such as water, air and noise pollution) light pollution also causes damage to the environment. It affects human health and psychology, disrupts ecosystems and impinges on astronomical observation.

Approach & Implementation

Option A: Automatic lighting shutoff

The project should implement automatic lighting shutoff strategies (such as scheduling or the use of occupancy sensors) to control the exterior lighting fixtures and the interior lighting fixtures with a direct line of sight to any opening in the envelope.
All these lighting fixtures should be turned off during the period between midnight or business closing (whichever comes first) and 6AM or business opening (whichever comes first).

Exceptions: The following lighting fixtures do not require an automatic control device:

- Lighting intended for 24-hour operation.
- Lighting installed where patient care is rendered.
- Lighting installed where an automatic shutoff would endanger safety or security

Option B: Cutoff exterior lighting fixtures

All exterior lighting fixtures shall be full cutoff, cutoff or semi-cutoff (i.e. they must not be non-cutoff) (Figure WP.1).

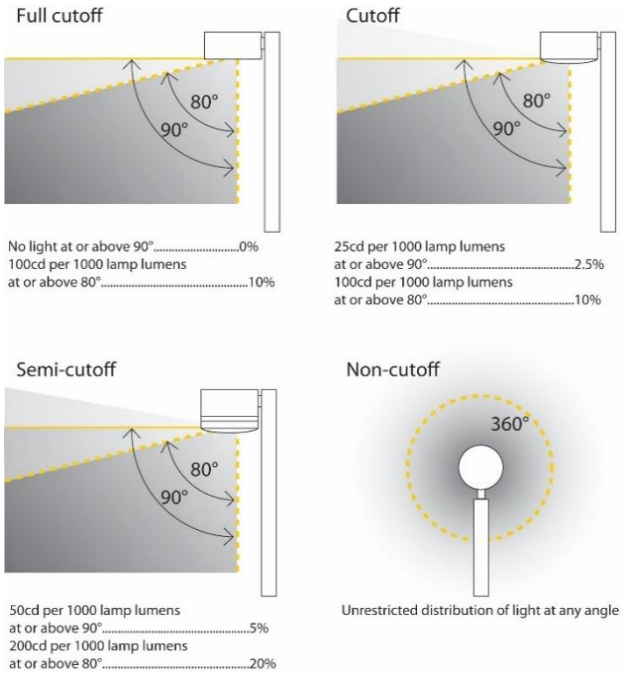


Figure WP.1: Light fixture cutoff classification

Submissions

Provisional Certification Stage
Option A: Automatic lighting shutoff
• Schedule and description outlining the existing or proposed automatic lighting shutoff strategy • Evidence showing all the existing automatic lighting shutoff strategies implemented, such as extract of the facility audit report, photographs, plans, commissioning report, etc.
Option B: Cutoff exterior lighting fixtures
• Schedule of all existing and/or proposed exterior lighting fixtures indicating their cut-off classification • Evidence showing all the existing exterior lighting fixtures and their cut-off classification, such as inventory report from facility audit, photographs, commissioning report, etc.
If any proposed exterior lighting fixtures are to be installed: • Manufacturer's published data -AND/OR- Specification extracts on all proposed exterior lighting fixtures to be installed

Full Certification Stage
Option A: Automatic lighting shutoff
If new automatic lighting shutoff strategies have been implemented after Provisional Certification: • Evidence showing all the new automatic lighting shutoff strategies implemented, such as photographs, plans, commissioning report, etc.
If the credit had not been awarded at Provisional Certification or if there is any change: • Schedule and description outlining all the automatic lighting shutoff strategy • Evidence showing all the existing automatic lighting shutoff strategies implemented, such as extract of the facility audit report, photographs, plans, commissioning report, etc.
Option B: Cutoff exterior lighting fixtures
If new exterior lighting fixtures have been installed after Provisional Certification: • Evidence showing all the new exterior lighting fixtures installed and their cut-off classification, such as photographs, manufacturer's data, commissioning report, etc.
If the credit had not been awarded at Provisional Certification or if there is any change: • Inventory of all exterior lighting fixtures indicating their cut-off classification • Evidence showing all the existing exterior lighting fixtures and their cut-off classification, such as inventory report from facility audit, photographs, commissioning report, etc.

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, noise and light pollution can also affect occupants and surrounding communities. As the population of Vietnam becomes increasingly urbanized, it is estimated by the Ministry of Construction that the urban population will increase by 45% within the next 20 years. This urban migration results in more people spending more time within the built environment. As a result, the quality of life of building occupants depends greatly on the Indoor Environmental Quality (IEQ).

Improving IEQ results in reduced cases of asthma, allergies, respiratory disease and other occupant ailments described as "sick building syndrome". In office buildings good IEQ has been linked with increased worker productivity and reduced absenteeism which translates into reduced costs and increased savings for building owners, operators and tenants. Good IEQ also increases a building's resale value.

Credits within the Health & Comfort category of LOTUS BIO measure the quality of the overall indoor environment in buildings. The credits consider four different aspects of the indoor environment. The first and most important aspect is the quality of indoor air; the building must ensure fresh, clean air free of toxic chemicals and dust for occupants. Moreover, a healthy indoor environment in a building should be comfortable visually, acoustically and thermally for building occupants.

Health & Comfort		12 Points
Item	Criteria	Points
H-1	Occupant Comfort	3 points
	Conduct a building occupant survey and develop an action plan based on the responses	H&C Prerequisite 1
	Occupants' average overall satisfaction score from the building occupant survey is 3.5 out of 5	1
	1 point for every 0.5 point increase in the occupants' average overall satisfaction score of 3 (Up to 4.5)	3
H-2	Indoor Smoking	1 point
	Prohibit smoking in the building in accordance with Decision 1315/QĐ-TTg	H&C Prerequisite 2
	Provide outdoor designated smoking areas	1
H-3	Fresh Air Supply	2 points
	Provide sufficient fresh air supply to a minimum of 90% of the net occupied area of the building	2
H-4	CO_2 Monitoring	1 point
	Conduct CO_2 monitoring in high density occupied areas of the building	1
H-5	Daylighting	2 points
	40% of the net occupied area has average daylight factor between 1.5% and 3.5%	1
	70% of the net occupied area has average daylight factor between 1.5% and 3.5%	2
H-6	External Views	2 points
	50% of the net occupied area has a direct line of sight to the outdoor environment	1
	65% of the net occupied area has a direct line of sight to the outdoor environment	2
H-7	Green Cleaning	1 point
	Develop and implement a green cleaning program	1

H-PR-1 and H-1 Occupant Comfort

Intent

To improve occupant satisfaction and workplace productivity.

Requirements

Criteria	3 Points
Conduct a building occupant survey and develop an action plan based on the responses	Health & Comfort Prerequisite 1
Occupants' average overall satisfaction score from the building occupant survey is higher than 3.5 out of 5	1
1 point for every 0.5 point increase in the occupants' average overall satisfaction score (Up to 4.5)	3

Overview

Comfort is best defined as the absence of discomfort. People feel uncomfortable when they are too hot or too cold, or when the air is odorous and stale. Positive comfort conditions are those that do not distract by causing unpleasant sensations of temperature, drafts, humidity or other aspects of the environment. Ideally, in a properly conditioned space, people should not be aware of equipment noise, heat or air motion.

Occupant surveys are an excellent source of information for improving the performance of buildings. Surveys allow building managers to objectively gauge which building services and design features are working and which aren't, and to prioritize the steps needed to improve occupant satisfaction and workplace productivity.

Approach & Implementation

Health & Comfort Prerequisite 1

Conduct a building occupant comfort survey to collect anonymous responses about air quality, thermal comfort, visual comfort and acoustic comfort in the building. It should include an assessment of overall satisfaction and identification of problems. Survey responses must be collected from at least 30% of building occupants.

VGBC recommends that the first survey is conducted before the Performance Period and a subsequent survey is conducted during the Performance Period. After the Performance Period, applicants are encouraged to conduct a survey each year or every 2 years as a helpful tool to identify problems related to user comfort.

It is required that respondents score their satisfaction for each occupant comfort category on a scale of 1 to 5 (1 being very bad to 5 being excellent).

Applicants must use the survey template in Table H.1. Applicants may wish to ask additional questions specific to the building in the survey, however, the average score used to determine the number of points awarded for this credit must be calculated using only the results of the questions in Table H.1.

Table H.1: Occupant Comfort Survey template

Comfort Category	1 Very bad	2 Bad	3 Satisfactory	4 Good	5 Excellent
Thermal Comfort					
Air temperature					
Humidity					
Air speed					
Air quality					
Air odor					
Air freshness					
Visual Comfort					
Lighting level					
Glare					
Daylighting					
Acoustic Comfort					
Exterior noise					
Interior noise					
Overall Comfort					

If the survey results indicate an average score of less than 3 out of 5 for any of the comfort categories, a corrective action plan should be developed and implemented.

This plan should first aim to identify precisely each problem and determine the root cause by doing inspections, more detailed occupant survey and/or measuring relevant environmental variables including:

- Thermal comfort: air temperature, relative humidity and air speed,
- Air quality: odor problem, CO_2 level, VOCs and particulate concentration
- Visual comfort: lighting level (lux), glare problem
- Acoustic comfort: background noise level.

Then, appropriate corrective actions should be implemented to fix the problem and prevent the problem happening again.

Records of corrective actions should be kept by the building management team to evidence that the problems were recognized, corrected, and proper measures were implemented to make sure that it does not happen again.

Health & Comfort Credit 1

Based on the occupant survey results, calculate the occupants' average overall comfort.

At Provisional Certification, points will be awarded based on the results of an initial occupant survey. At Full Certification, points will be awarded based on the results of an occupant survey that has be realized during the Performance Period.

Submissions

Provisional Certification Stage
Health and Comfort Prerequisite 1
If no initial occupant survey has been performed for Provisional Certification: • Signed letter of intent from the building owner or building manager that an occupant survey will be performed during the Performance Period for Full Certification
If an initial occupant survey has been performed: • Template used for the initial occupant survey • Results of the initial occupant survey • Corrective action plan for any comfort category identified as not satisfactory
Health and Comfort Credit 1
• Calculation of the occupants' average overall comfort score based on the initial occupant survey

Full Certification Stage
Health and Comfort Prerequisite 1
• Template used for the occupant survey performed during the Performance Period • Results of the occupant survey performed during the Performance Period
If any comfort category has an average score of less than 3 out of 5 in the occupant survey performed during the Performance Period: • Corrective action plan • Records for all corrective actions implemented
Health and Comfort Credit 1
• Calculations of the occupants' average overall comfort score

H-PR-2 and H-2 Indoor Smoking

Intent

To minimize the effect of passive smoking on building occupants.

Requirements

Criteria	1 Point
Prohibit smoking in the building in accordance with Decision 1315/QĐ-TTg	Health & Comfort Prerequisite 2
Provide outdoor designated smoking areas	1

Overview

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

Approach & Implementation

Health and Comfort Prerequisite 2

Decision 1315/QĐ-TTg strictly prohibits smoking in schools, kindergartens, health facilities, libraries, cinemas, theatres, community cultural centers, indoor working areas and places at high risk of explosion and fire.

Smoking is only allowed in designated smoking areas with separate ventilation systems in indoor public places (sporting halls, roofed stadia, exhibition centers, waiting rooms at railway stations, bus stops, airports, seaports), indoor entertainment centers, bars, karaoke bars, and hotels.

“No Smoking” signs must be put up in places where smoking is prohibited and must be displayed in areas of prominence that may be frequented by smokers.

Health and Comfort Credit 2

Provide outdoor designated smoking areas that are located at least 10 meters away from entrances, outdoor air intakes and operable windows. Information and signage about the location of these areas should be posted inside and outside of the building

Submissions

Provisional Certification Stage
Health and Comfort Prerequisite 2
• Description outlining existing or proposed compliance with Decision 1315/QĐ-TTg • Photographs showing the existing no smoking signage and the existing smoking areas (if any)
Health and Comfort Credit 2
• Site plan/sketch indicating the existing or proposed location of the designated outdoor smoking and the location of any nearby entrances or operable windows

Full Certification Stage
Health and Comfort Prerequisite 2
If the prerequisite had not been awarded at Provisional Certification or if there is any change: • Description outlining compliance with Decision 1315/QĐ-TTg • Photographs showing the no smoking signage and the smoking areas (if any)
Health and Comfort Credit 2
• Photographs showing the outdoor smoking area and associated signage
If the credit had not been awarded at Provisional Certification or if there is any change: • Site plan/sketch indicating the location of the designated outdoor smoking areas and the location of any nearby entrances or operable windows

H-3 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 net occupied 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. Fresh air is assumed to be free of contaminates (investigation of the fresh air quality is advised, especially in dense urban areas) and increased fresh air supply can help decrease respiratory illnesses and associated absenteeism. Reduced instances of sick building syndrome symptoms and improved productivity are also results of high fresh air intake rates.

Approach & Implementation

This credit applies to all occupied spaces in the building in order to provide good air quality for all occupants. A minimum of 90% of the total net occupied area should meet with the following requirements.

- Mechanically ventilated spaces:
  HVAC systems and distribution ductwork that supply mechanically ventilated spaces must meet or surpass the requirements of one of the following international standards:
  - TCVN 5687:2010 - Ventilation - Air Conditioning, Design Standards
  - ASHRAE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality (versions 2007, 2010 or 2013)
  - CIBSE Guide B - Heating, Ventilating, Air Conditioning and Refrigerant
  - Australian Standard, AS1668.2 - The Use of Ventilation and Air-conditioning in Buildings - Ventilation Design for Indoor Air Contaminant Control

  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.

If, for some spaces, reaching the minimum value of the standards can be proven to be unfeasible due to the physical constraints of the existing ventilation system, at least 25 m^3/h of outdoor air per person under all normal operating conditions (including worst-case system conditions) should be supplied.

- Naturally ventilated spaces (or mechanically assisted naturally ventilated spaces) must either comply with Strategy A of the Credit E-3 or meet the following requirements (taken from section 5.1.1 of ASHRAE 62.1-2007):
  - All naturally ventilated spaces shall be within 8 meters of (and permanently open to) an operable wall or roof opening
  - The total area of wall or roof openings shall be at least 4% of the naturally ventilated spaces' floor area
  - Interior spaces without direct openings to the outdoors can be naturally ventilated through adjoining rooms if the unobstructed openings between the rooms are at least 8% of the floor area (with a minimum of 2.3 m^2)

- Mixed-mode ventilated spaces (combination of natural ventilation from operable window, and mechanical systems that include air distribution equipment and HVAC) must meet both the above requirements for HVAC systems and for natural ventilation.

In order to verify that fresh air supply rates are compliant with one of the standards selected from the list, they should be measured for every mechanically ventilated and mixed-mode ventilated occupied space within the building.
To measure the fresh air supply flow rate in an existing building, several different methods can be employed such as (but not limited to):

1. Direct fresh air measurement methods:

- Pitot static tubes or anemometers traversing the intake duct
- Air intake attachment (e.g. airflow hood, duct attachment with anemometer, venturi or orifice plate, etc.)

2. Indirect fresh air measurement methods:

- Spot temperature measurements (mix air, return air and fresh air temperatures) combined with a pitot static tube traverse of the total supply duct
- Traverse of the total supply and recirculation ducts by pitot static tube and determination of the fresh air rate from the difference
- Measurement of CO2 in the total supply, return and intake ducts and a traverse of the total supply duct by pitot static tube

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.

Calculation

- Mechanically ventilated and mixed-mode ventilated occupied spaces:

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

- Naturally ventilated and mixed-mode ventilated occupied spaces:

For each of these occupied spaces, perform calculations to show compliance with the requirements set in Strategy A of the Credit E-3 or with the requirements given in Approach & Implementation.

Submissions

Provisional Certification Stage
• Table outlining every occupied space along with each space's ventilation type and area
For spaces with mechanical ventilation and spaces with mixed-mode ventilation:
• Calculations showing that all the occupied spaces meet and/or will meet the requirements of the national or international standard selected • In case the requirements of the national or international standard selected cannot be met for all occupied spaces, relevant explanations demonstrating that it is unfeasible to meet the requirements of the standard followed • Schedule of all the existing and/or proposed HVAC equipment handling air supply • Evidence showing fresh air supply rates of all the existing HVAC equipment, such as as-built drawings, commissioning records, inventory report from facility audit, etc.
For spaces with natural ventilation and spaces with mixed-mode ventilation:
• Elevations and plans marking all existing and/or proposed operable wall and roof openings • Window schedule indicating the number, location and size of all existing and/or proposed operable wall and roof openings or room data sheets that indicate area and window specifications (glazing type, size and whether the window is operable) • Calculations demonstrating that naturally ventilated occupied spaces conform and/or will conform to the requirements

Full Certification Stage
If the credit had not been awarded at Provisional Certification or if there is any change: • Table outlining every occupied space along with each space's ventilation type and area
For spaces with mechanical ventilation and spaces with mixed-mode ventilation:
If the credit had not been awarded at Provisional Certification or if there is any change: • Calculations showing that all the occupied spaces meet the requirements of the national or international standard selected • In case the requirements of the national or international standard selected cannot be met for all spaces, include relevant explanations to demonstrate that it is unfeasible to meet the requirements of the standard followed • Schedule of all the HVAC equipment handling air supply • Evidence showing fresh air supply rates of all the existing HVAC equipment, such as as-built drawings, commissioning records, inventory report from facility audit, etc.
For spaces with natural ventilation and spaces with mixed-mode ventilation:
If the credit had not been awarded at Provisional Certification or if there is any change: • Elevations and plans marking all operable wall and roof openings • Window schedule indicating the number, location and size of all operable wall and roof openings or room data sheets that indicate area and window specifications (glazing type, size and whether the window is operable). • Calculations demonstrating that naturally ventilated occupied spaces conform to the requirements

H-4 CO_2 Monitoring

Intent

To regulate indoor air quality via CO_2 monitoring.

Requirements

Criteria	1 Point
Conduct CO_2 monitoring in high density occupied areas of the building	1

Overview

Typical air pollutants within buildings include environmental tobacco smoke, formaldehydes, VOCs, nitrogen oxides, carbon monoxide, carbon dioxide, allergens, pathogens, radon, pesticides, lead and dust. CO_2 is often chosen as the general indicator for indoor air quality and the appropriateness of the ventilation rate. High CO_2 concentrations indicate poor indoor air quality and inadequate ventilation in enclosed spaces. With an integrated CO_2 monitoring system, it is possible to indicate that the concentration of CO_2 is too high and that the outdoor air supply should be increased. CO_2 monitoring can also be used as part of a demand control ventilation system which can automatically adjust ventilation supply rates before poor air quality impacts on occupants' health.

Approach & Implementation

One of the two following techniques should be applied to all high density occupied areas (1 person/3 m^2) of buildings to meet the requirements of the credit:

- Install permanent CO_2 sensors integrated with building management systems (BMS) to ensure continuous adjustments of the fresh air supply
- Monitor CO_2 concentrations and manually amend the operation schedules of ventilation systems accordingly. Configure all monitoring systems to generate an alarm when the CO_2 concentration gets higher than a CO_{2max} concentration set for each space. The alarm should be able to alert either the building operator through building automation system or the building occupants through visible or audible alerts. The CO_{2max} concentration, at which fresh air supply must be increased, shall be set at 1000 ppm or appropriately calculated for each different high density occupied area. Designers can refer to Appendix A of ASHRAE 62.1 - 2007 User's Manual for more details.

For both techniques, CO_2 sensors should be located between 1 and 2 meters above the finished floor (breathing zone). When monitoring large open spaces with largely uniform concentration levels, it is also acceptable to mount sensors in return air ducts.

In the case that hazardous gas risks (carbon monoxide, hydrogen sulphide, 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.

Submissions

Provisional Certification Stage
• Schedule indicating the high density occupied spaces with their areas, occupancies, number of sensors installed and/or to be installed and CO_{2max} concentration set • Drawings/sketches showing location of existing and/or proposed CO_2 sensors • Operation and maintenance manual indicating the procedures for operation, adjustment and maintenance of the CO_2 monitoring system • Evidence showing the existing CO_2 sensors installed such as inventory report from facility audit, photographs, drawings, commissioning reports, etc.

Full Certification Stage
• Evidence showing the proper implementation of the CO_2 monitoring system during the Performance Period, such as records, measurements, photographs, etc.
If the credit had not been awarded at Provisional Certification or if there is any change: • Schedule indicating the high density occupied spaces with their areas, occupancies, number of sensors installed and CO_{2max} concentration set • Drawings/sketches showing location of all CO_2 sensors • Operation and maintenance manual indicating the procedures for operation, adjustment and maintenance of the CO_2 monitoring system • Evidence showing that the CO_2 sensors are installed such as inventory report from facility audit, photographs, drawings, commissioning reports, etc.

H-5 Daylighting

Intent

To provide building occupants with access to natural light.

Requirements

Criteria	2 Points
40% of the net occupied area has an average daylight factor between 1.5% and 3.5%	1
70% of the net occupied area has an average daylight factor between 1.5% and 3.5%	2

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 greatest ingress of natural light while minimizing 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

The average daylight factor is the average indoor illuminance (from daylight) on the working plane within a room, expressed as a percentage of the simultaneous outdoor illuminance on a horizontal plane under an unobstructed CIE Standard Overcast Sky.

Natural light promoting strategies include:

- Use of specific types of glazing with high light transmittance
- Installation of interior light shelves
- Use of internal surfaces (ceiling, walls and floors) with high reflectance
- Maintenance plan for glazed areas to prevent accumulation of dust and solid particles on glazed areas that reduce the performance of natural lighting
- Shading systems to regulate the intensity of the sun coming into different parts of the building

Calculation

The daylight factor (DF) must be calculated for all occupied spaces (spaces included in the net occupied area). In order to simplify calculations, spaces within a building which present same orientation and glazing distribution can be grouped, but this has to be justified.

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.

Note that measured data is not an acceptable method for demonstrating compliance with this credit because results will vary depending on the external brightness.

Daylight modelling software

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

Spreadsheet calculations

The average DF for each occupied space is calculated as follows (methodology developed by the Building Research Establishment in the UK):

$$DF = \frac{A_g \times \theta \times M \times t \times 100}{A_{total} \times (1 - \rho^2)}$$

DF = Average daylight factor [%]

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

A_{total} = Total internal surface area of the space including ceiling, floors, walls and windows [m^2]

θ = Angle of visible sky from the mid-point of the window/skylight [Rad]. Angle of visible sky is determined as per the below figure (Figure H.1)

M = Maintenance factor (Table H.2)

t = Visible light transmission (Values of Table H.3 can be used if manufacturer's data is not available)

ρ = Average reflectance of surrounding room surfaces (recommended values in Table H.4 can be used)

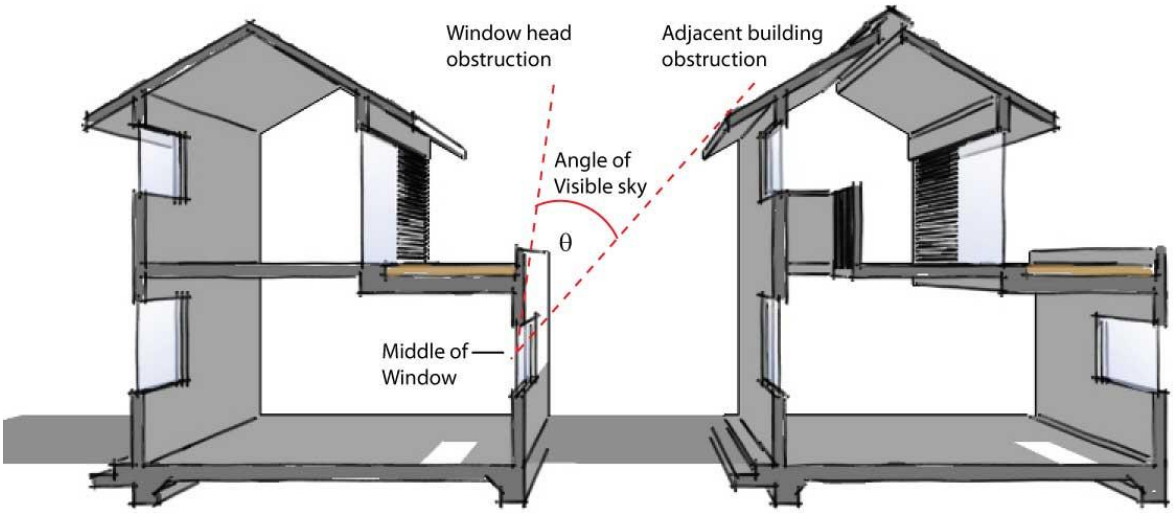


Figure H.1: Angle of visible sky from the mid-point of the window

Table H.2: Maintenance factors
(Source: Introduction to Architectural Science. Steven V. Szokolay)

Location	Slope of the window/skylight	Window/skylight 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.3: 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.4: Reflectance values of common building finishes
(Source: CIBSE Lighting Guide 7 Office Lighting)

Materials used internally	Reflectance	Paint colors (with BS 4800 color code)	Reflectance
White paper	0.8	White 00E55	0.85
Stainless steel	0.4	Pale cream 10C31	0.81
Cement screed	0.4	Light grey 00A01	0.68
Carpet (cream)	0.35	Strong yellow 10E53	0.64
Wood (light veneers)	0.4	Mild-grey 00A05	0.45
Wood (medium colors)	0.2	Strong green 14E53	0.22
Wood (dark oak)	0.1	Strong red 04E53	0.18
Quarry tiles	0.1	Strong blue 18E53	0.15
Window glass	0.1	Dark grey 10A11	0.14
Carpet (deep colors)	0.1	Dark brown 08C39	0.10
		Dark red-purple 02C39	0.10
		Black 00E53	0.05

In both calculations methods, the following procedure shall be followed:

- Calculate the average DF in all the rooms part of the net occupied area
- Identify all the rooms that have an average DF value between 1.5% and 3.5%
- All these rooms are considered as compliant for the daylighting credit (rooms with a DF above 3.5% can also be considered compliant but only if manual shadings are provided)
- Sum the areas of all these rooms and compare them to the net occupied area of the building using the following formula:

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

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

A_O = Net occupied area [m^2]

Submissions

Provisional Certification Stage

- Plans and elevations indicating the occupied spaces and all glazed areas
- Calculations of the percentage of the net occupied area that is compliant

If calculations have been done using a spreadsheet:

- Spreadsheet calculations showing the average daylight factor values of all the occupied rooms

If calculations have been done using a daylight modelling software:

- Report indicating the inputs and outputs (average daylight factor values of all the occupied rooms) of the modelling

Full Certification Stage

If the credit had not been awarded at Provisional Certification or if there is any change:

- Plans and elevations indicating the occupied spaces and all glazed areas
- Calculations of the percentage of the net occupied area that is compliant

If calculations have been done using a spreadsheet:

- Spreadsheet calculations showing the average daylight factor values of all the occupied rooms

If calculations have been done using a daylight modelling software:

- Report indicating the inputs and outputs (average daylight factor values of all the occupied rooms) of the modelling

H-6 External Views

Intent

To increase occupants' connection to the outdoors by ensuring a direct line of sight outside.

Requirements

Criteria	2 Points
50% of the net occupied area has a direct line of sight to the outdoor environment	1
65% of the net occupied area has a direct line of sight to the outdoor environment	2

Overview

Windows and openings provide a direct connection between building occupants and the outdoor environment. This connection improves occupants' well-being, which can lead to improved health, comfort and productivity. The possibility of refocusing the eyes on a distant object periodically can reduce eyestrain and related health problems.

Approach & Implementation

Many strategies can enhance the provision of views to the outdoors for occupants, including:

- Locating open plan areas near the perimeter of the building
- Locating unoccupied spaces within the core of the building
- Applying glazing to internal partitions

For this credit, a glazing can be considered as an external view only if:

- it is present between 0.8 m and 2.2 m above the finished floor, and
- it provides a clear image of the exterior, not obstructed by frits, fibers, patterned glazing, or added tints that distort color balance.

This line of sight begins at 45 degrees from the edge of each external view. Lines of sight can pass through 2 interior glazing surfaces, but not a doorway with a solid door. Moveable partitions and non-fixed furniture shall not be taken into account

Calculation

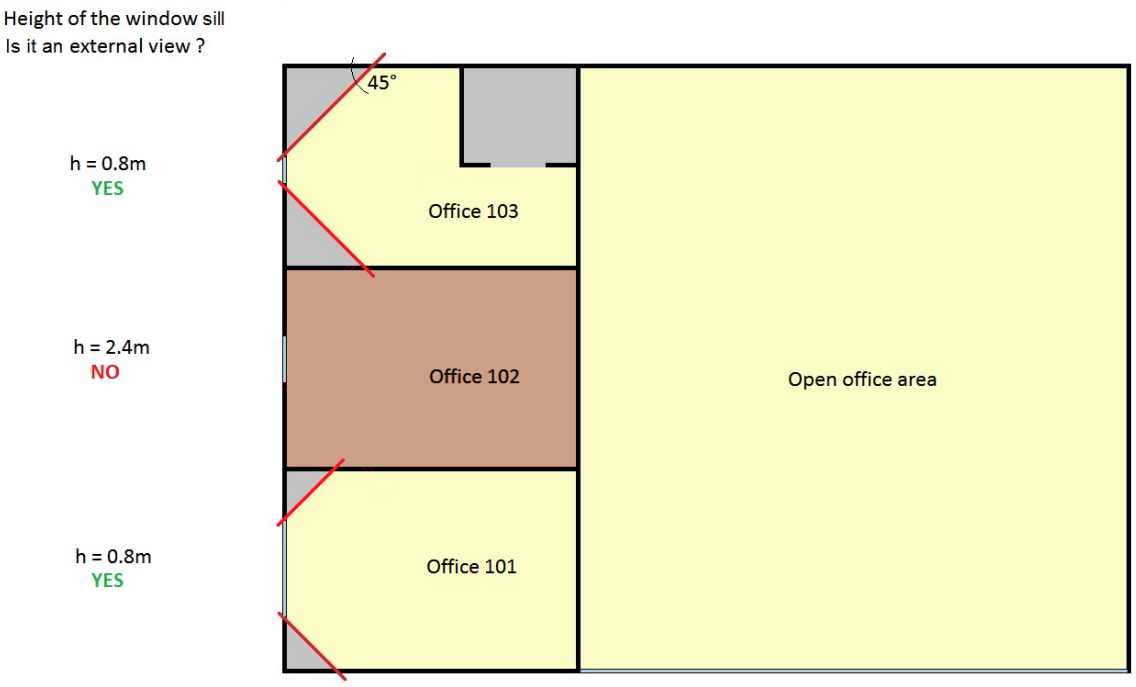
Present calculations in a spreadsheet format indicating adherence to the requirements (see Table H.5 below).

Compliant areas shall be calculated using the following method:

- Identify all occupied spaces and their areas
- Identify and measure all areas within these occupied spaces that have a direct line of sight to the exterior.
- If at least 75% of a room's floor area has a direct line of sight to the outdoor, the entire floor area shall be counted as compliant
- If less than 75% of the room's floor area has a direct line of sight to the outdoor, the actual area with a direct line of sight to the exterior shall be counted as compliant
- Calculate the percentage of the floor space that is compliant using the following formula:

$$\text{Compliant Area } [\%] = \frac{\text{Total compliant floor space}}{\text{Net occupied area}} \times 100$$

Figure H.2 and Table H.5 highlight the calculation method.



	Office 101	Office 102	Office 103	Open Office Area
Area with external views	20 m^2	0 m^2	15 m^2	145 m^2
Area without external views (out of line of sight)	5 m^2	0 m^2	10 m^2	0 m^2
Area without external views (no complying windows)	0 m^2	25 m^2	0 m^2	0 m^2

Figure H.2: Example of Calculation Method for External Views

Table H.5: Example of Calculation Method for External Views

Room	Total Occupied Area [m^2]	External View Present? [Y or N]	Area with External View		Compliant Area [m^2]
			[m^2]	[% of room's floor area]	
Office 101	25	Y	20	80%	25
Office 102	25	N	/	/	0
Office 103	25	Y	15	60%	15
Open Office Area	145	Y	145	100%	145
TOTAL	220	-	175	-	185

In this example, it can be shown that 90% of the net occupied area is compliant, leading to the award of 2 credit points.

Submissions

Provisional Certification Stage

- Floor plans indicating occupied areas and areas with external views
- Elevations indicating window height
- Calculations demonstrating compliance with the requirements
- Photographs showing the external views

Full Certification Stage

If the credit had not been awarded at Provisional Certification or if there is any change:

- Floor plans indicating occupied areas and areas with external views
- Elevations indicating window height
- Calculations demonstrating compliance with the requirements
- Photographs showing the external views

H-7 Green Cleaning

Intent

To promote the use of safer cleaning products and practices to protect building occupants from the adverse impacts of cleaning chemicals and toxic substances.

Requirements

Criteria	1 Point
Develop and implement a green cleaning program	1

Overview

The chemicals contained in cleaning products are particularly worrisome because their use may affect not only the cleaning staff but also the other building occupants. The chemicals contained in traditional cleaning products can cause a range of health effects and research has found links between these affect all building occupants and birth defects, asthma, respiratory disease, neurological disorders and other health impacts.

Green cleaning refers to using safer cleaning products and procedures. Traditional cleaning products should be substituted with environmentally friendly products that are less hazardous and less toxic and cleaning procedures should be improved.

Approach & Implementation

A green cleaning program should be developed and implemented. The green cleaning program should include green cleaning procedures to address the cleaning of all the areas within the building and site management's control. The cleaning can be realized in-house or by appointing cleaning service providers.

The following green cleaning procedures should be implemented:

- Select environmentally friendly cleaning products when possible. Else, find "less toxic" substitutions to the products already in use.
  Environmentally friendly cleaning products are less hazardous and less toxic cleaning products. Such products should be natural products (baking soda, lemon, apple cider, etc.) or should be certified by recognized green labelling scheme such as: Green Seal, Singapore Green Labelling Scheme, Safer Choice (US EPA), Green Specifications from EPD Hong Kong, etc.

Products which are not natural or not certified but can justify compliance with the Green Specifications of a recognized green labelling scheme will be considered as environmentally friendly cleaning products.

- Manage the use of disinfectants and sanitizers which can be highly toxic:
  - Determine where the use of disinfectants and sanitizers is needed
  - Identify areas that need the highest level of disinfecting, such as nurses' offices
  - Clean before disinfecting (unless the product specifically states otherwise)
  - Follow the product instructions carefully
  - Use the least toxic antimicrobials to disinfect or sanitize
- Manage flooring maintenance.
- Manage carpet cleaning

Submissions

Provisional Certification Stage
• Copy of the green cleaning program developed for the project

Full Certification Stage
• List of all the environmentally friendly cleaning products used during the Performance Period • Evidence that the green cleaning procedures have been implemented during the Performance Period such as: log books, records, photographs, etc. For all the non-natural products environmentally friendly cleaning products used, • Manufacturer's published data showing that cleaning product is environmentally friendly • Invoices, receipts or purchase orders
If the credit had not been awarded at Provisional Certification or if there is any change: • Copy of the green cleaning program developed for the project

Adaptation & Mitigation

Climate change is widely accepted as being among the greatest challenges to face mankind this century. Today, the term climate change is usually used with regard to changes in global climate, which result from human activities. From the industrial revolution until today, we have become increasingly reliant on fossil fuels as our main source of energy. The process of burning fossil fuels for energy has resulted in the release of large amounts of Greenhouse Gases (GHG) into the atmosphere. The increasing concentration of GHGs in the atmosphere changes the radiation balance of the earth, increasing the greenhouse effect and leading to global warming. The impacts of climate change can now be seen in the form of stronger and more frequent storms, flooding and drought, sea level rise and other extreme weather phenomena.

Although developed countries are responsible for 40% of emissions globally, it is the poorer developing countries which will face the most severe climate change impacts. In the first part of the century it has been predicted that Vietnam will be one of the five countries most affected by climate change. In Vietnam these impacts will include flooding to more than 1 million residents who currently live below 1 m above sea level due to predicted sea level rise and increased frequency and intensity of extreme rainfall events and droughts.

In response to the severity of the situation, the government has issued guidance to all related sectors, instructing immediate preparation in response to climate change. However, existing Vietnamese buildings built with conventional construction practices are susceptible to damage from flooding, storms and earthquakes. Therefore, it is crucial for building managers to identify any measures they can take to improve the resilience of buildings against natural disasters. This will protect the occupants of a building in the event of a natural disaster and maximize the building's life span.

Credits within the Adaptation & Mitigation category of LOTUS BIO target the building's resistance towards natural disasters and the reduction of the building's transport related GHG emissions. A green building must account for all possible disasters such as flooding, typhoon and fire and comprehensive strategies must be prepared to ensure the safety of occupants. At the same time, it should alleviate its own impacts on climate change by increasing the perviousness of the site and reducing the amount of paved surfaces that contribute to the heat island effect. It should also reduce the consumption of fossil fuels required for transport by occupants during the operation of the building.

Adaptation & Mitigation		11 Points
Item	Criteria	Points
A-1	Disaster Resilience	3 points
	Strategy A: Disaster risk report	
	Prepare a disaster risk report	1
	Strategy B: Disaster response plan	
	Prepare a disaster risk report and produce a disaster response plan	1
	Strategy C: Disaster resilience	
	Prepare a disaster risk report and demonstrate that disaster resilience is incorporated within the building and site	1
A-2	Storm Water Runoff	2 points
	Strategy A: High average perviousness	
	Average perviousness of the site is at least 30%	1
	Average perviousness of the site is at least 50%	2
	Strategy B: Self-improvement	
	Average perviousness of the site at Performance Period is increased by 30% compared to the historical average perviousness of the site	1
A-3	Heat Island Effect	2 points
	30% of paved and roof areas limit the heat island effect	1
	50% of paved and roof areas limit the heat island effect	2
A-4	Green Transportation	4 points
	Provide building occupants with information on the different collective transportation means available for travel to and from the site	A&M Prerequisite 1
	Strategy A: Green transportation policy	
	Implement a green transportation policy	1
	Strategy B: Green transport Facilities	
	Provide Green transport facilities for the building occupants	1
	Strategy C: Green Commuting	
	10% of occupant trips are made by green commuting	1
	20% of occupant trips are made by green commuting	2

A-1 Disaster Resilience

Intent

To ensure buildings are well prepared for natural disasters.

Requirements

Criteria	3 Points
Strategy A: Disaster risk report	
Prepare a disaster risk report	1
Strategy B: Disaster response plan	
Prepare a disaster risk report and produce a disaster response plan	1
Strategy C: Disaster resilience	
Prepare a disaster risk report and demonstrate that disaster resilience is incorporated within the building and site	1

Overview

Vietnam is one of the most natural disaster-prone countries in the world. Natural disasters that occur include typhoons, tropical depressions, floods, whirlwinds, droughts, landslides, forest fires, salt-water intrusion and earthquakes.

Most recorded damage to buildings is caused by typhoons, flooding and whirlwinds and although earthquakes are not as frequent in Vietnam, the risk to populated areas is significant. For this reason LOTUS BIO encourages buildings to make efforts to minimize the damage caused by disasters, protecting occupants and property in the event of natural disasters.

It is important that building managers are familiar with the risks presented by potential natural disasters so that they can adequately prepare for such an event. Once building managers are familiar with the risks, they should ensure that an appropriate disaster response plan is in place. Where possible, buildings should incorporate disaster resilience against natural disasters that have the potential to occur.

Approach & Implementation

Building owners and managers should prepare a disaster risk report and a disaster response plan that cover natural disasters which have the highest likelihood of affecting the building. For each type of natural disaster the report should assess the potential impacts on the building

if such a natural disaster were to occur and the disaster response plan should outline the response in the event of each type of disaster.

It is recommended that the following parties are involved in the compilation of the disaster risk report and disaster response plan:

- Building owner and manager
- Technical certification team, including any engineers and project managers
- Building occupants
- Local experts in relevant fields (e.g. geologists familiar with seismic activity, meteorologists familiar with weather patterns, engineers familiar with flooding risks etc.)
- Local authorities

Strategy A: Disaster risk report

For each natural disaster, the report should first consider the likelihood of such an event occurring and if it has the potential to occur, include at least the following information:

- Flooding:
    - A flood map, if available, identifying whether the building is within a flood prone area
    - All relevant published data from local hydrometeorology institutes or other qualified organizations including:
        - Precipitation/rainfall level and history
        - Local history of storms
        - Tropical low pressure and flooding
        - Predicted climate change impacts such as increased storm frequency or sea level rise
    - A local flood survey is to be conducted by collecting experiences and opinions of local communities and authorities regarding disasters in the past 15 years. The survey should collect the following information:
        - Main causes and sources of local flooding (e.g. nearby rivers, tides, street stormwater network, etc.)
        - Average and highest frequency per year
        - Annual flood peaks
        - Average and highest intensity/water height
        - How long the area remains flooded after all inputs halt
        - Existing flood hazards
    - Potential flood damage to buildings
    - If possible, flooding trend for the next 50 years and worst-case scenario

- Earthquakes:
    - Design report indicating that proper earthquake resistance solutions were considered in the design in accordance with building code QCVN 02:2009/BXD Natural Physical and Climatic Data for Construction, and justification of the design standard used

    If design report is not available:
    - Seismic map showing any fault lines and the risk of an earthquake occurring at the building site
    - History of seismic activity in the area
    - If risk is considered significant, conduct an engineering review of the building's structural resilience against a possible earthquake

- Typhoon:
    - Design report indicating that building was designed in accordance with QCVN 02:2009/BXD including maximum wind speed considered in design

    If design report is not available:
    - Assessment of likelihood of typhoons occurring including a review of historical records of typhoons occurring in the area
    - Predicted maximum wind speeds in the event of typhoons occurring
    - Review of building's resilience in the event of a typhoon and associated winds. This should include an assessment of any parts of the building that may become dislodged in such high winds

- Drought:
    - Potential effect on building (e.g. building foundation movement, building cracking, water shortages, etc.)
    - Review of building resilience against drought

- Fire:
    - Potential effect on building
    - Review of building resilience against fire

- Landslide:
    - Potential effect on building
    - Review of building resilience against landslide

This is not an exhaustive list and the report may need to cover other potential natural disasters.

The VGBC understands that some information may be difficult to find and will assist applicants in finding this information where possible.

Strategy B: Disaster response plan

Based on the outcomes of the disaster risk report, building management should ensure that building occupants are appropriately prepared for any potential natural disaster by implementing a disaster response plan.

The disaster response plan should be provided to building occupants and, at a minimum, this should include the following:

- Response plan for different disasters
- Evacuation route and assembly points
- Alarms and warning systems
- Fire extinguishing equipment

Strategy C: Disaster Resilience

The building should incorporate disaster resilience within its design and operation. The measures suitable for each building will depend on the building's location and susceptibility to different natural disasters. The natural disaster resilience should be against disasters found to be of the highest risk of occurring in the disaster risk report. Examples of natural disaster resilience measures for different types of natural disasters that can be incorporated into the building design are as follows:

- Flooding:
    - Ensure the building floor level is above the current highest flood level. If this is not possible, ensure no critical infrastructure is located below the current highest flood level.
- Earthquake:
    - Design the building to withstand an earthquake in accordance with the building site's seismic zone (in accordance with QCVN 02:2009/BXD)
    - Ensure no parts of the facade have the potential to be dislodged in such an earthquake
- Typhoon:
    - Design the building to withstand predicted wind speeds generated by typhoons in the area (in accordance with QCVN 02:2009/BXD)
    - Ensure no parts of the facade have the potential to be dislodged in such a typhoon

- Drought:
  - Ensure building has a backup water supply
  - Ensure foundations have been designed with consideration to movement in underlying soils
- Fire:
  - Ensure building incorporates fire resistance
- Landslide:
  - Ensure building incorporates landslide protection

Submissions

Provisional Certification Stage
Strategy A: Disaster risk report
• Copy of the disaster risk report
Strategy B: Disaster response plan
• Copy of the disaster response plan
Strategy C: Disaster resilience
• Report indicating existing and/or proposed measures to ensure disaster resilience of the building and site

Full Certification Stage
Strategy A: Disaster risk report
If the credit had not been awarded at Provisional Certification or if there is any change: • Copy of the disaster risk report
Strategy B: Disaster response plan
• Evidence showing that the disaster response plan have been provided to the building occupants such as photographs, records, etc.
If the credit had not been awarded at Provisional Certification or if there is any change: • Copy of the disaster response plan
Strategy C: Disaster resilience
If it had not been submitted at Provisional Certification or if there has been any change: • Report indicating measures to ensure disaster resilience of the building and site

A-2 Stormwater Runoff

Intent

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

Requirements

Only projects that have a non-building area and/or a green roof area that make up more than 10% of the total site area or make up more than 200 m^2 are eligible for this credit.

Criteria	2 Points
Strategy A: High average perviousness	
Average perviousness of the site is at least 30%	1
Average perviousness of the site is at least 50%	2
Strategy B: Self-improvement	
Average perviousness of the site at Performance Period is increased by 30% compared to the historical average perviousness of the site	1

Overview

Stormwater runoff is the water created during precipitation events which is then fed into sewer, storm water or river systems. All precipitation that falls on surfaces within the building's site boundary is considered storm water runoff.

Reducing stormwater 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 and/or the improvement of its quality will reduce the amount of pollutants washed into water bodies.

One way to maximize site perviousness is to minimize hard surfaces and where hard surfaces are required, use pervious surface materials that allow water to pass through them. These strategies allow the site to take advantage of the infiltration capacity of the native soil. This is critical in minimizing the impact on ground water quantity and quality, and reducing local flooding. Moreover, this strategy also prevents soil erosion.

Approach & Implementation

The most effective way to control stormwater runoff quantity and quality is to increase the permeability of outside areas and to restore the site's natural functions.

Strategies to increase site perviousness include:

- Minimize hardscape areas
- Use permeable hardscaping materials for driveways, car parks and walkways such as:
    - Permeable paving blocks
    - Porous asphalt
    - Unbound gravel
    - Wood
    - Mulch
    - Brick, cobbles or natural stone arranged to promote infiltration
- Landscaping that diverts water from impervious areas to pervious areas, such as gardens and lawns, before leaving the site
- Use of vegetated swales, biofiltration swales, wetlands, dry wells and rain gardens improving water quality and infiltration
- Green roofs
- Retention and detention ponds

Also, it is possible to construct infiltration tanks or detention tanks to capture the storm water. With detention tanks, the stormwater can be reused in a same way as harvested rainwater. To integrate such methods in the average perviousness calculation, projects should contact the VGBC for guidance.

Calculation

The calculation shall take into account the entire non-building area of the site with the addition of any green roof area. Use the following method to determine the perviousness of the site:

- Quantify the non-building area of the site and the green roof area
- 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:

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

A_i = Area of space i [m^2]

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

A_{site} = Total site area deducted of building footprint(s) not covered by a green roof [m2]

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

Table A.1: Runoff Coefficients of different surfaces
(*Sources: TCVN 7957:2008, American Society of Civil Engineers)*

Character of surface	Runoff Coefficient
Pavement	
Roofs	0.92
Asphalt	0.90
Brick pavers	0.80
Concrete	0.92
Gravel (unbound)	0.7
Permeable pavers	0.5
Lawns (Sandy soil)	
Average slope 0-2%	0.1
Average slope 2-7%	0.15
Average slope > 7%	0.2
Lawns (Heavy soil)	
Average slope 0-2%	0.15
Average slope 2-7%	0.2
Average slope > 7%	0.25
Others	
Garden bed/rain garden	0.15
Playgrounds	0.25

For strategy B, the average site perviousness should be calculated before and after some (additional) strategies to increase site perviousness have been implemented. An increase of 30% of the average site perviousness is required to earn one point.

Example of calculation:

A project with a non-building area of 850 m^2 and no green roof has a site with the following features: a concrete paved area of 500 m^2; a vegetated area on a sandy soil with no slope of 200 m^2 and an asphalt area of 150 m^2.
To increase the site perviousness at Performance Period, the project replaces 200 m^2 of the concrete paved area with 100 m^2 of vegetated area and 100 m^2 of open-grid pavement.

- Calculation of the initial average site perviousness:

$$\text{Initial average site perviousness } [\%] = \frac{500 * (1 - 0.92) + 200 * (1 - 0.1) + 150 * (1 - 0.9)}{850} = 27.6\%$$

- Calculation of the average site perviousness at Performance Period:

$$\text{Average site perviousness at Performance Period } [\%] = \frac{300 * (1 - 0.92) + 300 * (1 - 0.1) + 150 * (1 - 0.9) + 100 * (1 - 0.5)}{850} = 42.2\%$$

- Calculation of the increase of the average site perviousness:

$$\text{Increase of the Average Site Perviousness at Performance Period } [\%] = \left(\frac{42.2\%}{27.6\%} - 1\right) * 100 = 53\%$$

This project can be awarded one point in Strategy A with an average site perviousness higher than 30% and one point in Strategy B with an increase of the average site perviousness of more than 30%.

Submissions

Provisional Certification Stage
For both strategies:
• Landscape plans showing existing and/or proposed hardscape/landscape areas and materials used • Calculation of the average site perviousness at Performance Period based on existing and/or proposed strategies • Photographs showing existing strategies (if any) for the onsite control of stormwater runoff If runoff coefficients other than those from Table A.1 have been used: • Manufacturer's data or logical justification indicating runoff coefficients used
Strategy B: Self-improvement
• Landscape plans or photographs showing hardscape/landscape areas and materials used before the implementation of new strategies to increase site perviousness • Calculation of the initial average site perviousness • Calculation of the expected increase of the average site perviousness at Performance Period

Full Certification Stage
For both strategies:
If the credit had not been awarded at Provisional Certification or if there is any change: • Landscape plans showing hardscape/landscape areas and materials used • Photographs showing strategies for the onsite control of storm water runoff • Calculation of the average site perviousness If runoff coefficients other than those from Table A.1 have been used: • Manufacturer's data or logical justification indicating runoff coefficients used
Strategy B: Self-improvement
If the strategy had not been awarded at Provisional Certification or if there is any change: • Landscape plans or photographs showing hardscape/landscape areas and materials used before the implementation of new strategies to increase site perviousness • Calculation of the increase of the average site perviousness at Performance Period

A-3 Heat Island Effect

Intent

To minimize the heat island effect and reduce the impact of the built environment on microclimates, as well as human and wildlife populations.

Requirements

Criteria	2 Points
30% of paved and roof areas limit the heat island effect	1
50% of paved and roof areas limit 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 A.1).

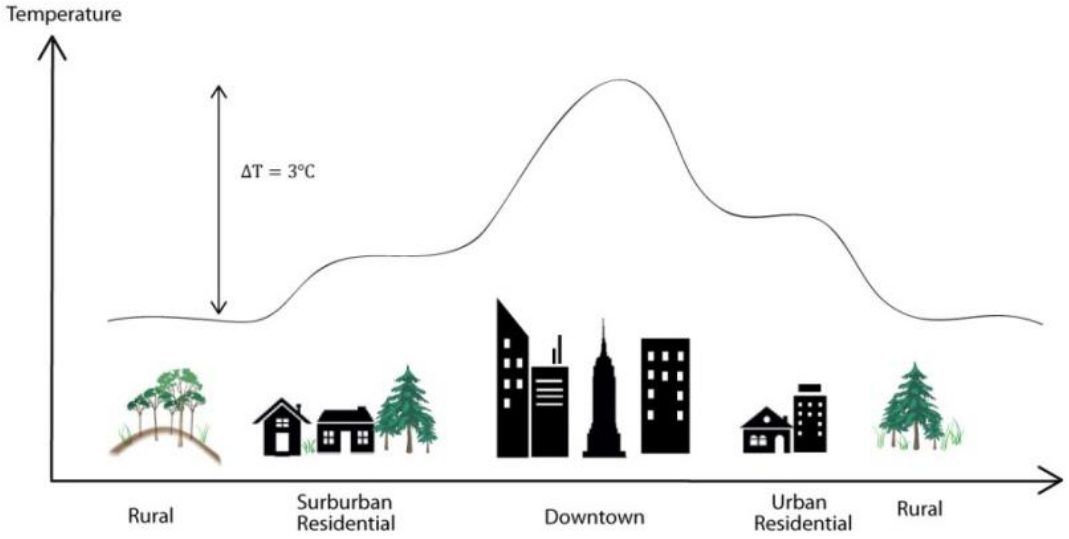


Figure A.1: Heat island effect

The urban heat island effect occurs when the temperature is warmer in urban landscapes than rural areas. It can detrimentally effect air quality, energy consumption and human health. Urban heat islands occur when surfaces made of brick, concrete and asphalt (such as streets, foot paths, car parks and buildings), retain solar energy and reradiate that heat back into the surrounding atmosphere.

Approach & Implementation

Reducing the heat island effect can be achieved by installing the following:

- Roof surfaces with a Solar Reflectance Index (SRI) higher than 78 for low sloped roof (i.e. less than 2:12 rise over run)
- Roof surfaces with SRI higher than 29 for steep sloped roof
- Green roofs
- Solar panels
- Paving materials with SRI higher than 29
- Open grid pavement systems (at least 50% pervious) to reduce paved areas
- Shading devices with a SRI higher than 29 or shading from existing trees canopy or within 10 years of landscape installation (shades must cover paved or roof areas)

Roof surfaces with high SRI value are called cool roofs. They can be made of a highly reflective type of paint, a sheet covering, highly reflective membranes, etc.

Paving materials with SRI higher than 29 can be achieved by using concrete, concrete pavers, white portland cement concrete, surface coatings, etc.

Calculation

The 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 considered as paved areas. The strategies listed in the Approach & Implementation section are considered as limiting the heat island effect. Areas covered with mechanical equipment should be deducted from the roof area.

The percentage of surface area that limits the heat island effect can be calculated by the following method:

- Quantify total site's paved and roof area
- Quantify surfaces considered as limiting the heat island effect:
    - For shading devices, the area to consider is the area of the device as it can be seen from above.
    - For trees, shade must be calculated at 10 a.m., 12 noon, and 3 p.m. on the summer solstice. The arithmetic mean of the 3 values will be used as the effective shaded area. For simplification, 1 m² per tree can also be considered.
    - For 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

- Calculate the percentage of surface area limiting the heat island effect using the following formula:

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

A_{cool} = 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

Provisional Certification Stage

- Site plan showing all existing and/or proposed paved areas, roof areas, shading devices (including shading vegetation), green roofs and surface materials used
- Photographs showing all the existing areas of the site that limit the heat island effect
- Calculations indicating adherence to the credit requirements

For all surface materials with high SRI:

- Manufacturer's published data indicating SRI value of existing and/or proposed materials -OR- Sourced SRI values of existing and/or proposed materials (data must be from a VGBC approved source)

Full Certification Stage

If the credit had not been awarded at Provisional Certification or if there is any change:

- Site plan showing all paved areas, roof areas, shading devices (including shading vegetation), green roofs and surface materials used
- Photographs showing all the areas of the site that limit the heat island effect
- Calculations indicating adherence to the credit requirements

For all surface materials with high SRI:

- Manufacturer's published data indicating SRI value of materials -OR- Sourced SRI values of materials (data must be from a VGBC approved source)

A-PR-1 and A-4 Green Transportation

Intent

To raise awareness of the different collective transport means available and implement policies to ensure a significant proportion of occupant trips are made by green transport.

Requirements

Criteria	4 Points
Provide building occupants with information on the different collective transportation means available for travel to and from the site	A&M Prerequisite 1
Strategy A: Green transportation policy	
Implement a green transportation policy	1
Strategy B: Green transport facilities	
Provide Green transport facilities for the building occupants	1
Strategy C: Green Commuting	
10% of occupant trips are made by green commuting	1
20% of occupant trips are made by green commuting	2

Overview

Green transport refers to modes of transport that have a low impact on the environment. The most common forms of green transport include walking, cycling and catching public transport. It is important to promote green transport alternatives as motor vehicles in general, and private motor vehicles (cars and motor bikes) in particular, are responsible for many forms of pollution. Exhaust fumes emitted when motor vehicles burn fuel cause local air pollution in cities and contribute to global warming. In addition, a significant amount of energy is required to build vehicles and their supporting infrastructure such as roads and car parks.

Taking into account the current urban traffic situation, demography and urbanization forecasts, Vietnam is set to have substantial challenges developing efficient and low carbon urban transportation systems in the future. This credit rewards buildings in which a substantial portion of occupants use green commuting options to get to and from the building, thus reducing private motor vehicle usage. This reduces congestion, air pollution and CO_2 emissions generated from occupants travelling to and from the site.

Approach & Implementation

Adaptation and Mitigation Prerequisite 1

Provide collective transportation information to occupants including routes and schedules in an obvious and accessible location. This service must be regularly maintained.

Strategy A: Green Transportation Policy

The green transportation policy is to be developed by the building's management team and should be available and communicated to all building occupants.

The following steps should be taken in developing the green transportation policy:

- Transport Survey: Survey all building occupants to determine their mode of transport to and from the building on a randomly chosen day before the Performance Period begins. (It is recommended that this is done in conjunction with the H-PR-1 Occupant Survey)
- Limitations and Opportunities: Analyze the limitations and opportunities provided by the site, including available public transport, facilities and infrastructure
- Set Targets: Based on the transport survey set realistic targets for building occupants to reach during the Performance Period
- Action: Identify strategies to achieve the targets set. This may include: provision of new facilities or infrastructure in the building (e.g. showers, electric bicycle recharge stations), preferred parking, vehicle sharing programs, provision of shuttle service, free or subsidized public transport, free or cash back on bicycles or related equipment, incentive programs (e.g. employee rewards), occupant awareness raising programs, etc.

Strategy B: Green transport facilities

The building should provide facilities to encourage cycling and electric biking as a means of transport to and from the building. This should be done by providing:

- covered and secured bicycle parking spaces for at least 5% of peak building occupants
- shower facilities for at least 0.5% of full-time occupants (for non-residential buildings)
- electric vehicle charging stations for 3% of the total vehicle parking capacity of the site

Strategy C: Green Commuting

Demonstrate that a substantial proportion of building occupants use a green transport to commute to and from the building using the method outlined in the calculations section.
The following transport modes are considered as green transport options: walking, bicycles, electric bikes, public transport (bus, train, metro, etc.), private bus services, carpooling, motorbike sharing and telecommuting.

All the other modes of transport are considered as private motor vehicle modes of transport.

Calculations

Strategy B: Green transport facilities

Note: Non-integer values shall be rounded up. The minimum number of parking spots, showers and electric vehicle charging stations to be awarded 1 point in strategy B is 1.

Calculation of the required number of bicycle parking spaces is based on number of occupants at peak period. Capacity of bicycle parking spaces shall be calculated as follows:

- Quantify number of building occupants at peak period
- Calculate minimum capacity of bicycle parking spaces with the following formula:

$$\text{Number of parking spots} = N_P \times 0.05$$

N_P =Number of building occupants at peak period

Calculation of the required number of shower facilities is based on number of full-time occupants. Full-time occupants are employees/staff in the building and their number should be calculated based on a daily occupancy of 8 hours. Part-time occupants should be given an equivalent 'full-time occupants' value based on the number of hours they spend in the building per day divided by 8. Capacity of showering facilities shall be calculated as follows:

- Quantify number of building full-time occupants
- Calculate minimum capacity of showering facilities with the following formula:

$$\text{Number of showers} = N_{FT} \times 0.005$$

N_{FT} =Number of full-time occupants

Calculation of the required number of electric vehicle charging stations is based on number of parking spaces. Number of electric vehicle charging stations shall be calculated as follows:

- Quantify total vehicle parking capacity
- Calculate minimum capacity of electric vehicle charging stations with the following formula:

$$\text{Number of electric vehicle charging stations} = T \times 0.03$$

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

Strategy C: Green Commuting

The calculation is based on the occupant trips identified in a transport survey made on a randomly chosen day.

The percentage of occupants using green transport modes is calculated as follows:

- Using the transport survey results, count the total number of trips
- Identify the number of green transport trips

$$\text{Green Transport Trips } [\%] = \left(\frac{G_T}{T_T}\right) \times 100$$

G_T = Number of green transport trips to and from the building

T_T = Total occupant trips (private motor vehicle + green transport) to and from the building

A final transport survey is to be taken on a random day during the Performance Period to demonstrate the final breakdown of transport modes for Full Certification.

Submissions

Provisional Certification Stage
Adaptation and Mitigation Prerequisite 1
• Photographs showing the public transport information displayed.
For both strategies A and C:
• Transport survey form and results showing the modes of transport used by building occupants to and from the building on a randomly chosen day before the Performance Period begins.
Strategy A: Green Transportation Policy
• Copy of the Green transportation policy
Strategy B: Green Transport Facilities
• Plans or sketches indicating the existing and/or proposed location and number of bicycle parking spots, showering facilities and electric vehicle charging stations • Calculations demonstrating compliance with the requirements • Photographs showing all the existing bicycle parking spots, showering facilities and electric vehicle charging stations.
Strategy C: Green Commuting
• Calculations of the percentage of green transport trips before Performance Period

Full Certification Stage
Adaptation and Mitigation Prerequisite 1
If the prerequisite had not been awarded at Provisional Certification or if there is any change: • Photographs showing the public transport information displayed.
For both strategies A and C:
• Final transport survey form and results showing the modes of transport used by building occupants to and from the building on a randomly chosen day during the Performance Period.

Strategy A: Green Transportation Policy
If the strategy had not been awarded at Provisional Certification or if there is any change: • Copy of the Green transportation policy • Evidence such as drawings/sketches or photographs showing the provision of sufficient parking spaces and showers in the building or on the building site
Strategy B: Green Transport Facilities
If the strategy had not been awarded at Provisional Certification or if there is any change: • Plans or sketches indicating the location and number of bicycle parking spots, showering facilities and electric vehicle charging stations • Calculations demonstrating compliance with the requirements • Photographs showing all the bicycle parking spots, showering facilities and electric vehicle charging stations.
Strategy C: Green Commuting
• Calculations of the percentage of green transport trips during Performance Period

Community

A building in operation should interact with the surrounding community in a positive way; this includes building occupants as well as residents, workers and visitors in the surrounding area. A building can enhance its interaction with the local community by ensuring building access for people with disabilities, providing training and information to occupants and by organizing public awareness campaigns.

Credits within the Community category of LOTUS BIO aim to maximize the benefits to the community and minimize the negative impacts of development on the surrounding community. This is important to ensure the built environment meshes organically with the residents of the area. Finally, it fits in with the concept of sustainable development, where the society, the economy and the environment develop in harmony.

Although existing buildings are not currently required to comply with Vietnam's legislation to provide convenient access for people with disabilities, it is strongly encouraged that standards for new buildings are met. Barrier-free design principles ensure age, physical ability or any other characteristic is not a limiting factor for use of the built environment.

Community		6 Points
Item	Criteria	Points
CY-1	Access for People with Disabilities	2 points
	Building complies with the requirements of QCVN 10:2014/BXD	2
CY-2	Occupant Behavior	2 points
	Provide a building user's guide to building occupants	Community Prerequisite 1
	Strategy A: Ongoing environmental-awareness campaign	
	Conduct an ongoing environmental-awareness campaign	1
	Strategy B: Occupant training	
	Conduct regular occupant training	1
CY-3	Public Awareness Campaign	2 points
	Perform at least two actions to promote general public awareness	1
	Perform at least four actions to promote general public awareness	2

CY-1 Access for People with Disabilities

Intent

To promote access for people with disabilities to buildings in operation.

Requirements

Criteria	2 Points
Building complies with the requirements of QCVN 10:2014/BXD	2

Overview

Providing access for people with disabilities is a significant task to ensure social justice. According to statistics, 15.3% of Vietnam's population live with a disability (National Coordinating Council on Disabilities, 2013). This is not a diminutive figure, thus ensuring basic comfort for people with disabilities to be able to access buildings safely and conveniently is important. Sharing the same point of view, the Ministry of Construction promulgated Regulation QCVN 10:2014/BXD National Technical Regulation on Construction for Disabled Access to Buildings and Facilities. This regulation only pertains to certain types of buildings such as: health care buildings, administrative bodies, educational buildings, gymnastic and sport buildings, cultural works, public service buildings, collective houses, as well as open public areas, roads and sidewalks. It does not apply to office buildings, factories, private enterprises or commercial buildings but LOTUS encourages all existing buildings to provide an identical level of performance with regard to access for people with disabilities.

Approach & Implementation

The project must comply with the requirements of the regulation QCVN 10:2014/BXD. In particular, requirements on building entrances, access to all the spaces of the building, doors, elevators, and parking spots should be met.

Submissions

Provisional Certification Stage
• Report indicating existing and/or proposed measures taken to ensure compliance with QCVN 10:2014/BXD - OR- Completed LOTUS Template - Access for People with Disabilities
• Floor and site plans indicating location of the existing and/or proposed measures taken
• Evidence such as photographs showing the existing measures taken (if any)

Full Certification Stage
If the credit had not been awarded at Provisional Certification or if there is any change: • Report indicating measures taken to ensure compliance with QCVN 10:2014/BXD -OR- Completed LOTUS Template - Access for People with Disabilities • Floor and site plans indicating location of the measures taken • Evidence such as photographs showing the measures taken

CY-PR-1 and CY-2 Occupant Behavior

Intent

To achieve optimal building performance by improving the interaction between building occupants and building systems.

Requirements

Criteria	2 Points
Provide a building user's guide to building occupants	Community Prerequisite 1
Strategy A: Ongoing environmental-awareness campaign	
Conduct an ongoing environmental-awareness campaign	1
Strategy B: Occupant training	
Conduct regular occupant training	1

Overview

Many buildings although designed with numerous energy or water efficient features, rarely perform as well as they were intended to. Most of the time, the main factor affecting the building's performance is the behavior of building occupants who do not always make best use of the building's sustainable design features. Simple changes in occupant behavior can lead to significant energy and water savings, but such changes will only occur if occupants are aware of their influence on the performance of the building. Giving all occupants access to information on how to operate the building efficiently through a building user's guide is a good first step and should be implemented in all green buildings. But only an environmental-awareness campaign and training program can further enhance the knowledge and involvement of occupants to encourage them to contribute to improvements in the performance of the building.

Approach & Implementation

Community Prerequisite 1

Produce a building user's guide. It should be a non-technical, easy to understand guide with information for users about:

- Design specifications of the building and how these affect its operation
- The building's standard of performance

- Energy efficiency features
- Water-saving features (including irrigation)
- Correct operation of HVAC and lighting systems
- Access, security and safety systems
- Evacuation/disaster response plan
- Methods for reporting problems
- Information on parking, public transportation, car sharing schemes etc.
- Waste recycling procedures

Strategy A: Ongoing environmental-awareness campaign

The ongoing environmental-awareness campaign needs to involve all building occupants and encourage them to contribute to the performance of the building. Posters or screens displayed in the most frequented areas of the building can be effective when, as a minimum, the following information is provided:

- Energy and water use of the building
- Energy consumption breakdown
- Quantity of waste generated
- The impacts of the building on the environment
- Green features of the building and how they should be operated
- Solutions linked to occupant behavior that can reduce energy consumption (e.g. switch off the lights and computer, avoid standby mode, etc.), improve waste management, etc.

Other solutions like real time data displayed on screens, giving specific targets and outlining building performance should be considered.

This environmental-awareness campaign should be ongoing with the information displayed regularly updated. Also, it is essential to check the evolution of the performance to ensure the continuity of efforts made by occupants.

Strategy B: Occupant training

Another means to improve occupant behavior is to conduct regular occupant training in order to further educate the occupants on the green features of the building, the sustainability goals, the impact of their behavior on the performance of the building and ways to improve their behavior. Such training should be based on the building user's manual where all relevant information for the occupants is included.

Submissions

Provisional Certification Stage
Community Prerequisite 1
• Copy of the Building user's guide -OR- • Signed letter of intent from the building owner or building manager guaranteeing to provide complete building user's guide to the users at the time of the Performance Period
Strategy A: Ongoing environmental-awareness campaign
• Implementation plan for the ongoing environmental awareness campaign describing the strategies to improve occupant behavior and plans showing the location of existing and/or proposed billboards, posters and display screens
If the ongoing environmental-awareness campaign is already conducted: • Evidence of environmental-awareness campaign such as photographs of posters or screenshots of displays that have been shown in the building • Plans showing the location of all billboards, posters and display screens
Strategy B: Occupant training
• Occupant training course materials
If the occupant training has already been conducted: • Training session attendance sheets

Full Certification Stage
Community Prerequisite 1
If the Building user's guide had not been provided at Provisional Certification or if there is any change: • Copy of the Building user's guide
Strategy A: Ongoing environmental-awareness campaign
If the strategy had not been awarded at Provisional Certification or if there is any change: • Implementation plan for the ongoing environmental-awareness campaign describing the strategies to improve occupant behavior and plans showing the location of existing and/or proposed billboards, posters and display screens • Evidence of environmental-awareness campaign such as photographs of posters or screenshots of displays that have been shown in the building • Plans showing the location of all billboards, posters and display screens
Strategy B: Occupant training
• Training session attendance sheets If the strategy had not been awarded at Provisional Certification or if there is any change: • Occupant training course materials

CY-3 Public Awareness Campaign

Intent

To promote general public awareness on sustainability and green buildings.

Requirements

Criteria	2 Points
Perform at least two actions to promote general public awareness	1
Perform at least four actions to promote general public awareness	2

Overview

The creation of a sustainable future strongly depends on the knowledge and participation of the people who need to have an understanding of the consequences of individual behavior. Though the number of green building projects in Vietnam keeps increasing over the years, green buildings still receive little public attention and a lot more work is necessary to enhance public awareness towards sustainability.

Approach & Implementation

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

- Hold a public open house including a guided tour that highlights the green building features of the building. The public open house should be advertised, be opened to all people and last at least 12 hours (in one or few days).
- Organize a green building conference/seminar including topics such as:
    - Strategies implemented by the project to achieve LOTUS BIO
    - The importance of proper operations for existing buildings
- Create a website with at least three pages that provide detailed information about:
    - the green features of the project,
    - the benefits of green buildings, and
    - the importance of individual behavior in achieving sustainable outcomes.
- Write and release a press release on the project and/or organize a press conference for the LOTUS BIO Certification ceremony
- Perform an environmental-awareness campaign as described in Credit CY-2 - Strategy A.
- Other actions may be accepted (subject to VGBC approval)

Submissions

Provisional Certification Stage
• Report indicating the actions that will be performed to enhance general public awareness • Signed letter of intent from the building owner or building manager that the actions described in the report will be performed

Full Certification Stage
If the strategy had not been awarded at Provisional Certification or if there is any change: • Report indicating the actions that will be performed to enhance general public awareness • Site plan/sketch indicating public space and highlighting the features implemented to improve the quality of the public spaces. For each action that has not been performed yet: • Signed letter of intent from the building owner or building manager that the action will be performed as described in the report

Management

Building management is vitally important and is highlighted by the fact that operations costs represent approximately 80% of a commercial building's total cost (encompassing design, construction and operation). The credits and requirements within the LOTUS BIO Management category ensure effective and efficient building operation. To attain the standards expected of a LOTUS BIO certified building, high levels of communication and coordination between all parties involved including; building designers, commissioners, contractors, managers and occupants is vital.

Good management will ensure that the building is operated the way that designers intended. Of particular importance is that building tenants are educated in the correct operation of technologies within the building. In this way, effective management can influence user behavior, which is a major factor in energy and water consumption.

Commissioning is a critical operation to ensure building performance meets the design specification. Retro-commissioning and recommissioning can be conducted on equipment in buildings in operation to ensure that their performance is optimized and they are meeting performance requirements.

A key part of effective building management is the implementation of a preventative maintenance plan. By conducting preventative maintenance periodically, equipment is able to operate more efficiently and needs to be replaced less frequently resulting in significant cost savings.

The behavior of building users is also vitally important in ensuring that a building is operated to its optimal capacity. This includes things as simple as turning off electrical equipment at the end of the day, minimizing water use through behavior such as taking shorter showers, notifying building staff of any maintenance requirements and operating equipment correctly. This behavior can be improved through training and an environmental awareness campaign targeted at building users.

Management		10 Points
Item	Criteria	Points
Man-PR-1	Facility Audit	PR
	Perform a facility audit of the building	Management Prerequisite 1
Man-1	LOTUS Certified Building	1 point
	The building has previously achieved LOTUS NR or LOTUS MFR Full Certification	1
Man-2	LOTUS AP	1 point
	Involve a LOTUS AP as a member of the project team	1
Man-3	Commissioning	4 points
	Strategy A: Commissioning	
	1 point for providing commissioning for each of the following systems: – Water-side equipment of central chiller plant – Air-side equipment of central chiller plant and/or direct air-conditioning systems – Electrical services systems – Plumbing and drainage systems	4
	Strategy B: On-going commissioning	
	Prepare and implement an on-going commissioning plan	1
Man-4	Maintenance	2 points
	Provide a building operation and maintenance manual to the building management team	Management Prerequisite 2
	Define and implement a preventative maintenance plan of the building's major services and equipment	2
Man-5	Green Management	2 points
	Strategy A: Green management system	
	Develop and implement a green management system for the building	1
	Develop and implement a green management system for the building - AND - The building is at least 50% owner-occupied	2
	Strategy B: Green leases	
	Sign green leases with 50% of the tenants	1

Man-PR-1 Facility Audit

Intent

To make sure projects have extensive knowledge of the systems and components installed in the building.

Requirements

Criteria	PR
Perform a facility audit of the building	Management Prerequisite 1

Overview

Facility audits are comprehensive reviews of a facility's assets. The aim of facility audits is to provide a snapshot of how the various systems and components of the building are operating. They are important for managers and staff to know what is in the building, its condition, its maintenance needs, its location and other information.

In LOTUS BIO, facility audits with inventories of building's systems, equipment, materials, etc. can be particularly helpful to document compliance with credits and prerequisites.

Approach & Implementation

The facility audit of the building can be performed together with the preliminary energy audit, the vegetation survey of the site and the solid waste stream audit required in other prerequisites.

The auditors in charge of doing the audit can be building staffs or outside consultants but they must possess a thorough understanding of facility maintenance and operations and must be given enough time to perform the task properly. Auditors must sign the facility audit report to evidence that the contents of the report are accurate to the best of their knowledge.

At a minimum, the scope of the facility audit should include inventories of all the lighting fixtures, HVAC equipment (from air-conditioning units to pumps and fans), water fixtures, energy and water meters and building controls.

Inventory reports should be generated and should show for each type of equipment the following information:

- type of equipment,
- brand name and model number

- location,
- quantity
- age (if possible) and estimated remaining useful life
- condition and if it is working as it should
- and, any relevant information, such as:
    - electric power input for electrical appliances,
    - flow/flush rates for water fixtures,
    - rated cooling capacity, COP, refrigerant type and charge for air-conditioning systems,
    - air flow rates for fans, etc.

Inventory reports should be included in a facility audit report that should be reviewed by facilities managers for accuracy and quality.

Projects interested to have a more comprehensive audit and/or interested to submit results of the audit for other LOTUS credits are encouraged to broaden the scope of work and include:

- roofing materials (for heat island effect)
- hardscaping materials (for stormwater runoff and heat island effect)
- access for people with disabilities
- electrical systems
- building envelope
- room inventory
- structure
- plumbing

Submissions

Provisional Certification Stage
• Copy of the facility audit report -OR- • Signed letter of intent from the building owner or building manager guaranteeing to provide facility audit report at the time of the Performance Period

Full Certification Stage
If the credit had not been awarded at Provisional Certification or if there is any change: • Copy of the facility audit report

Man-1 LOTUS Certified Building

Intent

To give recognition to a building that has previously achieved LOTUS certification.

Requirements

Criteria	1 Point
The building has previously achieved LOTUS NR or LOTUS MFR Full Certification	1

Overview

LOTUS NR and MFR certification recognizes exceptional performance at the design and construction phase. This credit rewards buildings that have previously achieved LOTUS NR or MFR Full certification.

Approach & Implementation

LOTUS NR and MFR certification includes two stages. First, a Provisional Certification submission is made which is submitted at the completion of the design stage, after which if prerequisites are met and a sufficient number of points are achieved Provisional Certification is awarded. At the completion of the construction stage, a Full Certification submission is made and if prerequisites are met and a sufficient number of points are achieved Full Certification is awarded. Only buildings that achieve Full Certification are eligible for this credit.

Submissions

Provisional Certification Stage
• Copy of the original LOTUS Full Certification certificate

Full Certification Stage
If the credit had not been awarded at Provisional Certification or if there is any change:
• Copy of the original LOTUS Full Certification certificate

Man-2 LOTUS AP

Intent

To encourage the involvement of a qualified individual to assist with the certification process

Requirements

Criteria	1 Point
Involve a LOTUS AP as a member of the project team	1

Overview

Environmental impacts resulting from the operation of a building can be understood and significantly reduced through effective operation. Through the appointment of a qualified individual, it can be assured that the objectives of the certification process are met in a uniform and coherent manner.

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 during the building's operation. This individual will be known as a 'green consultant' and should be a LOTUS Accredited Professional (LOTUS AP). The primary objective of the LOTUS AP is to ensure that reliable analysis tools are used in the certification process and integrated solutions are sought for operational improvements.

Submissions

Provisional Certification Stage
• Copy of the LOTUS AP certificate • Evidence showing the involvement of a LOTUS AP such as minutes of meeting, photographs, copy of contract, etc.

Full Certification Stage
If the credit had not been awarded at Provisional Certification or if there is any change: • Copy of the LOTUS AP certificate • Evidence showing the involvement of a LOTUS AP such as minutes of meeting, photographs, copy of contract, etc.

Man-3 Commissioning

Intent

To ensure all of the building's equipment is correctly installed, calibrated, optimized and is performing according to the design intent

Requirements

Criteria	4 Points
Strategy A: Commissioning	
1 point for providing commissioning for each of the following systems: – Water-side equipment of central chiller plant – Air-side equipment of central chiller plant and/or direct air-conditioning systems – Electrical services systems – Plumbing and drainage systems	4
Strategy B: Ongoing Commissioning	
Prepare and implement an ongoing commissioning plan	1

Overview

In practice, many buildings do not operate as the building owner required and design specifications intended. This is largely due to discrepancies during construction or poor commissioning practice upon transfer to the building user, where the risk of information and knowledge loss is high.

Existing building commissioning aims to bring buildings up to the design intentions of their current usage by:

- Improving building performance through energy savings and reduced operational costs
- Identifying and resolving building system operation, control and maintenance problems
- Reducing or eliminating occupant complaints and increase tenant satisfaction
- Improving indoor environmental comfort

Commissioning (Cx) is a planned and systematic form of quality control that aims to verify and document that the performance of the building systems meet the owner's operational needs.

Retro-commissioning is the application of the commissioning process to existing buildings that have never been commissioned and seeks restore them to optimal performance.

Recommissioning is a type of commissioning specific for buildings that have already been commissioned and undergo another commissioning process.

Ongoing commissioning is continual recommissioning focusing on the persistence of completed improvements.

If a building in operation has not been commissioned previously, retro-commissioning is recommended. Depending on the age of the building, retro-commissioning can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building's life. Generally, retro-commissioning improves a building's operations and maintenance (O&M) procedures to enhance overall building performance.

If there is a change in building use or ownership, the onset of operational problems, or some other need, recommissioning is recommended. Ideally, a plan for re-commissioning is established as part of a new building's original commissioning process or an existing building's retro-commissioning process.

Approach & Implementation

Strategy A: Commissioning

Provide retro-commissioning, recommissioning or commissioning (where new systems are installed) of the following types of systems:

- All water-side equipment of central chiller plant (cooling towers, chillers, pumps, etc.)
- All air-side equipment of central chiller plant (AHUs, FCUs, VAVs, ductwork, etc.) and/or all direct air-conditioning systems
- Electrical services systems (including water heaters, lighting, equipment with a rated power greater than 20 kW, elevators, escalators, alarms and security devices, and monitoring systems)
- Plumbing and drainage systems (including pumps and water treatment systems)

For best results, it is advised for the existing building commissioning to follow the steps described in the document Best Practices in Commissioning Existing Buildings published by the Building Commissioning Association:

- Scope of commissioning activity (purpose of existing building commissioning, commissioning authority and systems included in the commissioning process)
- Planning Phase (Development of Existing Building Commissioning goals, facility requirements, and a commissioning plan)
- Investigation Phase (Field inspections, data gathering, testing and analysis to accurately assess system performance and identify improvement opportunities.)
- Implementation Phase (The desired facility improvements are completed and the results and performance are verified.)

- Turnover Phase: The systematic transition from a commissioning activity and the commissioning team to standard operating practice and the operations and maintenance team.

All commissioning activities should be performed based on current facility requirements (CFR) and following a commissioning plan (Cx plan) that should meet requirements below.

As defined in ASHRAE Guideline 1.4P, current facility requirements is a written document that details the current functional requirements of an existing facility and the expectations of how it should be used and operated. This includes goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information to meet the requirements of occupants, users, and owners of the facility.

The Cx plan should cover all of the systems that are being commissioned, recommissioned and/or retro-commissioned and should include at least the following:

- Goals of the commissioning
- Description of the Cx processes including:
  - List of equipment/systems to be tested
  - Number and duration of tests to be conducted
  - Parameters to be tested for all equipment/systems
  - Expected equipment/system performance
- Description of the Cx team, including roles and responsibilities of each member
- Communication matrix for Cx processes
- List of Cx milestones (overall building commissioning project schedule)

Ideally, a commissioning team, which can be composed of owner's representatives, building managers, staff is appointed to perform the commissioning and is led by a commissioning agent (CxA). Preferably, the CxA is an independent consultant or an employee of a firm offering commissioning/project management services, but can be a member of building management.

Strategy B: Ongoing commissioning

Ongoing commissioning should involve regularly scheduled sessions with the building occupants and with the operation and maintenance staff and should include monitoring and analysis of data provided by metering equipment to verify building performance and the satisfaction of the facilities management and staff.

An ongoing commissioning plan covering all the systems that have been commissioned, recommissioned or retro-commissioned in Strategy A should be prepared and implemented.

The ongoing commissioning plan should include:

- Summary of the existing building commissioning measures implemented
- Operation & Maintenance activities to ensure optimized systems operation persists over time.
- Strategies to track and verify optimized systems operation persists over time (monitoring, energy use analysis, water use analysis, occupant survey, etc.)
- Action plan for identifying and correcting operational errors and deficiencies
- Planning for reports on the performance of building systems

Submissions

Provisional Certification Stage
Strategy A: Commissioning
• Copy of the Commissioning plan • Current facility requirements (CFR) • Statement of qualifications and experience of the commissioning team
Strategy B: Ongoing commissioning
• Copy of the ongoing commissioning plan

Full Certification Stage
Strategy A: Commissioning
• Final commissioning report including: - List of systems commissioned - Evaluation of results obtained during performance testing - Recorded operation of the building's systems - Master list of improvements implemented including a description of the improvements - New and/or corrected sequences of operation of the commissioned systems
If the strategy had not been awarded at Provisional Certification or if there is any change: • Copy of the Commissioning plan • Current facility requirements (CFR) • Statement of qualifications and experience of the commissioning team
Strategy B: Ongoing commissioning
• Records of all activities and tasks implemented as part of the ongoing commissioning plan
If the strategy had not been awarded at Provisional Certification or if there is any change: • Copy of the ongoing commissioning plan

Man-PR-2 and Man-4 Maintenance

Intent

To encourage the definition and implementation of a preventative maintenance plan by qualified personnel to ensure that the building's systems and equipment achieve optimum performance and life expectancy

Requirements

Criteria	2 Points
Provide a building operation and maintenance manual to the building management team	Management Prerequisite 2
Define and implement a preventative maintenance plan of the building's major services and equipment	2

Overview

The primary goal of maintenance is to prevent failure before it occurs and thus mitigate damage and inconvenience to the building and its occupants. It includes preserving and restoring equipment reliability to maximize the life of equipment and services. Moreover, the hot and humid weather of Vietnam provides excellent conditions for mold and other biological contaminants (e.g. pollen, bacteria, viruses, etc.) to exist. These contaminants can grow on damp materials and surfaces due to leakage or high humidity or breed in stagnant water that has accumulated in AC systems, drainpipes and ducts or where water has collected on ceiling tiles, insulation, carpets and upholstery. Therefore, periodical inspection of the whole building and regular maintenance of building service systems are also essential in ensuring a healthy indoor environment for building occupants.

Preventive maintenance activities include systematic inspection, partial or complete overhauls at specified periods, oil changes, lubrication, cleaning, etc. In addition, maintenance workers should keep record of equipment deterioration so parts can be repaired or replaced before they cause system failure. This will require a dedicated in-house team or qualified maintenance contractors.

Approach & Implementation

Management Prerequisite 2

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

The building operation and maintenance manual should include:

- A description of the operation principles of the main systems (HVAC, electrical, etc.)
- As-built drawings (when available)
- 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 (if any)

Management Credit 4

Produce and implement a preventative maintenance plan for the building's major services and equipment. The maintenance should be performed by qualified in-house staff and/or outsourced contractors.

The preventative maintenance plan shall include, as a minimum, the following information:

- List of all equipment requiring maintenance and their respective technical documentation and installation drawings (when available)
- Timeline of maintenance for all listed equipment
- Schedule indicating when each maintenance operation must be conducted
- Corrective actions plan

When the preventative maintenance plan is implemented, log books for all pieces of equipment maintained must be produced and kept to have a record of maintenance operations.

Submissions

Provisional Certification Stage
Management Prerequisite 2
If the Building operation and maintenance manual has already been produced: • Evidence showing the building operation and maintenance manual which can be either: - photographs or scans showing front cover, table of contents, and at least 3 key sheets of the building operation and maintenance manual, - or, if available, full electronic version of the manual
If the Building operation and maintenance manual is not produced yet: • Signed letter of intent from the building owner or building manager that a building operation and maintenance manual will be produced for Full Certification
Management Credit 4
• Copy of the Preventative maintenance plan

Full Certification Stage
Management Prerequisite 2
If the prerequisite had not been awarded at Provisional Certification or if there is any change: • Evidence showing the building operation and maintenance manual which can be either: - photographs or scans showing front cover, table of contents, and at least 3 key sheets of the building operation and maintenance manual, - or, if available, full electronic version of the manual
Management Credit 4
• Log books/records of corrective actions and maintenance operations performed during the Performance Period
If the credit had not been awarded at Provisional Certification or if there is any change: • Copy of the Preventative maintenance plan

Man-5 Green Management

Intent

To encourage the development and implementation of a green management system and green leases.

Requirements

Criteria	2 Points
Strategy A: Green management system	
Develop and implement a green management system for the building	1
Develop and implement a green management system for the building - AND - The building is at least 50% owner-occupied	2
Strategy B: Green leases	
Sign green leases with 50% of the tenants	1

Overview

Strategy A: Green management system

A green management system is a set of procedures and associated documentation that enable an organization to reduce its environmental impacts and improve operating efficiency. The benefits of adhering to a green management system include:

- Provides a framework for all environmental initiatives
- Enhances corporate reputation and commitment to environmental responsibility
- Increases attractiveness to investors and potential tenants
- Differentiates building owners, managers and tenants from competitors

Strategy B: Green leases

A green lease is a lease between the building owner and tenant which aims to ensure that the ongoing use and operation of the building minimizes environmental impacts. A green lease can include information about:

- Environmental measures to be taken under the lease
- How the parties will cooperate to achieve these measures
- Who will monitor compliance with these measures
- What happens if the targets are not met

Green leases enable building owners and tenants to benefit from the environmental features of the building. Benefits for tenants include:

- Lower operation costs (lower electricity and water bills, reduced waste management costs, etc.)
- Better work environment for employees
- Improved tenant's reputation

Benefits for building owners include:

- Good relationships with tenants (long term leases, less disputes, etc.)
- Financial benefits (improved rents, reduced maintenance costs, increased life-span of equipment, etc.)
- Better management of the building
- Improved reputation

Approach & Implementation

Strategy A: Green management system

Green management systems can focus on areas such as: waste reduction, sustainable purchasing, energy savings, water savings, transportation, health and comfort as well as occupant safety.

Building owners should select at least 3 of these specific areas where they will aim to reduce their environmental impacts. For each selected area, the green management system, outlined in a green management system manual, should encompass the following:

- Policy statement: A statement of the organization's commitment to the environment
- Identification of significant environmental impacts: Environmental attributes of products, activities and services and their effects on the environment
- Objectives and targets: Measurable environmental goals for the organization
- Action plan: Practical steps to meet objectives and targets
- Training: Instruction to ensure employees are aware and capable of fulfilling their environmental responsibilities
- Management review

Through the last step, management review, building owners should check periodically that the action plans are implemented and that they are effective in meeting targets. In case objectives are not met, either the action plans should be modified or the objectives should be adjusted.

Strategy B: Green leases

Green leases must be signed by at least 50% of the tenants (based on GFA) and should include the following elements:

- Targets on environmental performance standards (e.g. LOTUS BIO, Energy Star, etc.)
- Metering and data reporting requirements (essential for the management of the building and to overcome “split incentives”, when tenants pay the energy bills, but owners pay for upgrades)
- Environmental management plan (tenant to become actor of the green management system implemented by the building owners)
- Building management committee (formed from both tenant and landlord representatives, they manage the building’s performance and make sure targets and the green management system are respected)
- Remedial action/dispute resolution regime (in case of compliance failure with the green requirements)

Submissions

Provisional Certification Stage
Strategy A: Green management system
• Copy of the Green management system manual If the building is more than 50% owner-occupied: • Evidence showing that the building is more than 50% owner-occupied
Strategy B: Green leases
• List of tenants which have signed or will sign a Green lease and their respective leased GFA • Provisional calculation of the percentage of the GFA leased to tenants which signed or will sign a Green lease • Extract of the leases with tenants showing green requirements and the means to ensure their implementation

Full Certification Stage
Strategy A: Green management system
• Reports (including minutes of meetings) of the management reviews ensuring the proper implementation of the green management system If the objectives have not been met: • Copy of the Green management system manual with updated action plans and/or objectives

If the strategy had not been awarded at Provisional Certification or if there is any change: • Copy of the Green management system manual If the building is more than 50% owner-occupied : • Evidence showing that the building is more than 50% owner-occupied
Strategy B: Green leases
If the strategy had not been awarded at Provisional Certification or if there is any change: • Final list of tenants which have signed a Green lease and their respective leased GFA • Final calculation of the percentage of the GFA leased to tenants which signed a Green lease • Extract of the leases with tenants showing green requirements and the means to ensure their implementation

Innovation

The purpose of this category is to reward innovative strategies and initiatives, as well as exceptional performance in other LOTUS BIO credits.

There are up to 8 points available over the 2 credits, but these points are not specifically assigned to one credit or the other.

Innovation		8 bonus Points
Item	Criteria	Points
Inn-1	Exceptional Performance Enhancement	8
	Exceed significantly the credit requirements of LOTUS credits	
Inn-2	Innovative techniques / initiatives	
	Create a credit template for a technique or strategy outside the scope of LOTUS and adhere to the requirements	

Inn-1 Exceptional Performance Enhancement

Intent

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

Requirements

Criteria	8 Points
Exceed significantly the credit requirements of LOTUS credits	1-8

Overview

The weightings and benchmarks in LOTUS have been set to reflect what is perceived as possible in the current market. However, if any innovative idea allows the design team to exceed 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 points in this 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 8 Exceptional Performance Enhancement Innovation credits may be targeted (1 point each) out of a maximum of 8 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 W-3 Water Recycling/Reuse and Rainwater Harvesting

- Requirement (Level 1) – Recycling/reused water or rainwater harvesting contributes 5% of the building's total water consumption
- Requirement (Level 2) – Recycling/reused water or rainwater harvesting contributes 10% of the building's total water consumption

- Surpass by the next increment – Recycled/reused water contributes 15% or more of the building's total water consumption, therefore building is eligible for one Innovation point

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

Example: Credit H-4 Fresh Air Supply

- Requirement - Provide sufficient fresh air supply to all occupied spaces in accordance with national or international standard
- 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 WP-3 Refrigerants (2 points available)

- Strategy A – The average Refrigerant Atmospheric Impact of all the air-conditioning systems installed in the building is below 11 and 2 points can be achieved.
- Strategy B – The building also implements effective measures to reduce annual leakage of refrigerants and 1 point can be achieved.
- This building can be awarded 2 points in Credit WP-3 Refrigerants and 1 point in credit Inn-1.

Calculation

The calculation of each exceeded benchmark should be done in the exact same method as specified in the given credit.

Submissions

Provisional Certification Stage
For each existing and/or proposed Exceptional Performance Enhancement of a credit: • Submissions as per initial credit requirements showing that the existing and/or proposed performance exceeds significantly the credit requirements • Report indicating what measures were/will be taken to surpass the initial credit requirements

Full Certification Stage

For each Exceptional Performance Enhancement of a credit:

If the Exceptional Performance Enhancement of a credit had not been awarded at Provisional Certification or if there is any change:

- Submissions as per initial credit requirements showing that the performance exceeds significantly the credit requirements
- Report indicating what measures were be taken to surpass the initial credit requirements

Inn-2 Innovative Techniques/Initiatives

Intent

To promote techniques and/or initiatives that are outside of the scope of the current version of LOTUS BIO.

Requirements

Criteria	8 Points
Create a credit template for a technique or strategy outside the scope of LOTUS and adhere to the requirements	1-8

Overview

LOTUS BIO covers a broad range of credits for measuring the environmental performance of a building in operation. 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 BIO credits. For innovative strategies, the applicant must justify measures taken and the achieved performance in order to be awarded points.

Approach & Implementation

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

Provisional Certification Stage
For each existing and/or proposed Innovative Technique/Initiative: • Report outlining the existing and/or proposed innovative strategy and the expected/achieved performance • Supporting evidence verifying the expected/achieved performance such as manufacturer's data, calculations, etc.

Full Certification Stage
For each Innovative Technique/Initiative: If the Innovative Technique/Initiative had not been awarded at Provisional Certification or if there is any change: • Report outlining the innovative strategy and the performance achieved • Supporting evidence verifying the performance achieved such as manufacturer's data, calculations, etc.

Glossary

Specific LOTUS Terms

Additions - Construction work on an existing building resulting in an increased floor area.

Alterations - Improvement work not related to the primary structural components, exterior shell or roof of the building. Specifically renovation work that may result in changes to the building envelope or floor plan, such as removing/erecting interior walls, removing/installing new windows. This does not include minor changes such as the installation of new water fixtures, replacement of electrical equipment, replacement of windows etc.

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. Normally a LOTUS AP, the Applicant Representative will directly liaise with the Assessment Organization throughout all stages of LOTUS Certification.

Application Form - The Application Form is the first step in registering a project. Once completed, the Assessment Organization will check to see that all relevant information is present and correct, register the project and request the payment of a Registration/Certification 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 specific requirements 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 Accredited Professional examination. Upon Accreditation, the LOTUS AP is then deemed qualified to work either as an internal or external consultant within a LOTUS project.

LOTUS Certified Level - The LOTUS Certified Level (or LOTUS Certified rating) is the result obtained after Submission has been assessed at Certification stage by the Assessment Organization Representative. Projects can achieve 4 different 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 LOTUS Certification. It provides technical guidance for all LOTUS Credits in order for users to understand intents, requirements, approaches and implementations, calculations and submissions.

Operational Data - Operational data is real data that is collected during the operation of the building. It includes energy and water consumption data, renewable energy generation and recycled water volume among others.

Prerequisite *or* LOTUS Prerequisite - Indicates the minimum requirements in a LOTUS rating system. There are stand-alone prerequisites as well as credit-involved prerequisites, but regardless of types, buildings that apply for LOTUS certification are obliged to fulfil all prerequisites in every category. Each prerequisite is organized in a standard format, similar to credit format. A list of all prerequisites is provided at the beginning of the LOTUS Technical Manual.

Project Assessment Committee (PAC) – The committee led by the Assessment Organization's project manager that consists of experts drawn from within the Assessment Organization and externally from the private sector, academia, institutes and public departments that are responsible for the independent assessments of projects submitted for LOTUS Certification.

Project Certification Team - The project certification team are the core team of experts involved in the certification of a building in operation that must integrate the principles of sustainability into the certification process in order to gain points for certification.

Project Identification Number (PIN) - The Project Identification Number (PIN) is a unique 8 digit reference number issued at the Registration Confirmation. This reference number must be protected and is for the use of the Applicant Representative when providing submissions to the Assessment Organization.

Project Submission Folder - Pre-arranged folder provided to the Applicant Representative once the project is registered. The Project Submission Folder is the folder that should be completed and submitted to the Assessment Organization's Representative for assessment.

Registration Fee - The Registration Fee is a one off charge for the administration process of registration to a LOTUS Rating System.

Submission - The Submission is the process where all documents are provided to the Assessment Organization for assessment.

Submissions Section - The Submissions Section provides the list of all documents that projects need to submit and that will be assessed for LOTUS Certification.

LOTUS Submission Terms

Calculations - The mathematical interpretation and computation of numbers and quantities. Calculations are required for many credits to prove that a building meets LOTUS requirements.

Contract - A binding legal agreement of an exchange of promises between two or more parties.

Commissioning Records - Documents that record the activities and results of the Commissioning Process, including inspection reports, testing reports, etc.

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 façade 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 showing walls, window and door openings and other features at that level.

Inventory / Schedule - A complete list of specific items or contents within a building.

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

Log book – A written or electronic document keeping records of activities and occurrences.

Purchase order - A buyer-generated document that authorizes a purchase transaction

Record - Document that memorializes and provides objective evidence of activities performed, events occurred, results achieved, or statements made.

Report / Description - A written document that describes how a structure or system of a building satisfies the requirements of a certain LOTUS credit.

Schematics - A diagram that represents the elements of a system using symbols.

Site Plan - An accurate drawing or picture of a planned or completed development site, which has a scale of size for reference (to determine relative sizes and distances). Site plans often show, but are not limited to: boundaries, building locations, landscaping, topography, vegetation, drainage, floodplains, zoning, routes/streets, sidewalks and other site features.

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, such as streets and footpaths, where the upper soil profile is no longer exposed

Non-Building area - The site area minus the building footprint. Includes vegetated area as well as hardscaping, access roads, car parking and non-building facilities.

Site Area - The total area of the building site

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

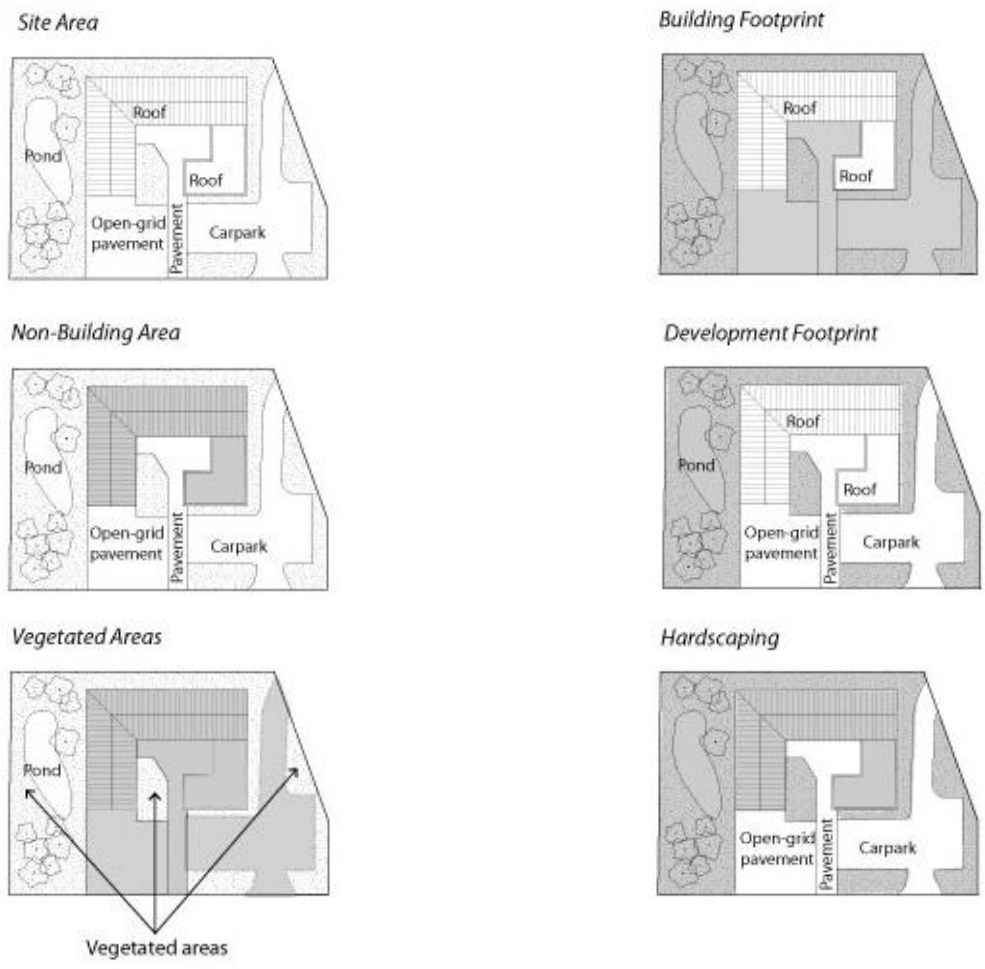


Figure G.1: Site area illustrations

Technical Terms

ASHRAE - The American Society of Heating, Refrigerating and Air Conditioning Engineers is an international technical society for all individuals and organizations interested in heating, ventilation, air-conditioning, and refrigeration. The society publications include handbooks, journals as well as a series of HVAC related standards and guidelines. These standards are often referenced in green building assessment reference guides/technical manuals and are considered useful guide for consulting engineers, mechanical contractors, architects and government agencies.

Baseline - A baseline model of a building would inherit all relevant characteristics of that building (e.g. GFA, number of occupants, number of operational days, etc.). However, the materials and equipment used in the baseline model are conventional ones that are defined in LOTUS credits.

Benchmark - A set standard from which improvement on efficiency is measured, allowing comparison of performance between buildings of the same type. For example, in Credit E-2, the energy use intensity benchmark for an office is 150kWh/m^2/year.

Biodiversity - Or biological diversity is a term that includes the variety of all life forms (plants, animals, microorganisms, their genes etc.) together with the ecosystems they are a part of. Biodiversity changes constantly due to processes such as evolution, extinction, habitat degradation, etc.

Black Water - Wastewater which contains human/animal wastes and requires treatment before reuse.

Building Envelope - The elements of a building that encloses conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from unconditioned spaces.

Building Management System (BMS) - A computer-based control system installed in buildings that controls and monitors equipment installed in buildings such as power systems (HVAC, lighting etc.), fire systems and security systems.

Climate Change - In modern terms, climate change refers to the changes of the Earth's climate mainly due to the uncharacteristic increase of greenhouse gas concentrations in the atmosphere, resulting from human activities.

Coefficient of Performance (COP) - The ratio of the rate of heat removal to the rate of energy input in consistent units, for a complete cooling system or factory assembled equipment, as tested under a nationally recognized standard or designated operating conditions. COP for air-cooled electrically driven air conditioners includes compressor, evaporator and condenser. COP for water chilling packages does not include chilled water or condenser water pumps or cooling tower fans.

Commissioning - A planned and systematic form of quality control to ensure all building services systems are installed, tested, understood and will be able to be operated and maintained to the operational requirements of their respective design brief. The process includes a post occupancy analysis, ensuring that once the building is occupied, fine tuning is undertaken under the normal operating conditions of the building.

Common Areas - Those areas within a building or tenancy not leased to a particular tenant, but which are available for the use of all tenants and usually, members of the public.

Computational Fluid Dynamics (CFD) Analysis - A modelling technique that can be used to calculate fluid properties such as temperature, heat flow, wind velocity and air flow within a building.

Consumables - Goods and materials of low cost per unit which are regularly used and replaced for day to day activities. This includes paper, ink and toner cartridges, binders, batteries and desk accessories.

Daylight Factor - The daylight factor is the ratio of the interior illuminance to the global horizontal illuminance under CIE standard overcast sky conditions.

Proposed Model – The "proposed model" refers to the case of the proposed project. It carries with it the assumption that it will have a calculable improvement in green performance as compared to what is deemed standard practice for a building of equivalent size, location and use - the baseline model.

Domestic Water - Treated water supplied to the building from municipal water supply systems for domestic uses and meets the quality requirement as stated in TCVN 5502:2003 - Domestic Supply Water - Quality Requirements. LOTUS considers both municipal water and groundwater as domestic water.

Energy Use Intensity – Measured in kWh/m^2/year, the energy use intensity of a building is the total energy consumption of a building during one year (kWh) divided by the NFA of the building (m^2).

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

Gray Water - Waste water recovered from households or buildings and has not come to contact with food or human/animal waste.

Green Lease Agreement - An agreement between the landlord and tenant of a building. It expands the scope of a standard lease to include responsibilities of both the landlord and tenant regarding environmental sustainability goals. It would usually include such things as performance targets, binding rules for tenants, obligations of the landlord, fit-out requirements and dispute resolution mechanisms.

Green Management System - A program that can be used to identify, manage and reduce an organization's impact on the environment and generate reports on environmental performance progress. A common framework used to do this is ISO14001.

Greenhouse Gases (GHG) - Gases in the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. (As defined in the IPCC AR4 SYR Appendix Glossary)

Global Warming Potential (GWP_{100}) - A value assigned to a gas based on scientific measurements showing how much that gas 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 measured over a 100-year period and the lower the GWP of a gas is, the better or less harmful the refrigerant is for the environment. GWP is particularly useful when selecting refrigerant gases.

Green roof - Green roof refers to a building roof that is partially or completely covered with vegetation and soil, or a growing medium, planted over a waterproofing membrane along with appropriate additional layers such as a root barrier and drainage and irrigation systems. The term does not refer to roofs which are merely colored/painted green, as with green roof shingles, or decorated with pot plants.

Gross Floor Area (GFA) - The sum of the fully enclosed covered floor area and the unenclosed covered floor area of a building at all floor levels. Car parks are not to be included as GFA.

Habitat - The natural environment in which an organism exists.

Historical Baseline - The standard from which a building's improvement in efficiency is measured. This is determined by the past consumption data of the same building. The past consumption data must be available for an equivalent time period and occupancy rate as the building's Performance Period. Once this baseline is determined, it becomes the baseline for all future re-certifications using this calculation method.

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

Illuminance - The density of the luminous flux incident on a surface. It is the quotient of the luminous flux multiplied by the area of the surface when the latter is uniformly illuminated.

Landscaping - All activities that modify the visible features of the non-building area.

Lighting Ballast - A device used to obtain the necessary circuit conditions (voltage, current, and wave form) for starting and operating an electric-discharge lamp.

Lighting Power Density (LPD) - Lighting power density (W/m^2) is the ratio of lighting electric power to the illuminated area.

Line of Sight - An imaginary line/path from occupant eyes to perceived objects. A direct line of sight refers to an unobstructed path from a building occupant's eyes to the external view.

Mixed-Mode Ventilation - A hybrid approach to space conditioning that uses a combination of natural ventilation from operable windows and mechanical ventilation systems including air distribution and cooling equipment.

Native Species - Species endemic to a location within 1000km.

Natural Lighting - Technologies or design strategies used to provide natural light 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 the 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 Floor Area (NFA) - The total gross floor area of a building minus all unoccupied tenancies.

Occupied Spaces - Enclosed spaces that can accommodate human activities. They include work spaces (offices, meeting rooms, laboratories, etc.), event spaces (halls, sales areas, libraries, gyms, etc.), common areas (receptions, waiting rooms, lounges, lobbies, etc.), and

learning spaces (classrooms). They exclude corridors, staircases, storage areas, toilets, changing facilities, IT equipment rooms and mechanical rooms.

Ozone Depletion Potential (ODP) - A value assigned to a gas 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.

Performance Period - The continuous, unbroken period over which performance is measured and during which time evidence is produced for all credits a project is applying for. For LOTUS BIO, this period lasts 12 months.

Power Monitoring System (PMS) - A system including meters to record data, software to gather, manage and display the data, and a communication interface between the software and the meters.

Public Space - Any space which is open to the public, not limited to building occupants. There might be certain rules applied to the spaces but no fee may be paid to access.

QCVN - Quy chuẩn xây dựng Việt Nam (Vietnam Construction Regulation/Building Code) - All mandatory regulations applied in building activities, which are issued by governmental authorities on building.

Recommissioning - Re-application of the commissioning process requirements to a project that has been delivered already using the commissioning process. This may be a scheduled recommissioning developed as part of an ongoing commissioning process, or it may be triggered by a use change, operations problems, or other needs.

Reflectance - The ratio of light reflected by a surface to the light incident upon it.

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

Recycling - A process in which materials that have been processed into products are collected, processed again and returned to the market as raw materials or as finished goods.

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

Retro-commissioning - The commissioning process applied to an existing facility that was not previously commissioned. The same basic process needs to be followed from pre-design through to occupancy and operations to optimize the benefits of implementing the commissioning process philosophy and practice.

Reuse - A process in which processed materials are collected and returned to the market without reprocessing to change form or characteristics.

Solar Reflectance Index (SRI) - It is a measure of a surface's ability to reject solar heat and to stay cool. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100.

Solid Waste Stream Audit - A structured process used to quantify the amount and types of ongoing solid consumable waste being generated by a building over a certain time period. It can be used to identify opportunities for improving solid waste management systems.

Stormwater - Stormwater is the water that originates during precipitation events.

TCVN (Vietnam Standard) - All technical documents describing principles, guidelines or properties/results of activities issued by authorized agencies to help maximize effectiveness in certain conditions (25/2001 QĐ-BXD issued on 04/09/2001). Application of most TCVNs are on a voluntary basis except for standards relating to life safety, fire and explosion protection, environment sanitation and environmental conditions recording. The Vietnam Directorate for Standards, Metrology and Quality is mainly responsible for issuing Vietnamese standards.

TCXD/TCXDVN (Vietnam Construction Standard) - All Vietnamese standards which are applicable to construction and building, but are not mandatory as opposed to the Vietnam Construction Regulation or building code. (TCXDVN definition at item 19 and 20, Article 3, Building Code - 26/2003/L-CTN issued on 10/12/2003)

Thermal Comfort - A term describing conditions in which building occupants are comfortable with the surrounding environment. Conditions include air temperature, radiant temperature, humidity, draught, clothing and activity rates.

Ventilation - The process of supplying and removing air by natural or mechanical means to and from a space. Such air may or may not have been conditioned.

VBEEC (Vietnam Building Energy Efficiency Code) - VBEEC (latest released version QCVN 09:2013/BXD) is issued by the Ministry of Construction and is mandatory in Vietnam in order to help meet energy savings goals.

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.

VAV (variable air volume) - Type of HVAC system which has the ability to vary the airflow of cooled supply air (maintained at a constant temperature) to the different air-conditioned spaces in order to meet precisely the thermal setpoint.

VRV/VRF (variable refrigerant volume/flow) - Type of direct (one refrigerant only) air-conditioning system with variable speed compressors, several air handlers (indoor units) on the same refrigerant loop/circuit.

VSD (variable-speed drive) - Equipment used to control the speed of a pump or fan to adjust to the demand.

Water Efficient Fixture - Water-based fixture that requires less water to complete a designed task than typical fixtures.

Water Use Intensity - The water consumption per occupant or per m^2 of a building.

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