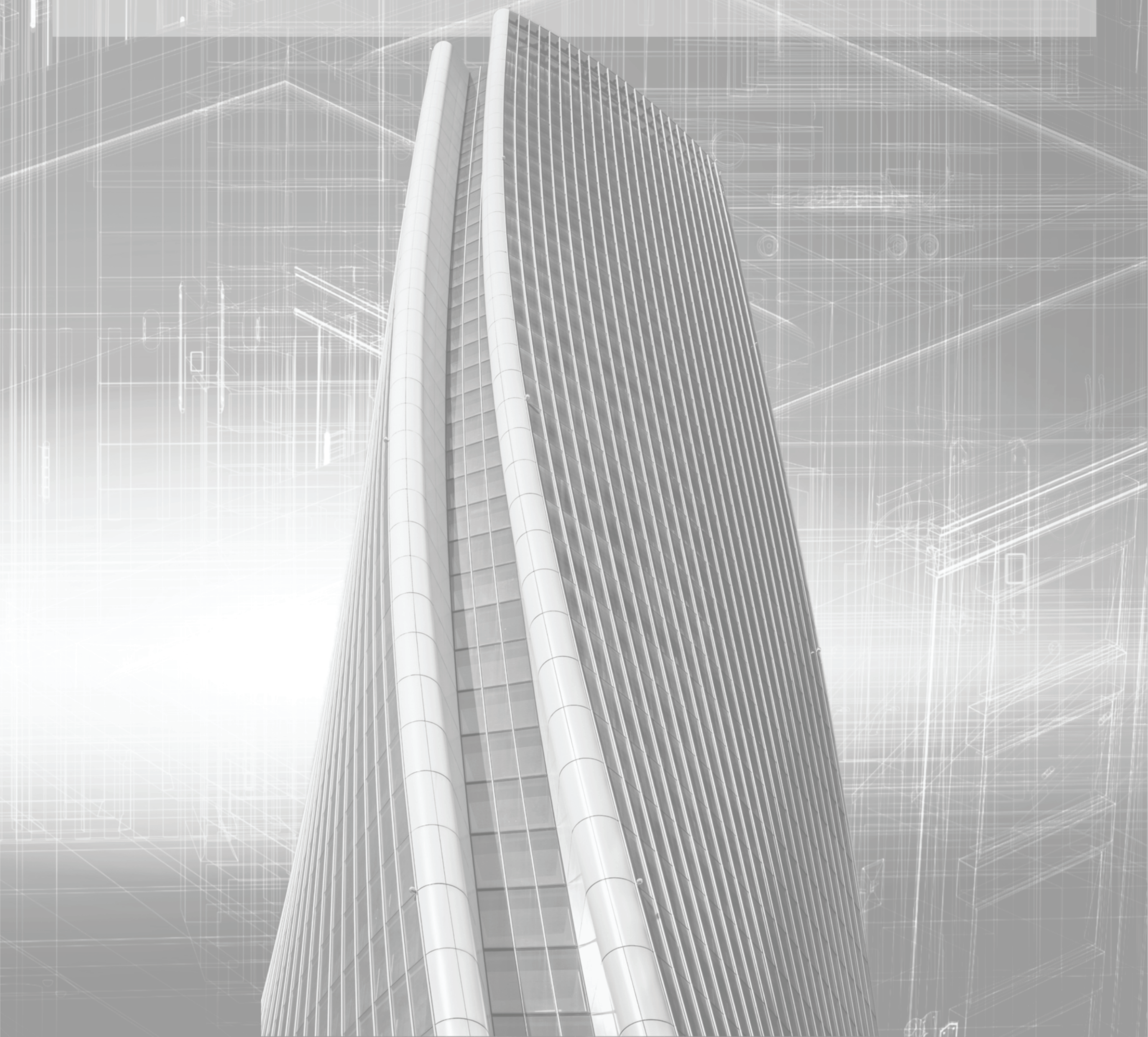
GUIDELINES ON ENERGY CONSERVING DESIGN OF BUILDINGS

2020 Edition

USER MANUAL



First Printing: August 2021

This publication was produced by the Department of Energy with the support of the European Union through the Access to Sustainable Energy Programme (ASEP). Its contents are the sole responsibility of the Department of Energy and do not necessarily reflect the views of the European Union.

Contents

Section VI: Steam and Hot Water System

PART III: ELECTRICAL SYSTEMS

Section VII: Lighting

Republic of the Philippines
DEPARTMENT OF ENERGY
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MESSAGE

Building construction is one of the energy-intensive phases in a country's development and I am very confident that this User Manual will be a great reference in designing major parts of building systems.

With the Department of Energy (DOE) issuance of the Department Circular No. DC2020-12-0026 or *Adoption of the Guidelines on Energy Conserving Design of Buildings*, the need to provide guidance in the designing and construction of buildings in the Philippines is imperative.

The User Manual focused on references and guidelines from application for building to occupancy permits areas that will greatly affect energy efficiency and conservation including resilience of the buildings. It will supplement the minimum requirements for the energy conserving design of new buildings and major renovation of existing buildings.

Notwithstanding the pandemic, the DOE continues its mission to improve the quality of life of the Filipinos through providing programs that will provide opportunities and improved energy technologies. Through this User Manual, we envisioned that it will be a useful document to assist government regulators, developers, building officials and other stakeholders in complying on energy conserving design of buildings.

This endeavor will not be possible without the assistance of the European Union – Assisted Access to Sustainable Energy Program (EU-ASEP), their experts, and all those people who exerted efforts in crafting this User Manual.

Maraming salamat po!

Jesus Cristino P. Posadas
Senior Undersecretary
Department of Energy

List of tables, figures and case studies

Introduction

Energy efficiency and conservation strategies offer vast opportunities to realize energy self-sufficiency, reduce carbon emissions at cost-effective manner, and greening the building sector. With the Philippine building sector accounting for 20% of the total energy consumption, there is a big potential for achieving economic savings through improved building energy efficiency.

Republic Act No. 11285 otherwise known as the Energy Efficiency and *Conservation Act of 2019* strengthens the policy of the State towards the efficient and judicious utilization of energy. The law mandates that all building constructions, new and building retrofits, shall comply with minimum requirements for energy efficiency and conservation as stated in the Guidelines on Energy Conserving Design of Buildings.

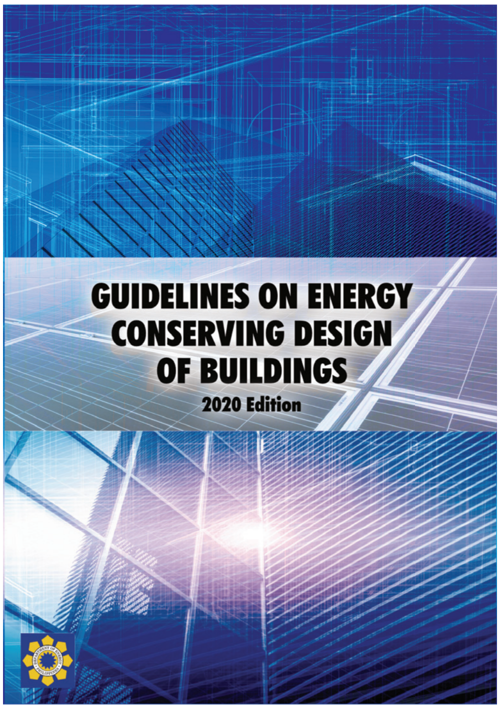
In this connection, the Department of Energy (DOE) issued *Department Circular DC2020-12-0026* on 22 December 2020 enforcing the adoption of the Guidelines on Energy Conserving Design of Buildings, 2020 Edition. The Guidelines address the need to provide energy efficiency guidance in the design and construction of buildings in the Philippines.

The Guidelines provide technical requirements based on two building codes that impact on energy performance of buildings: the *National Building Code* and the *Philippine Green Building Code*. Obligations of buildings consistent with the *Energy Efficiency and Conservation Act* were cited. Renewable energy systems and equipment were added in support of the *Renewable Energy Act of 2008*. Updated international standards, notably the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), were also reflected.

This User Manual supplements the Guidelines and is intended as an easy reference for government regulators, building proponents or developers, design professionals, contractors, building officials and other stakeholders. This initiative of DOE with technical assistance from the European Union-supported Access to Sustainable Energy Programme (ASEP) aims to ensure the effective and timely adoption of energy-efficient systems in the building sector.

Conscientious efforts have been exerted to make the contents of this User Manual technically sound for reference of duly qualified and competent professionals. Please address any concern or issue on the applicability, accuracy, or completeness of this document to DOE for further validation and interpretation. All suggestions will be considered for inclusion in the Guidelines next edition.

HOW TO USE THIS USER MANUAL



This User Manual follows the structure and should be used together with the Guidelines on Energy Conserving Design of Buildings, 2020 Edition. It provides basic information on the energy efficiency measures, as well as some practical examples, illustrations, and applications. The focus is on "hard" requirements that impact energy efficiency and conservation, sustainability and resilience of the building.

It also contains references and guidelines for design documentation required to be submitted with the application for building permit as well as construction documentation required with the application for an occupancy permit.

This Manual covers three major parts of building systems:

» Building Envelope
» Mechanical Systems
» Electrical System

The Guidelines and this Manual is applicable to the design of the following:

1. New buildings and their systems with at least 112.5 kVA of connected electrical loads or has at least 10,000 square meters (m2) Total Gross Floor Area (TGFA); and
2. Any expansion and/or modification of existing buildings or systems designed with connected electrical loads of at least 112.5 kVA or with at least 10,000 square meters (m2) TGFA.

HOW TO USE THIS USER MANUAL

This manual also comes with Compliance Checklists covering the requirements for the building envelope, mechanical and electrical systems which can be downloaded from the DOE site through the QR Code included in the back cover.

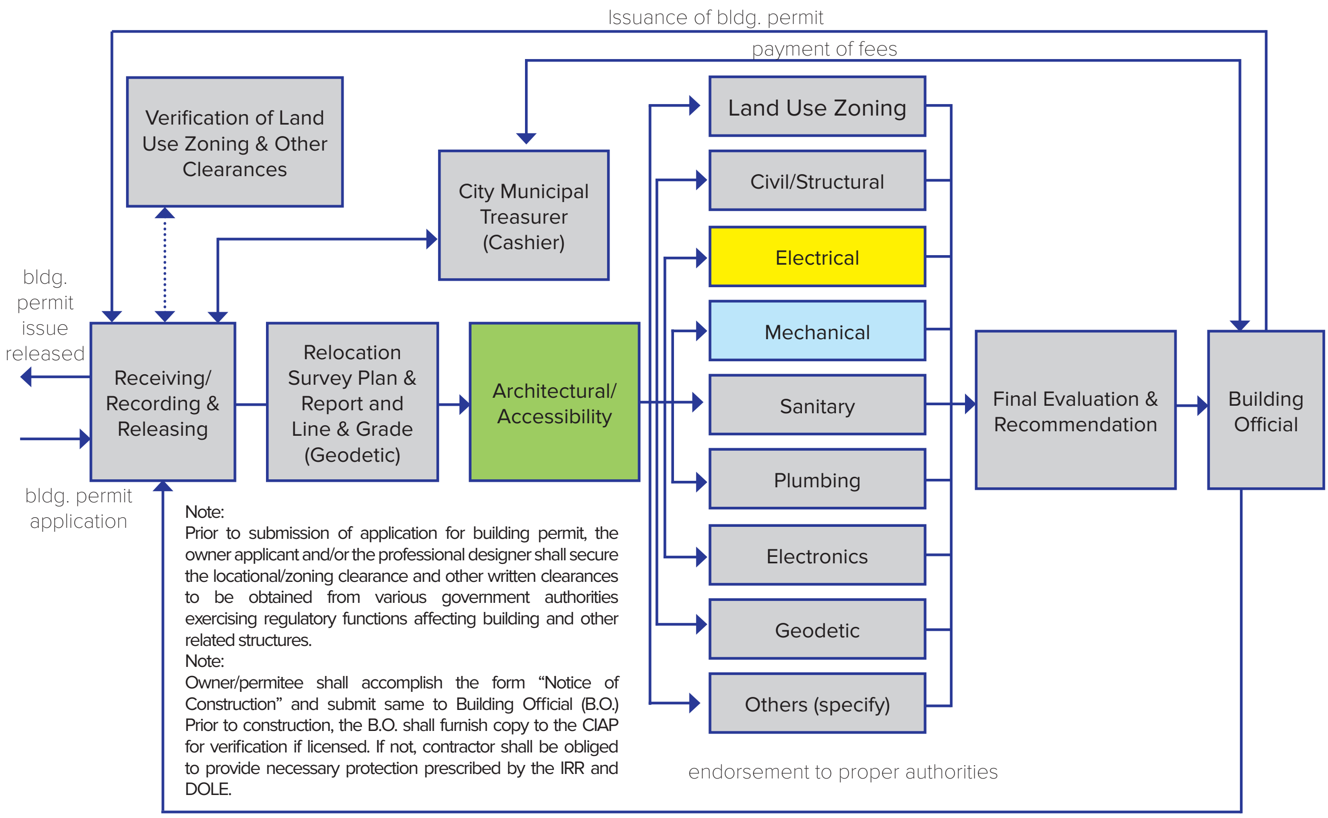
Below is a sample requirement (Daylighting under Electrical Systems) included in the compliance checklists:

DOE BUILDING GUIDELINES 2020 CODE COMPLIANCE CHECKLIST								
10	ENERGY EFFICIENCY		Requirement	Developer	Regulator			
Item	DOE Building Guidelines Requirement	*Applicability*	Required value	Design Value	Design Compliance			
					Documentation needed	Document Provided?	Design Specification Relevant	
Electrical Systems						Yes/No	Yes/No	Remarks
1	**Daylighting, Photoelectric Switch and/or Automatic Dimmer**	*Applies to all regularly occupied spaces of all building occupancies except building spaces where daylight access hinders intended functions*	Required?	Complied?				
a	All regularly occupied spaces inside the building shall employ features that can allow daylight into the room space				Floor Plan or Roof Plan			
b	Daylight sensor or photoelectic sensor in lighting system - for use within lighting control systems in day-lit zones				Building Elevations and Sections			
					Daylight Provisions Details			
					Technical data of the glass			
					Interior Lighting Design Floor Plan			
					Exterior Lighting Design Drawings			
					Lighting Control Diagram			
					Technical Data Sheets (TDS) of the various sensors and controllers employed			

BUILDING PERMITTING PROCESS

The Guidelines on Energy Conserving Design of Buildings, 2020 Edition follows the process flow of the National Building Code, as shown below. As these Guidelines are limited to providing energy efficiency and conservation measures only, they provide additional minimum requirements on the highlighted parts in the Building Permit Flow Chart, namely (1) Architectural/Accessibility which covers the Building Envelope Requirements, (2) Mechanical for the Mechanical Systems Requirements and (3) Electrical for the Electrical Systems Requirements.

Processing of Application of Building Permit Flow Chart



Building Permit Application Process
(National Building Code of the Philippines)

Project Proponent Application

1. Get Requirement Check List and Application Forms from the Office of the Building Official (OBO).
2. Accomplish prescribed application form from the Office of the Building Official and file the prescribed application forms:
   a. Location of proposed structure and description of the work to be covered.
   b. Certified true copy of OCT/TCT
   c. Tax declaration

d. Current real property tax receipt
e. Five sets of survey plans, design plans, specifications, and other documents prepared, signed and sealed over the printed names of the duly licensed and registered professionals.

Evaluation and Processing

1. When satisfied that all plans, specifications and other documents are in order, the Building Official gives due course to the application.
2. Building Official evaluates and ensures that plans conform with approvedminimum requirements on energy efficiency and conservation implementation in the building envelope, mechanical and electrical systems as well as with other rules and regulations promulgated in accordance with the provisions of *PD 1096*.

Treasurer Payment of Fees

1. Applicant pays the prescribed assessment building permit fees at the Municipal Treasury.

OBO Approval

1. Upon complying with all the minimum standards of plans based on all pertinent rules and regulations of the Guidelines and other referral codes with respect to specific disciplines, Building Official approves the building permit application.
2. Building Official within 15 days from payment of the required fees by the applicant, issues the building permit applied for.

PART I: BUILDING ENVELOPE

SECTION IV: THERMAL PERFORMANCE OF THE BUILDING ENVELOPE

4.1 Introduction of Building Envelope

Building envelope physically separates the indoor and outdoor environments. It encompasses the entire exterior surface of a building, including walls, roof, doors, and windows, which enclose, or envelope the interior spaces. It is composed of layers of building materials that protect interior spaces from changes in outdoor weather and climate conditions.

Some elements of a building envelope include:

Roof – covering of the top of a building to protect against sunlight, wind, rain, and extreme temperature.

Exterior Walls – structural element used to enclose a building construction to form the envelope of a building.

Demising Wall – an interior wall of partition used to subdivide one space from one another or from the common spaces.

Window – opening in the wall of a building for the admission of light and air that is usually closed by casements or sashes containing glass panel and capable of being closed or shut.

Soffit – connecting the top of an exterior wall to a projecting eave.

Skylight – roof opening covered with transluscent or transparent glass or plastic designed to admit daylight.

The following illustrates how a building envelope acts as a barrier between outdoor and indoor conditions.

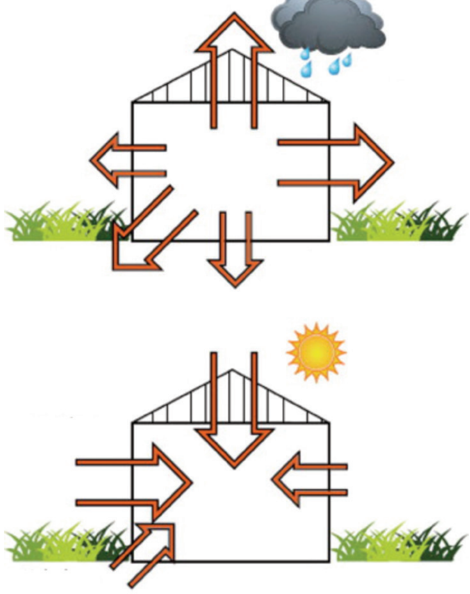


Figure 1: Building Envelope interface with exterior and interior environments

Source: https://www.sciencedirect.com

GUIDELINE REFERENCE AND REQUIRED MEASURES

To fulfil the minimum requirements of the Guidelines on Energy Conserving Design of Buildings regarding the thermal performance of the facade and the roof, there are two paths for approval:

» **Overall Thermal Transfer Value (OTTV) Method (see Section 4.2 of Guidelines on Energy Conserving Design of Buildings); and**
- $OTTV_{facade} \leq 45\ W/m^2$
- $OTTV_{roof} \leq 45\ W/m^2$

» **Prescriptive Method (see Section 4.3 of Guidelines on Energy Conserving Design of Buildings)**
- Limit the window to wall ratio according to Table 6 of Guidelines on Energy Conserving Design of Buildings.
- $U_{roof} \leq 1.4\ W/m^2K$
- $U_{wall} \leq 3.4\ W/m^2K$
- Opening ratio of skylights ≤ 5% related to the floor area of the room beneath

» Shading devices **(see Section 4.4 of Guidelines on Energy Conserving Design of Buildings)** devices is included in 4.2 OTTV Method and 4.3 Prescriptive Method.

Additionally, there are minimum requirements regarding airtightness of the building envelope:

» **Airtightness of the building envelope (see Section 4.5 Guidelines on Energy Conserving Design of Buildings)**

» The envelope of the building is completely enclosed to minimize the infiltration of warm air and exfiltration of cool air.
- As a basic requirement, buildings shall not have unenclosed doorways, entrances etc.
- To further minimize the exfiltration of cool air and infiltration of warm air and moisture through leaky windows and doors, effective means of weather-stripping shall also be incorporated.

Also, the roof must fulfil the following requirements to prevent heat transfer from the roof due to solar radiation:

Reflectance of the Roof (see Section 4.6 Guidelines on Energy Conserving Design of Buildings)

» Roofs shall have one or the combination of the following measures:
- Roof color with a minimum average SRI of 70
- More than 70% of the roof is back ventilated
- More than 70% of the roof is covered by solar thermal and/or PV
- More than 70% of the roof is covered by a green

Application

All air-conditioned spaces in new buildings and any expansion and/or modification of existing buildings with total connected electrical loads of at least 112,5 kVA or with at least 10,000 square meters TGFA.

Exception

For naturally ventilated spaces only the following requirements apply:

» OTTV method: OTTVroof ≤ 45 W/m2
» Prescriptive method: Uroof ≤ 1.4 W/m2K
» Opening ratio of skylights ≤ 5% related to the floor area of the room beneath
» Reflectance of the roof

Rationale

The building envelope separates the air-conditioned interiors of a building from the ambient climate and hence reduces the energy demand for cooling and dehumidification. The main drivers of the ambient climate regarding the energy demand of the building are:

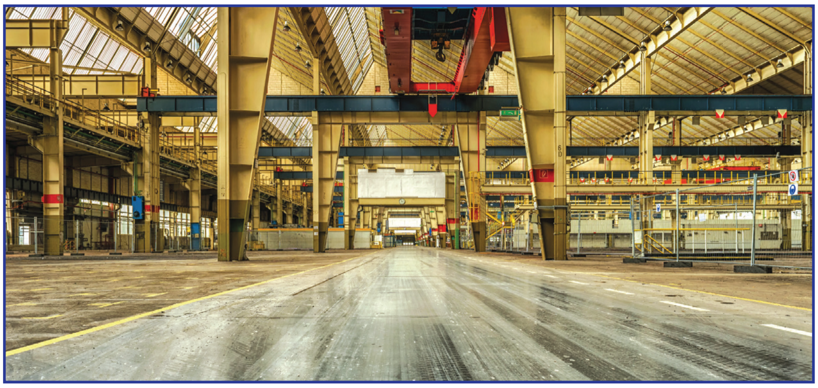
» Solar radiation
» Air temperature and humidity

To reduce the impact of the before mentioned climate parameters on the energy demand of a building the following measures can be taken:

» Solar radiation
  - Install external shading
  - Reduce window-to-wall-ratio
  - Reduce skylight-to-roof-ratio
  - Reduce the solar heat gain coefficient of the glazing
  - Apply reflective coatings on the exterior of the building
  - Apply back ventilation of walls and roofs or use green roofs and facades

» Air temperature and humidity
  - Insulate walls and facades
  - Insulate the roof
  - Use insulated glazing and frames
  - Improve airtightness of the building envelope

Hence, there are no requirements regarding the insulation performance of the facade and airtightness. Thermal insulation and a high reflective roof are necessary to reduce long wave radiation and discomfort for the occupants. The insulation value of the facade has a lower impact on thermal comfort and can be neglected. Airtightness is contra productive in naturally ventilated spaces.



Naturally ventilated factory building with insulated roof and reduced skylight area (< 5%). The facade is not insulated and partly open for natural ventilation.

Design Application

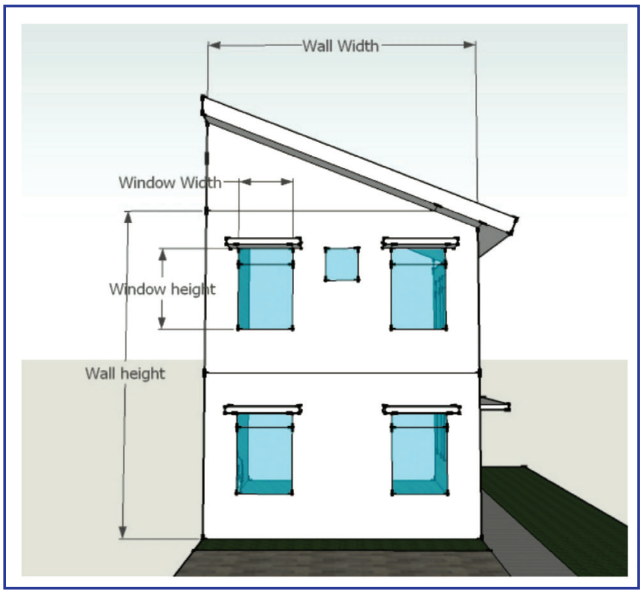
1. **Install external shading:** External shading is one of the most effective ways to reduce the influence of solar ration on the energy consumption for air-conditioning of a building.

Source: horizontal overhang https://www.researchgate.net/

From left to right: horizontal overhang, vertical fins, movable jalousies.

2. **Reducing window-to-wall (WWR) ratio:** The WWR is the ratio of vertical fenestration area to gross exterior or wall area. The fenestration area is the rough opening, i.e., it includes the frame, sash, and other non-glazed window components. The gross exterior wall is measured horizontally from the exterior surface; it is measured vertically from the ground floor to the bottom of the roof.

Figure 2: Building sketch showing relationship betweenwindow area and wall area
Source: Philippines Green Building Guideline



Window-to-wall ration = (Net Glazing Area)
(total window area including frames)
(Grosss Wall Area)
(width of total wall area x height from ground floor to bottom of roof eaves)

For curtain wall systems, components that are opaque (e.g., aluminum composite panels, glass components with opaque finish or back pans), are not to be considered glazed components and therefore, not part of the "net glazing area".

The lower the WWR is, the lower the solar radiation load through the windows. However, the use of daylight and an unobstructed view to the outside is reducing the lighting energy consumption and well-being of people. Therefore, a good compromise between these competing requirements must be found.

3. **Reducing the solar heat gain coefficient of the glazing:** Lower heat levels indoors are highly dependent on the Solar Heat Gain Coefficient (SHGC) and Visible Light Transmittance, as seen below.

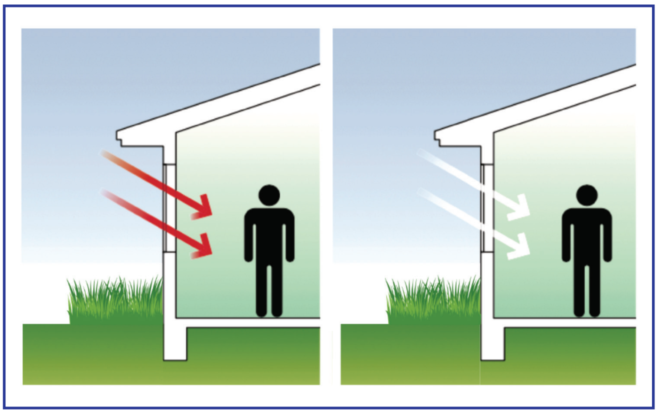
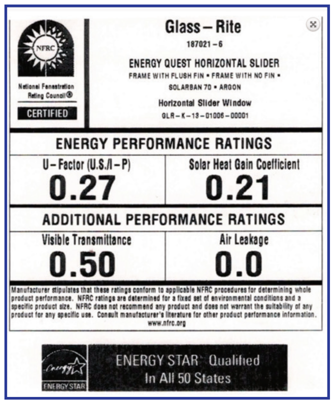


Figure 3: Solar Heat Gain Coefficient (SHGC) and Visible Light Transmittance (VLT)



Window performance label showing results of SHGC and VLT

To reduce solar heat load and improve daylight use in buildings, a glazing should be selected with a low SHGC and a high visual light transmittance should be selected.

4. **Apply reflective coatings on the exterior of the building:** Solar radiation on the roof and walls of a building will be absorbed depending on the reflectivity of the surface. Darker colors will lead to more absorption and more heat transfer through the wall and roof and hence higher air-conditioning energy demand. Therefore, surface color with a high solar reflectance should be selected for roofs and walls.

Table 1: Solar reflectance index (SRI) values of basic color coatings.

Metal Surface	SRI
reflective white	86 to 92
basic white	80 to 88
beige/tan	74 to 80
dark brown	0 to 33
light to medium brown	45 to 56
light to medium grey	39 to 63
dark grey	0 to 41
blue	23 to 30
light to medium blue	35 to 38
red	28 to 36
terracotta red	38 to 40
green	25 to 32
light to medium green	30 to 48

Source: The Philippine Green Building Code User Guide

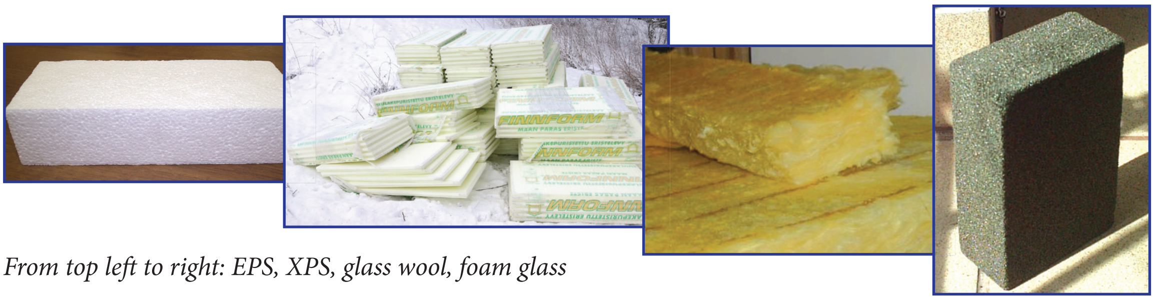
5. **Apply back ventilation of walls and roofs or use green roofs and facades:** Back ventilated walls and roofs are partly are protected from direct solar radiation by a secondary envelope. An air gap between the secondary and primary envelope will remove absorbed solar energy and reduce heat load on the air-conditioning system.

   Green roofs and facades can reduce heat transfer through the envelope and partly shade facades and walls.

Back ventilated roof (left) and green facade (right)

6. **Insulate walls and facades:** Insulated walls and facades are reducing the heat transfer from outside to the inside of a building. Furthermore, they are improving thermal comfort in the interior due to reduced surface temperatures. The industry provides many insulation materials for different applications and with different characteristics. Examples are expanded polystyrene (EPS), polyurethane (PU), stone, and glass wool for dry application (protected from humidity) in walls and roofs. Examples for application with direct contact with water in the roof area or with contact to soil are extruded polystyrene (XPS) and foam glass.

   Keep in mind that these insulation materials have different insulation values, fire characteristics and structural strengths.



From top left to right: EPS, XPS, glass wool, foam glass

   Furthermore, energy bridges should be avoided or reduced respectively. This can be achieved by completely covering the building envelope without gaps e.g., overlapping of wall insulation with window frames.

7. **Use insulated glazing and frames:** Windows which consist of the glazing and the frame have an important influence on the air-conditioning demand of a building. Besides the WWR, the shading of the window and the solar heat gain coefficient (SHGC) the thermal insulation properties of the glazing and the frame determining the heat transfer through the window.

   The insulation value of a window is defined by its U-value and is influenced by the coating (e.g., low-E), the number of pains (single, double, and triple), the gas filling, and the spacer which separates the glass panes.

Glazing	U_g [W/(m²K)]	SHGC [-]
Single	ca. 5,8	ca. 0,85
Double (air)	2,7 - 3,2	0,75 - 0,8
Double (argon)	,0 - 1,8	0,58 - 0,65
Triple (argon)	0,5 - 0,8	0,45 - 0,6

   The insulation value of the window frame is determined by:
   - the frame material (metal, wood, polymer), and
   - the internal structure of the frame (e.g., number of air chambers in polymer frames, thermal break in metal windows, polyurethane core in wooden frames).

8. **Improve airtightness of the building envelope through:**
   a. Sealed window and door assemblies: sealed by a continuous membrane along the joints between wall and window and door frames. Window and door assemblies should be complete with weather stripping and gaskets around the frames.

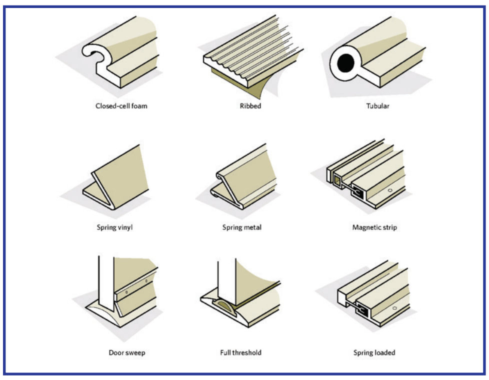


Figure 4: Different types of doors and windows weather stripping
Source: https://guides.co

b. Sealed utility services: Electrical, plumbing, and mechanical piping, conduit or ducting penetrating through walls, floor, and ceiling should be sealed to reduce air leakage. Joints in the membrane should be caulked, lapped, and sealed or taped.

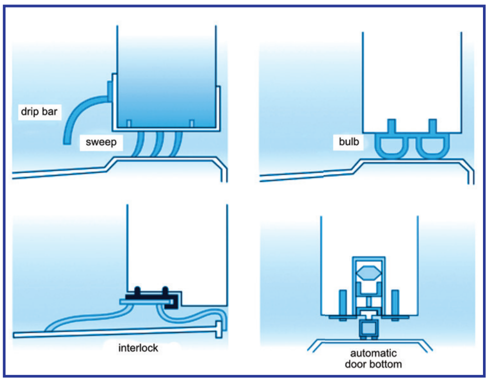
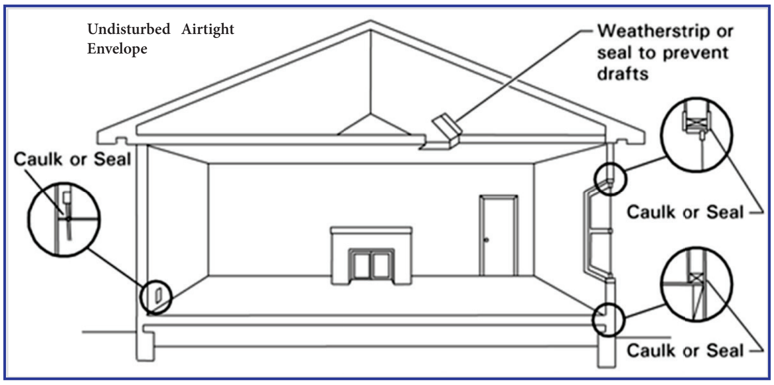


Figure 5: Installation of air tightness of different weather stripping for flooring and door frames

Source: https://energyeducation.ca

Sealing prevents transfer of air and moisture between spaces.

Figure 6: Air tightness in a building envelope
Source: https://energycodeace.com



Design Documentation

The following documents shall be required for the building permit application:

A. Architectural drawings:
- Floor plans with the supporting details and information
- Elevations with the supporting details and information
- Sectional drawings with the supporting details and information

B. Material specifications, e.g., in tender documents or detailed drawings:
- Windows, skylights: U-value, SHGC value
- Walls: material type, thickness, k-values
- Roofs: material type, thickness, k-values
- Shading: shading length, f-value
- Insulation specifications supporting wall and roof k-values
- Roof deck, wall, and floor specification on non-permeable coating

C. Proof/Evidence of building envelope: compliance
- OTTV method: OTTV calculation for wall and roof
- Prescriptive method: calculation of window-to-wall ratio
- SHGC of glass window to be used
- Proposed Roof U-value computation
- Proposed Wall U-value computation
- Skylight area and roof area computations
- Proposed methods and materials for building airtightness
- Proposed SRI of the roof

4.2 OTTV Method

Description of the Example Building

The following calculation is based on an example building as shown in Figure 7. It is a mixed-use building with 8 floors consisting of a retail area on the first floor and 7 office floors. The dimension of the building can be found in the drawing.

The material characteristics are gathered from the appendixes of the guidelines and are mentioned in the drawing. The wall is a brick wall, and the roof consists of a 5 cm layer of polystyrene and 20 cm of concrete.

The retail area on the first floor has a large shopwindow which is single glazed and not shaded. The offices feature single glazed windows which are shaded by a fixed shading with a horizontal overhang of 0.6 m.

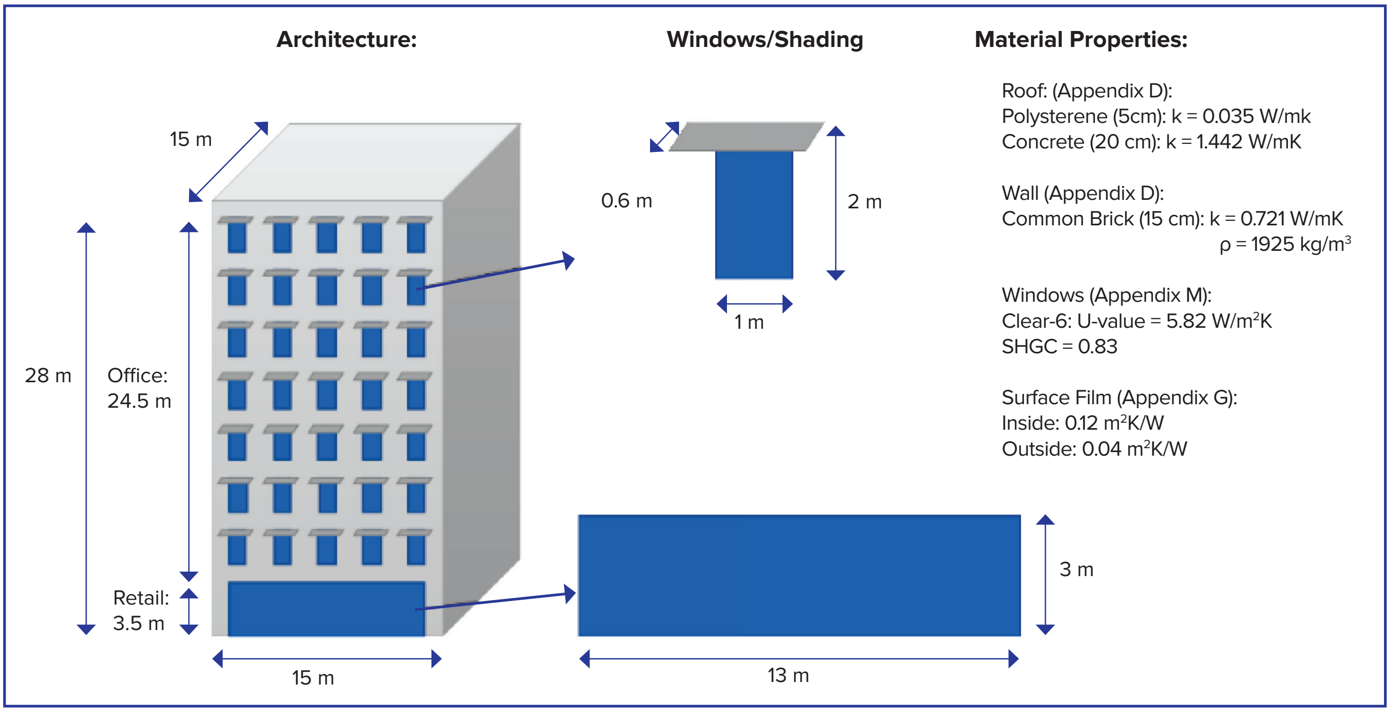


Figure 7: Example Building

4.2.1 Facade

The OTTV defines the thermal performance of a facade. The calculation methodology is described in Part I, Section 4.2 of the guidelines. The methodology will be applied on the south facade of the building as described in the previous section.

The OTTV is defined by the heat conduction through the window, the heat conduction through the wall and the solar radiation through the window. Since the south facade of the building has two facade types (office facade, retail facade), it is necessary to split up the calculation accordingly. See sample calculation for facade below.

4.2.1.1 Sample OTTV Calculation for Office Facade

$$OTTV = \frac{(A_w \times U_w \times T_{Deq}) + (A_f \times U_f \times \Delta T) + (A_f \times SHGC \times f \times SF)}{A_o}$$

After inputting the data from Figure 1 the equation looks like this:

$$OTTV_{Office} = \frac{(297.5m^2 \times 2.717 \frac{W}{m^2K} \times 10K) + (70m^2 \times 5.82 \frac{W}{m^2} \times 5K) + (70m^2 \times 0.83 \times 0.73 \times 130 \frac{W}{m^2} \times 0.74)}{367.5m^2}$$

$$OTTV_{Office} = 38.6\ W/m^2$$

Where:

$A_w = 297.5\ m^2$ Net wall area of the office facade without windows

$U_w = 2.717\ W/m^2$ U value of the wall considering a heat conductivity of the bricks of k = 0.721 W/mk and a surface air film resistance of $R_{si} = 0.12\ W/m^2K$ and $R_{so} = 0.04\ W/m^2K$:

$$U_w = \frac{1}{RSi + \frac{d}{k} + Rso}$$

$$U_w = \frac{1}{0.12W/m^2K + \frac{0.15m}{0.721 \frac{W}{mK}} + 0.04\ W/m^2K} = 2.717\ W/m^2K$$

$T_{Deq} = 10\ K$ Equivalent temperature difference selected according to table 1 of the guidelines depending on the specific wall weight:

$$m = \rho \times d = 1925 \frac{kg}{m^3} \times 0.15m = 288.75 \frac{kg}{m^3}$$

$A_f = 70\ m^2$ Total office window area of the South facade

$U_f = 5.82\ W/m^2$ Window U-value

$\Delta T = 5K$ Equivalent temperature difference for windows is always 5K.

SHGC = 0.83 Solar heat gain coefficient of the glazing.

f = 0.73 Shading factor for shading devices: see chapter 4.4.

$SF = 130\ W/m^2$ Solar factor is in average $130\ W/m^2$ and has to be corrected (multiplied) with the correction factor CF with reference to the orientation and the pitch angle of the facade. In case of a South facade with 90° pitch CF is 0.74.

4.2.1.2 Sample OTTV Calculation for Retail Facade

$$OTTV_{Retail} = \frac{(A_w \ x \ U_w \ x \ T_{Deq}) + (A_f \ x \ U_f \ x \ \Delta T) + (A_f \ x \ SHGC \ x \ f \ x \ SF)}{A_o}$$

After inputting the data from Figure 1 the equation looks like this:

$$OTTV_{Retail} = \frac{(13.5m^2 \ x \ 2.717 \ \frac{W}{m^2K} \ x \ 10K) + (39m^2 \ x \ 5.82 \ \frac{W}{m^2} \ x \ 5K) + (39m^2 \ x \ 0.83 \ x \ 1.0 \ x \ 130 \ \frac{W}{m^2} \ x \ 0.74)}{52.5m^2}$$

$$OTTV_{Retail} = 87.92 \ W/m^2$$

Compared to the calculation for the office facade OTTV the only differences are the areas and a shading factor of 1.0, because there is no external shading at the retail window.

The average OTTV of the South facade has to be calculated by an area weighting of the OTTV of the office and the retail facade:

$$OTTV_{South} = \frac{A_{Office} \ x \ OTTV_{Office} + A_{Retail} \ x \ OTTV_{Retail}}{A_{Office} + A_{Retail}}$$

$$OTTV_{South} = \frac{367.5m^2 \ x \ 38.6 \ W/m^2 + 52.5m^2 \ x \ 87.92 \ W/m^2}{367.5m^2 + 52.5m^2}$$

$$OTTV_{South} = 45.00 \ W/m^2$$

The average OTTV of the South facade is lower than the required 45 W/m2 and therefore the facade design is permitted.

4.2.2 Roof

The OTTV calculation for the roof is analogue to the calculation method of the facade. However, in the case of the example building, there are no transparent building components such as skylights and therefore the terms for the calculation of the heat and solar transfer through glazed areas can be neglected and the formula simplified. See sample calculation for roof below.

4.2.2.1 Sample OTTV Calculation for Roof

$$OTTV = \frac{(A_w \; x \; U_w \; x \; T_{Deq})}{A_o}$$

After inputting the data from Figure 1 the equation looks like this:

$$OTTV_{roof} = \frac{225m^2 \; x \; .56 \; W/m^2 + 52.5m^2K \; x \; 16K}{225m^2}$$

$$OTTV_{roof} = 9.0 \; W/m^2 < OTTV_{required} = 45.00 \; W/m^2$$

Where:

A_w = 297.5 m^2 Net roof area without skylights

U_w = 0.561 W/m^2 U value of the roof considering a heat conductivity of concrete (k = 1.442 W/mk) and polystyrene (k = 0.035 W/mk). Furthermore, the surface air film resistance of R_{si} = 0.16 W/m2K and R_{so} = 0.056 W/m^{2}K has to be considered:

$$U_w = \frac{1}{R_{si} + \frac{d_{concrete}}{k_{concrete}} + \frac{d_{polysterene}}{k_{polysterene}} + R_{so}}$$

$$U_w = \frac{1}{0.16 \frac{W}{m^2K} + \frac{0.2m}{1.442 \frac{W}{mK}} + \frac{0.05m}{0.035 \frac{W}{mK}} + 0.056 \; W/m^2K}$$

$$U_w = 0.561 \; W/m^2K$$

T_{Deq} = 16K Equivalent temperature difference selected according to table 4 of the guidelines depending on the specific roof weight:

$$OTTV_{roof} = 9.0 \; W/m^2 < OTTV_{required} = 45.00 \; W/m^2$$

$$m = \rho_{concrete} \; x \; d_{concrete} + \rho_{polysterene} \; x \; d_{polysterene}$$

$$m = 2400 \frac{kg}{m^3} \; x \; 0.2m + 16 \frac{kg}{m^3} \; x \; 0.05m = 480.8 \frac{kg}{m^3}$$

The roof OTTV is significantly lower than the required OTTV of 45 W/m2 and therefore the roof design is permitted.

4.3 Prescriptive Method

The prescriptive method is a simplified alternative to the OTTV calculation method as discussed in Section 4.2 of this manual. The thermal requirements of a facade are not unified in one number, but separated into:

- Solar transmittance of windows, and
- Minimum insulation values of the facade

The required calculation methodology according to the prescriptive method is demonstrated on the example of the building as described in Section 4.2 in the following two chapters.

4.3.1 Sample Calculation of the Solar Transmittance of Windows

The adjusted solar heat gain coefficient SHGCadj of the different window types has to be calculated by multiplying the solar heat gain coefficient of the glazing with the shading factor of the shading device.

Retail: $SHGC_{retail} \text{ x } f_{retail} = 0.83 \text{ x } 0.726 = 0.602$

Office: $SHGC_{adj,\ office} = SHGC_{office} \text{ x } f_{office} = 0.83 \text{ x } 1.000 = 0.830$

The SHGC value can be retrieved from the glazing manufacturer and are shown in Figure 1. The determination of the shading factors is described in chapter 4.4.

Next, the area weighted adjusted solar heat gain of the whole façade has to be calculated:

$$SHGC_{adj,total} = \frac{(A_{wall} + A_{window,retail}) \text{ x } SHGC_{adj,retail} + (A_{wall,office} + A_{window,office}) \text{ x } SHGC_{adj,office}}{A_{window,retail} + A_{window,retail} + A_{wall,office} + A_{wall,office}}$$

$$SHGC_{adj,total} = \frac{(297.5m + 70m) \text{ x } 0.602 + (13.5 + 39m) \text{ x } 0.83 = 0.631}{297.5m + 70m + 13.5m + 39m}$$

The adjusted solar heat gain coefficient of 0.631 has to be compared with the required maximum solar heat gain coefficient as described in table 6 of the guidelines on Energy Conserving Design of Buildings. Since the maximum SHGC depends on the window-to-wall ratio of the façade, it has to be calculated accordingly:

$$WWR_{facade} = \frac{A_{window,retail} + A_{window,office}}{A_{window,retail} + A_{window,office} + A_{wall,retail} + A_{wall,office}} = 100\% = 26.0\%$$

Since the window-to-wall ration of 25.0% is between the two values 20% and 30%, a linear interpolation must be applied. The result of the interpolation is a maximum solar heat gain value of 0.640.

Since the adjusted solar heat gain coefficient is lower than the maximum required solar heat gain coefficient, the façade has passed the requirements of the prescriptive method regarding solar heat gains.

4.3.2 Sample Calculation for Minimum Insulation Values

The prescriptive method considers the thermal performance of the façade in regard to solar transmittance of the windows and minimum insulation values separately. While Chapter 4.3.1 of this manual describes the calculation of the solar transmittance, this chapter explains how to proof the required insulation values for the wall and the roof.

The minimum insulation values of walls and the roof are as follows:

- $U_{wall} \leq 3.4$ W/m²K
- $U_{roof} \leq 1.4$ W/m²K

For the example building described in chapter 0 of this manual the wall U-value has to be calculated as follows:

$$U_w = \frac{1}{R_{si} + \frac{d}{k} + R_{so}}$$

$$U_w = \frac{1}{0.12W/m^2K + \frac{0.15m}{0.721\frac{W}{mK}} + 0.04W/m^2K} = 2.717W/\ m^2K$$

Since the U-value of the wall is with 2.717 W/m²K lower than the minimum requirement of 3.4 W/m²K, the wall construction can be approved.

For the example building described in chapter 0 of this manual the roof U-value has to be calculated as follows:

$$U_r = \frac{1}{R_{si} + \frac{d_{concrete}}{k_{concrete}} + \frac{d_{polysterene}}{k_{polysterene}} + R_{so}}$$

$$U_r = \frac{1}{0.16 + \frac{W}{m^2K} + \frac{0.2m}{1.442\frac{W}{mK}} + \frac{0.05m}{0.035\frac{W}{mK}} + 0.056W/m^2K}$$

$$U_w = 0.561W/m^2K$$

Since the U-value of the roof is with 0.561 W/m²K lower than the minimum requirement of 1.4 W/m²K, the roof construction can be approved.

4.4 Shading devices

External shading devices are the most efficient way to reduce the solar heat load in a building. Because of this, shading devices are considered both in the OTTV and the prescriptive method with the shading factor *f*.

In case of the example building described in chapter 0 the shading devices of the office windows have an overhang depth of 0.6 m and the window has a height of 2 m. This is results in a depth to height ratio of 0.3. According to table 7 of the guidelines, the shading factor f is 0.74 for horizontal shading. If the depth to height ratio is between the values in table 7 a linear interpolation is possible. Since the retail window has no shading, the shading factor is 1 in this case.

The shading factor f can now be used for the further calculation procedure according to the OTTV or prescriptive method.

PART II: MECHANICAL SYSTEMS

SECTION V: AIR CONDITIONING AND VENTILATING SYSTEM

5.1 Introduction of Mechanical System

Designers shall evaluate other energy conservation measures, which may be applicable to the proposed building or the proposed building renovations. (see Section 5 of **Guidelines on Energy Conserving Design of Buildings**.)

GUIDELINE REFERENCE AND REQUIRED MEASURES
Building owners with buildings with a TGFA of 10,000 m2 or more shall be required to submit the following: » building's annual electricity usage (kWh/year), » fuel consumption (liters/year) of generators, and » liquefied petroleum gas (LPG) consumption (kg/year). This shall be submitted in the application for the renewal of mechanical systems. Documents to be submitted in the report shall be: » the monthly electrical bills, » fuel, and » LPG delivery receipts.

Design Application

The design application checklist for submission to the Office of the Building Official of the LGU can be downloaded through the QR code included in this manual.

Design Documentation

- Load Calculation
- System Design and Sizing
- Mechanical Drawings
- Equipment Schedule
- P & ID

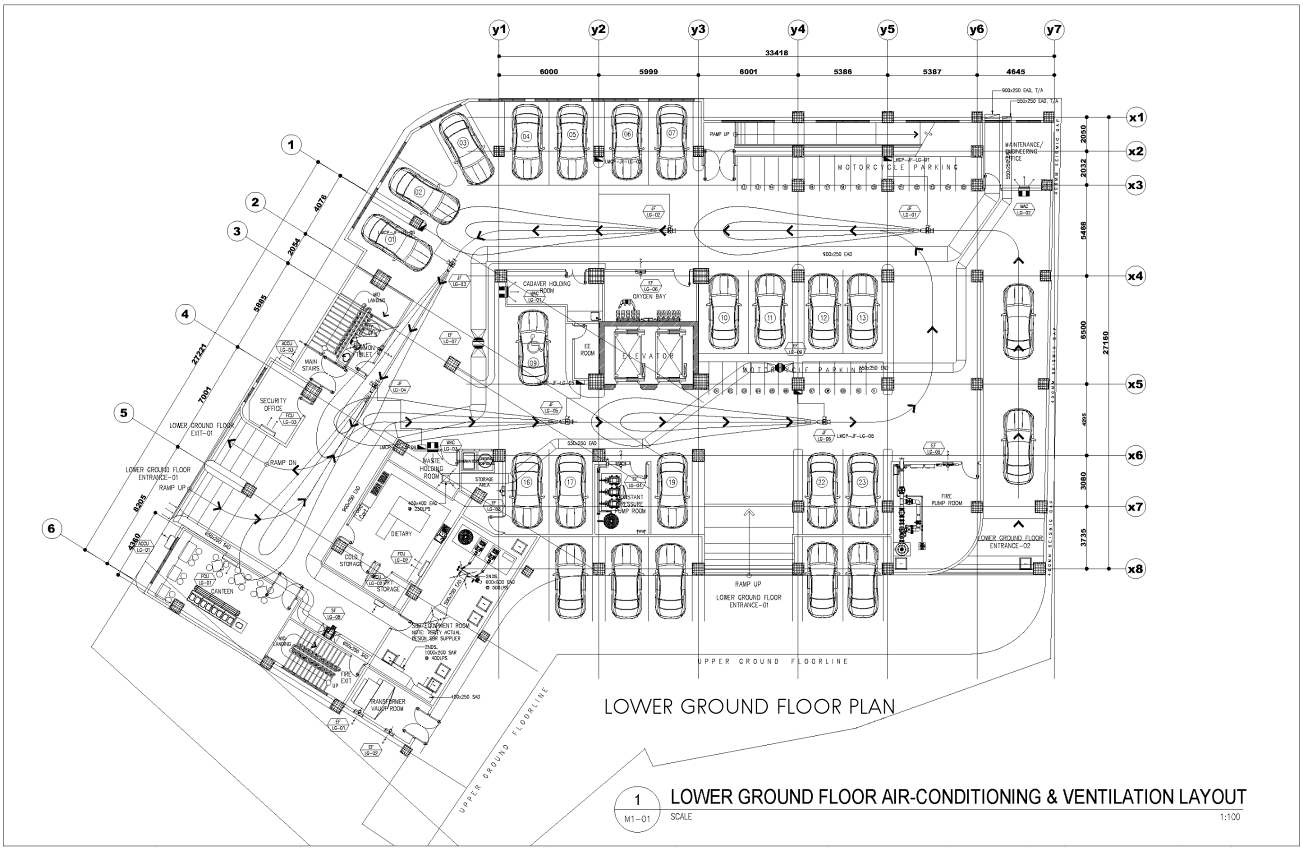


Figure 8: Sample Mechanical Plan with air-conditioning and ventilating system

5.2 Load Calculation

GUIDELINE REFERENCE AND REQUIRED MEASURES
Calculation Procedures Cooling system design loads for the purpose of sizing the system and equipment shall be determined in accordance with the procedures in the latest edition of the ASHRAE Handbook of Fundamentals or other equivalent publications. **Indoor Design Conditions** The indoor conditions in an air-conditioned space shall conform to the following: » Design Dry Bulb Temperature 25°C » Design Relative Humidity 55% » Maximum Dry Bulb Temperature 27°C » Minimum Dry Bulb Temperature 23°C » Maximum Relative Humidity 60% » Minimum Relative Humidity 50% **Outdoor Design Condition** The outdoor conditions shall be taken as follows for Climate Zone OA: 1. Design Dry Bulb Temperature 35°C 2. Design Wet Bulb Temperature 28°C *Note: Indoor design conditions may differ from those presented above because of special occupancy or process requirement, source control, air contamination, or local regulation.* *(see Section 5.2 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Ventilation

GUIDELINE REFERENCE AND REQUIRED MEASURES
The quality and quantity of air used to ventilate air-conditioned spaces shall always be sufficient and acceptable to human occupation and comply with applicable health and/or air quality requirements. Ventilation requirements shall conform to the design criteria in Table 15 of Guidelines on Energy Conserving Design of Buildings. *(see Section 5.2 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

Outdoor air qualities may exceed those shown in Table 16 of Guidelines on Energy Conserving Design of Buildings *because of special occupancy or process requirements, source control air contamination or local regulations.*

Kitchen Ventilation

GUIDELINE REFERENCE AND REQUIRED MEASURES

Figures 4 through 9 of Guidelines on Energy Conserving Design of Buildings show the six basic hood styles for Type 1 applications. The style names are not used universally in all standards and codes but are well accepted in the industry.

The styles are as follows:

5.2.4.1	Wall-mounted canopy – used for all types of cooking equipment located against the wall	(see Figure 4, Guidelines on Energy Conserving Design of Buildings)
5.2.4.2	Single-island canopy – used for all types of cooking equipment in a single-line island configuration	(see Figure 5, Guidelines on Energy Conserving Design of Buildings)
5.2.4.3	Double-island canopy – used for all types of cooking equipment mounted back to back in an island configuration	(see Figure 6, Guidelines on Energy Conserving Design of Buildings)
5.2.4.4	Back shelf – used for counter-height equipment typically located against the wall, but could be freestanding.	(see Figure 7, Guidelines on Energy Conserving Design of Buildings)
5.2.4.5	Eyebrow – used for direct mounting to oven and some dishwashers	(see Figure 8, Guidelines on Energy Conserving Design of Buildings)
5.2.4.6	Pass-over – used over counter-height equipment when pass- over configuration (from the cooking side to the serving side) is required	(see Figure , Guidelines on Energy Conserving Design of Buildings 9)

*(see Section 5.2.E of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

AIR CONDITIONING COOLING LOAD ESTIMATE

Table 2: Air Conditioning Cooling Load Estimate

Project:						By:
Location:						Date:
Length, ft.:	x Width, ft.:		= Floor Area			- Sq.Ft.
Height, ft.:						
By-pass Air Factor (BF)		0.15				
Conditions	Dry bulb, °F		Wet bulb, °F	% RH	Grain/lb	
Outdoor	95		82		131	
Room	75				71	
Difference	20				60	
Ventilation						
cfm/person x			0 persons =		0 cfm	
cfm/sq.ft. x			- sq.ft. =		0 cfm	
	Total cfm				cfm	

	Item	Area Length, ft.	Height, ft.	Sun Gain/ Temp Diff	U Factor	Btu/Hr

Solar Gain Heat

N	glass		x		SF x		x		=	-
S	glass		x		SF x		x		=	-
W	glass		x		SF x		x		=	-
E	glass		x		SF x		x		=	-
N	wall		x		SF x		x		=	-
S	wall		x		SF x		x		=	-
W	wall		x		SF x		x		=	-
E	wall		x		SF x		x		=	-
	roof		x		SF x		x		=	-

Conduction Heat Gain

All glass			x		x		=	-
All wall			x		x		=	-
Partition			x		x		=	-
Ceiling			x		x		=	-
Floor			x		x		=	-
Roof			x		x		=	-

AIR CONDITIONING COOLING LOAD ESTIMATE

Internal Heat Gain

N		0		persons	x	245			=	-
S		Watts x			x	3.42			=	-
W				Hp	x	2546			=	-
				Kw	x	3415			=	-
						Room Sensible Heat			=	-

Ventilation

1.08	x	20	x	0.15	BF x	0		cfm	=	-
				.	Effective Room Sensible Heat					-

Latent Heat Gain

Occupants	0	Persons	x	205					=	-

Ventilation

0	cfm x	71	gr/lb x	0.15	BF x	0.68			=	-
					Effective Room Latent Heat				=	-
					Effective Room Latent Heat				=	-

Outside Air

Outside Air Sensible			cfm x	20	°F	1.08	x			
	(	1	-	0.15	BF)				=	-
Outside Air Latent		0	cfm x	60	gr/lb x	0.68	x			
	(	1	-	0.15	BF)				=	-
						Outside Air Total				-
					GRAND TOTAL HEAT in Btu/hr				=	-
					In Tons of Refrigeration					-

Psychrometery:

ESHF = ERSH 0 / ERSH 0 = #DIV/0!

Indicated ADP = deg Selected ADP = 51 deg F

Temp. Rise = (1 – 0.15) x (75 deg F Room – 51 APD) = 20.4 deg F

Dehum Air = ERSH / (1.08 x 20.4 deg F) = CFM

Supply Air = RSH / (1.08 x 20.4 deg F) = CFM

Resulting Entering & Living Condition at Apparatus

T EDB = T Room + CFM OA ______ (TOA ______ - TRM) =
CFM*

T EDB = (CFMOA TOA) + (CFM RA x TRM / CFM RA

T LDB = (TADP + BF (TEDB - TADP)

Notes:
SF/TR =
CFM/TR =

Notes: Use the values in the Building Envelope and the Mechanical System Tables in the Guidelines on Energy Conserving Design of Buildings, 2020 Edition. Access the Excel File version of the Airconditioning Cooling Load Estimate form from the QR Code.

5.3 System Design and Sizing

GUIDELINE REFERENCE AND REQUIRED MEASURES
Air conditioning system and equipment shall be sized as close as possible to the space and system loads calculated in accordance with the subsection on load calculation. A. **Engineered system and equipment** • Shall be properly sized and selected to meet maximum loads and shall have good unloading characteristics to meet the minimum load efficiency. B. **Consideration at design stage** • Considerations shall be given at the design stage for providing centralized monitoring and control to achieve optimum operations with minimum energy consumption. *(see Section 5.3 of* ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

Design Application

Designer shall consider Table 8 of the Guidelines on Energy Conserving Design of Buildings.

General Notes for Number of Chillers: If the total capacity of the chilled water requirement is over 2,400 TR (8,450 kW), the sizing would be at the discretion of the designer. ***VFD drive would only be required for units that would be doing peaking loads. Baseload chillers would be soft-starter drive***.

The designer shall follow the system design performance goal shown in Table 4 below in order to comply with the guidelines.

Table 3: Performance Goals

Component	Typical kW/Ton	Efficient kW/Ton	Difference	% Savings
Chiller	0.62	0.485	0.135	22%
Cooling Tower	0.045	0.012	0.033	73%
Condenser Water Pump	0.0589	0.022	0.0369	63%
Chiller Water Pump	0.0765	0.026	0.0505	66%
Total Water Side System	0.8004	0.545	0.2554	32%

Source: ASHRAE Green Guide/Table of Efficiencies

5.4 Fan System Design Criteria

GUIDELINE REFERENCE AND REQUIRED MEASURES

The following design criteria apply to all air conditioning fan systems used for comfort ventilating and/or air conditioning.

Exception: System with a total fan motor power requirement of 5 kW or less.

A. **Constant Volume Fan Systems**
For fan systems that provide a constant air volume whenever the fans are operating the power required by the motor of the combined fan system at design conditions shall not exceed 0.5 W/ m3/h.

B. **Variable Air Volume (VAV) Fan Systems**
1. For fan systems that are able to vary system air volume automatically as a function of load, the power required by the motor of the combined fan system at design conditions shall not exceed 0.5 W/m3/h.
2. Individual VAV fans with motor rated at 5 kW and larger shall include control and devices such as a variable speed drive necessary to make the fan motor operate efficiently even at flow rates of as low as 40% of the rated flow. Electronically commutated (EC) motors shall be used.

*(see Section 5.4 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

5.5 Pumping System Design Criteria

GUIDELINE REFERENCE AND REQUIRED MEASURES
The following design criteria apply to all pumping systems used for comfort air conditioning as discuss in the guidelines. A. **Pressure Drop** Chilled water and cooling water circuits of air conditioning systems shall be designed at a maximum velocity of 1.2 m/s (3.9 fps) for a 50 mm diameter pipe and pressure drop limit of 39.2 kPa per 100 (4 ft/100 ft) equivalent meter for piping over 50 mm diameter. B. **Variable Flow** Pumping systems that are provided with control valves designed to modulate or step open or close, depending on the load, shall be required for variable fluid flow. The system shall be capable of reducing system flow to 50% of design flow or less. *(see Section 5.5 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Photo shows chilled water pumps to circulate the chilled water.

Exception

- System where a minimum flow greater than 50% of the design flow rate is required for the proper operation of the equipment served by the system
- Systems that serve only one control valve
- System with total pump motor requirement of 5 kW or less

5.6 Air Distribution System Design Criteria

GUIDELINE REFERENCE AND REQUIRED MEASURES

The temperature and humidity of the air within the conditioned space shall be maintained at an air movement from 0.20 to 0.30 m/s (39 fpm to 59 fpm).

*(see Section 5.6 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

5.7 Controls

GUIDELINE REFERENCE AND REQUIRED MEASURES

A. **System Controls**
1. Each air-conditioned system shall be provided with at least one control device for temperature regulation.
2. All mechanical ventilating system (supply and exhaust) equipment, either continuously operating or not, shall be provided with readily accessible manual and/or automatic controls or other means of volume reduction, or shut-off when ventilation is not required.

B. **Zone Control**
1. Each air-conditioned zone shall be controlled by individual thermostatic controls responding to temperature within the zone systems that serves
2. System that serve zones that can be expected to operate non-simultaneously for more than 750 hours per year (i.e. approximately 3 hours per day on a 5 day week basis) shall include isolation devices and controls to shut off the supply of conditioned air to each zone independently.

Isolation is not required for:
- a. Zones expected to operate continuously
- b. Systems which are restricted by process requirements
- c. Gravity and other non-electrical ventilating systems that may be controlled by readily accessible manual dampers.

C. **Control Area**
- C.1 The supply of conditioned air to each zone/area shall be controlled by an individual control device responding to the average temperature within the zone. Each controlled zone shall not exceed 465 m2 in area.
- C.2 For Buildings where occupancy patterns are not known at the time of the system design, such as speculative buildings, isolation areas may be pre-designed.
- C.3 Zones may be group into single isolation area, provided the total conditioned floor are does not exceed 465 m2 per group, or includes more than one floor.

D. **Temperature Controls**
Where used to control comfort cooling, temperature controllers shall be capable of being set locally or remotely by adjustment or selection of the sensors, between 23°C and 27°C, or in accordance with local regulation.

E. **Thermostat**
Location of the thermostats in controlled zones shall measure a condition `representing the whole space and shall not be affected by direct radiation, drafts, or abnormal thermal conduction or stratification.

F. **Building Automation System**
Buildings with an air-conditioning system with a capacity of 1053 kW (300 TR) or larger shall be provided with building automation systems with software that will optimize, monitor, and control mechanical and electrical equipment with complete data-logging of its operational performance and maintenance schedule.

G. **Germicidal Irradiation and Filtration System for AHUs and FCUs**
A germicidal irradiation filtration system is needed for air handling units (AHUs) and fan coil units (FCUs) for efficient disinfection. A High Efficiency Particulate Air (HEPA) filter or Minimum Efficiency Reporting Value (MERV) 13 filter and above would increase the static pressure of the equipment blower; thus, increasing the blower horsepower is needed to operate the AHU and FCU. With ultraviolet germicidal irradiation (UVGI) and MERV 6 filters, the increase in blower horsepower is no longer necessary; hence, the current blower can still be used.

The recent US CDC Approval is the use of UL 2998 Certified Bi-Polar Ionization that does not produce Ozone and can be an alternate to UVGI and MERV 6 filters also does not increase blower horsepower.

*(see Section 5.7 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

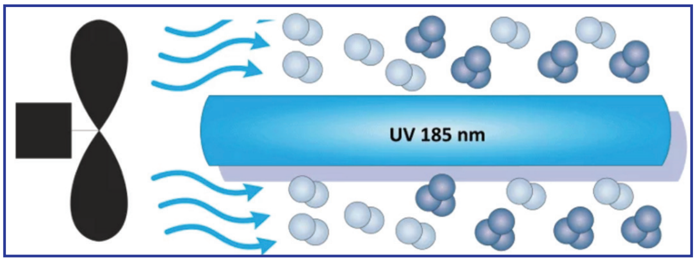
Design Application

Advantages and Disadvantages of Available Germicidal Irradiation Technologies:

1. **HEPA (High Efficiency Particulate Air) Media Filtration**
   - Pleated type filter that has proven 99.87% efficient to trap particles 0.3 microns and larger.
   - Can be incorporated into central HVAC systems or used as stan-alone units.
   - Is effective on particulate removal.
   - Cannot treat source of contaminants, commonly filter contaminated air from entering an area.
   - Is not effective on many mold spores, bacteria and viruses.
   - Is not effective on VOC's, gasses and most odors.
   - Will restrict airflow when incorporated into central systems and increase energy cost.
   - Requires several maintenance visits to replace used filters each year.

2. **UVGI (Ultra-Violet Light) Purification**
   - Disinfect bypassing air through ultra-violet light.
   - Can be incorporated into central HVAC systems or used as stand-alone units.
   - UV light can only treat contaminants that pass directly through the light field. Ambient air that does not enter through the light field will not be treated.
   - UV is dependent on contaminants being exposed to the light field for a time period long enough for the contaminant to be treated.
   - UV is dangerous when exposed to humans, except UVC.
   - Some elements (for example Aspergillus Niger) are resistant to UV altogether.
   - Is not effective on VOC's, gasses and odors.
   - Is not effective in reducing particulate levels.
   - Some of these systems produce undesirable ozone level.
   - Ozone is produced from UV lights wavelengths between 100 and 240 nm. A shortwave, low pressure UV lamp can be used for this purpose. These lamp will produce UV lights with two peaks in the UV light band, one at 254 nm and another at 185 nm. The 185 nm light is what is referred to as an "ozone producing" lamp, while the 254 nm light is referred to as a "germicidal" lamp.
   - Will not restrict airflow when incorporated into central system.
   - Requires maintenance each year to replace worn bulbs

Figure 9: Ozone Formation Commercially from UV Lighting

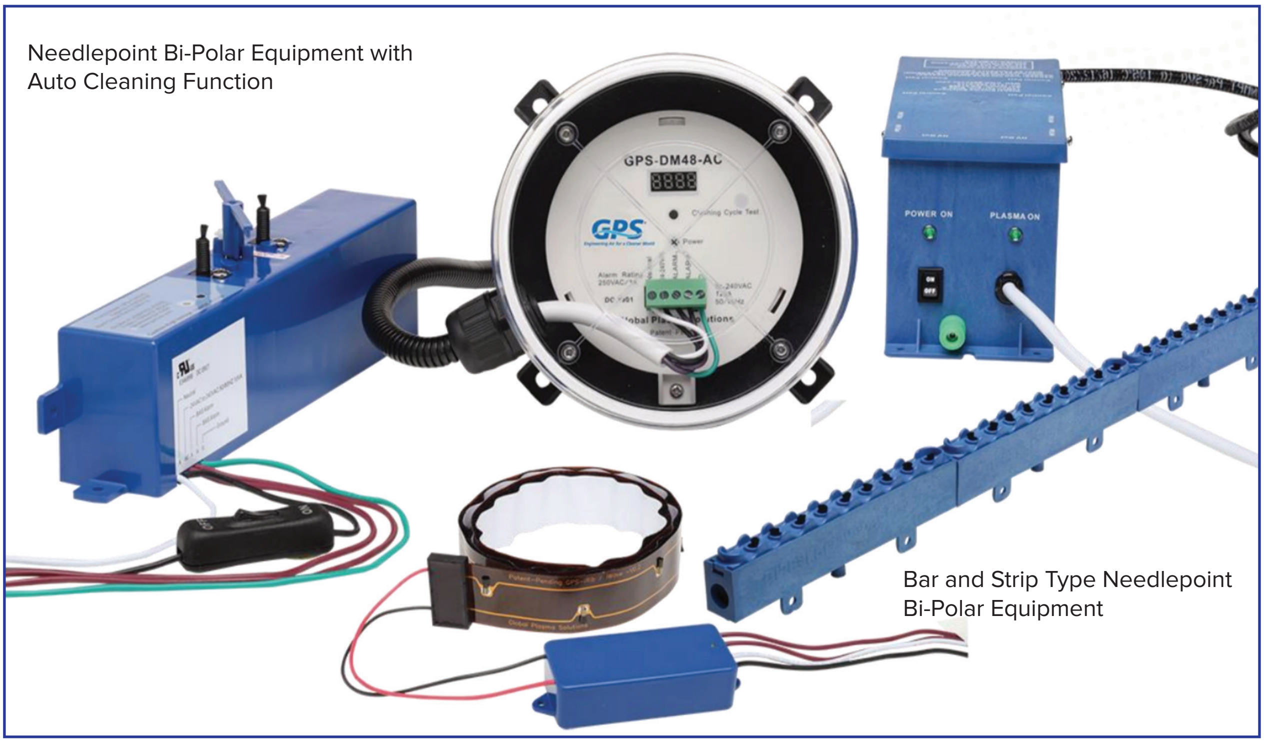


Ozone can be formed via a UV light similar to how it is produced naturally. Using a UV light tuned for UV production at 185 nm wavelength, ozone will be produced.

Source: https://www.oxidationtech.com

3. **Bi-Polar Ionization**
   - Disinfects air by producing and distributing a controlled amount of positive and negative air ions, which interact with oppositely charged elements.
   - Does not rely on contaminants passing through the unit to be cleaned, the bi-polar ionization process allows for air cleaning to occur within the desired space treating a larger volume of air within the breathing range.
   - Treats the source of contamination.
   - Can be incorporated into central HVAC systems, Window Room AC, Split and VRF AC or used as stand-alone units.
   - Will not restrict airflow when incorporated into central systems, Window Room AC, Split and VRF AC.
   - Needlepoint Bi-Polar ionizers are ionization needles that produce positive and negative ions.
   - Needlepoint Bi-Polar ionizer does not produces Ozone.
   - Some Tube Type Bi-Polar ionizers produces Ozone.
   - Needlepoint Bi-Polar Ionizer has a minimum life of 20 years and is transferable.
   - Bi-Polar ionization tubes are replaced every two years (older technology)

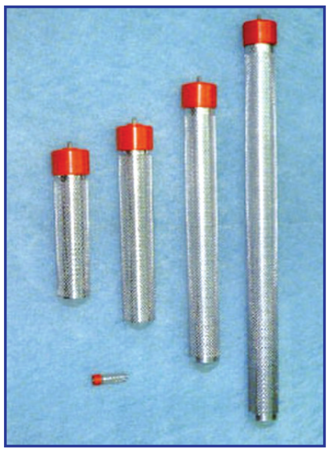
Below are samples of Needlepoint Bi-Polar Ionization Gadgets



source: globalplasmasolutions

Installation of Various Types of Needlepoint Bi-Polar Ionization Equipment

Bi-Polar Ionizer Tubes



Acrylic Bi-Polar Ionization Tubes (replaced every 2 years)

Sources:
https://www.the-review.com/
https://hvacelementsgroup.com/
https://www.vertisys.net/

Table 4: Comparative Table for Various Disinfection Systems for HVAC

Description	Media Filtration		Ultra Violet Lights	Bi-Polar Ionization	
	Hepa	Merv	UVGI (UVC)	Needlepoint	Tube Type
Replacement Interval	Annually	Annually	Annually	None	2 Years
Produce Detectabe Zone	No	No	Depends on frequency*	No	Yes
Must have CDC UL 2998 Certification	Need to present UL 2998 Certification	Yes	Need to present UL 2998 Certification	UL 2998 Certified	Need to present UL 2998 Certification
Kills mold, bacteria, and virus	No	No	Yes	Yes	Yes
Kills pathogens in the space	No	No	No	Yes	Yes
Controls odors	No	No	No	Yes	Yes
Reduces particulates	Yes	Yes	No	Yes	Yes
Contains Mercury	No	No	Yes	No	No
Electrode Fragile	No	No	Yes	No	Yes
Shock Resistant	Yes	Yes	No	Yes	No
Self Cleaning Function	No	No	No	Yes	Yes
Hazardous Disposal Required	None	None	Yes for Mercury	None	None
Type of Materia	Filter Media	Filter Media	Filter Media	Plastic Casing	Glass Tube
Affect the Life of Filter Media	No	No	Yes	No	No
Restrict Air Flow	Yes	Yes	Yes	No	No
Increase in Fan Horsepower	Yes	Yes	Yes	No	No
Maintenance Requirements	Annually	Annually	Annually	None	Every 2 years

Note:
1. Based on the tabulation UVGI is an efficient disinfectant and energy efficient compared to Filter Media Filtration, but needs annual maintenance to replace the UV light tubes.
2. The New Needlepoint Bi-Polar Technology is the most efficient disinfectant, and odor remover as compared to the other four (4) technology available in the market.

*Ozone can be produced from UV light at a frequency of 185 nm.

Case Studies

1. **The University of Maryland Baltimore**

Challenge
The University of Maryland Baltimore buildings needed an applied solution to reduce exhaust fumes and particles from helicopters using the nearby landing pad for their Medical Center. The UV system installed in the HVAC system was unable to control the VOC's and particulate from the helicopters nor the odor generated within the buildings.

Solution

The University of Maryland Baltimore tried several solutions and products and proved that the Needlepoint Bi-Polar with a cleaning function was the best. Their existing UV system was ineffective, and the tube-type bi-polar corona discharge products tested on-site produced ozone, aldehydes, and fine particles. The needlepoint bi-polar which is UL 2998 certified for no ozone, helps control the fine particles while tackling odors.

Results

The Needlepoint bi-polar drastically reduced the exhaust fume and odors within 24 hours, and reduced the particles in the space by up to 85%. The Needlepoint bi-polar not only addressed the odors coming from the animals in the vivarium and test labs nearby.

Source: University of Maryland Baltimore/GPS Solution

2. **Valencia College**

Challenge
The Valencia College, Lake Nona Campus, was constructed in 2012 and included state-of-the-art academe spaces, teaching labs, student services, bookstore, library, café, a Dean's suite, and administrative offices. The 88,821 sq. ft. campus was a $ 21.7 million project. The school wanted to proactively implement needlepoint bi-polar ionization for energy savings but also wanted to proactively get ahead on any futures issues around odors, particles, or pathogens.

Solution

They installed needlepoint bi-polar ionization in all the air handling units on campus. It is perfect for such a large facility because it kills molds, bacteria, and airborne pathogens while maintaining a clean cooling coil.

Results

The Valencia College, Lake Nona Campus was awarded 3 Green Globe Certifications by US Green Building Initiative (Equivalent of LEEDS Rating of the US Green Building Council).

The Needlepoint bi-polar reduced the outside air needed for ventilation by 9,300 cfm and saved S 180,000 in chiller cost.

The Needlepoint bi-polar ionization was compatible with their current air handling unit, which avoided costly renovation expenses. Testing revealed that there were no fungi or bacteria detected on the cooling fins.

Source: The Valencia College, Lake Nona Campus/GPS Solution

3. **The Leaning Experience**

Challenge
The Learning Experience a national child care center franchise realized that a large portion of their monthly operating budget was allocated to the heating and cooling of their facilities. Annually HVAC maintenance for the larger air handling equipment was also unpredictable and often an unforeseen additional expense.

Solution
The self-cleaning needlepoint bi-polar ionizer was installed to reduce the amount of outside air needed to treat the indoor space. The technology also kills airborne pathogens and reduces the level of odor-causing VOCs. Each installation incorporates 5 or 6 units to improve the indoor air quality of the building.

Results
The Leaning Experience realized a 10-ton reduction or about 1,500 cfm of outside air intake with the installation of the needlepoint bi-polar ionizer. This helps avoid costly HVAC equipment upgrades while reducing operating and maintenance cost.
The needlepoint bi-polar ionization technology also provides the added benefit of pathogen destruction, minimizing the number of airborne pathogens and ultimate cross-contamination of germs between the children and staff. The specified needlepoint bi-polar ionization solution for all the TLE facilities across the country.

Source: The Learning Experience National Child Care Center/GPS Solution

4. **Cleanroom Application**

Challenge
A new chemical introduced into the manufacturing process was creating odor issues for the employees working in the cleanroom and adjoining spaces that shared the same air handling system. The noxious odor needed to be contained or eliminated to improve the indoor air quality and working conditions for the employees.

Solution
The needlepoint bi-polar ionization system was installed in the air handling system that treats the air of the cleanroom.

Results
The odors were neutralized within 24 hours of the needlepoint bi-polar ionization system. Additionally, the annual cleanroom certification process revealed that the total particle count was reduced by 89.7 %. This new low particle count was the lowest the manufacturer had experience in 10 years.

Source: Project Spotlight Healthcare/GPS Solution

5.8 Chiller Plant Insulation

GUIDELINE REFERENCE AND REQUIRED MEASURES
All chilled water piping shall be thermally insulated in accordance with Table 20 of Guidelines on Energy Conserving Design of Buildings, to prevent heat gain and avoid sweating on the insulation surface. The insulation will be suitably protected from damage. *(see Section 5.8 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

1. Piping that conveys fluids that have not cooled through the use of fossil fuels or electricity
2. Piping at fluid temperatures between 20°C and 40°C
3. When the heat gain of the piping without insulation does not increase the energy requirements of the building

5.9 Air Handling System Insulation

GUIDELINE REFERENCE AND REQUIRED MEASURES
» All air handling ducts and plenums installed as part of the air distribution system and which are outside of air-conditioned spaces shall be thermally insulated sufficiently to minimize temperature rise of the air stream within them, and to prevent surface condensation. » Insulated ducts located outside of buildings shall be jacketed for rain tightness and for protection against damage. » Air ducts or plenums within air-conditioned spaces may not be insulated if the temperature difference (TD) between the air outside and within the ducts or plenum would not cause surface condensation. Due consideration shall be made to the dew point temperature of the air surrounding the ducts or plenums. *(see Section 5.9 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

1. When the heat gain of the ducts, without insulations, shall not increase the energy requirements of the building
2. Exhaust air ducts

5.10 Air Conditioning Equipment

GUIDELINE REFERENCE AND REQUIRED MEASURES
Minimum Equipment Performance Air conditioning equipment shall have a minimum performance corresponding to the rated conditions shown in Table 21 of Guidelines on Energy Conserving Design of Buildings. Data furnished by equipment suppliers or manufacturers certified under a nationally recognized certification program or rating procedure shall be acceptable to satisfy these requirements. **Performance Rating** » The performance rating of the air conditioning equipment above 14 kW (3.95 TR) shall be measured by its EER or kWe/TR, whichever is applicable. » The EER shall not be less than those quoted in Table 22 of Guidelines on Energy Conserving Design of Buildings, while kWe/TR shall not be greater than the figures in the same table. *(see Section 5.10 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

5.11 Heat Recovery

GUIDELINE REFERENCE AND REQUIRED MEASURES

Whenever there is a high demand for hot water requirement and if economical, heat recovery shall be adopted in the air conditioning system condenser heat. Another would be using Enthalpy Recovery of Exhaust Air or Energy Recovery Ventilation for exhaust air.

A. **Enthalpy of Exhaust Air**
All buildings with a centralized air supply system shall use an enthalpy recovery wheel or energy recovery ventilation with the efficiency of at least 60% of 90% of exhaust air. When buildings have outside air or fresh air supply and they extract air through mechanical means, heat exchangers can use the air extracted from the building area to pre-condition the incoming outdoor air. This process takes into account the fact that the extracted air is usually already conditioned, and therefore colder and drier.

*(see Section 5.11 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Figure 10: Circulation of Outdoor and Indoor Air in an Enthalpy (Energy) Recovery Ventilation

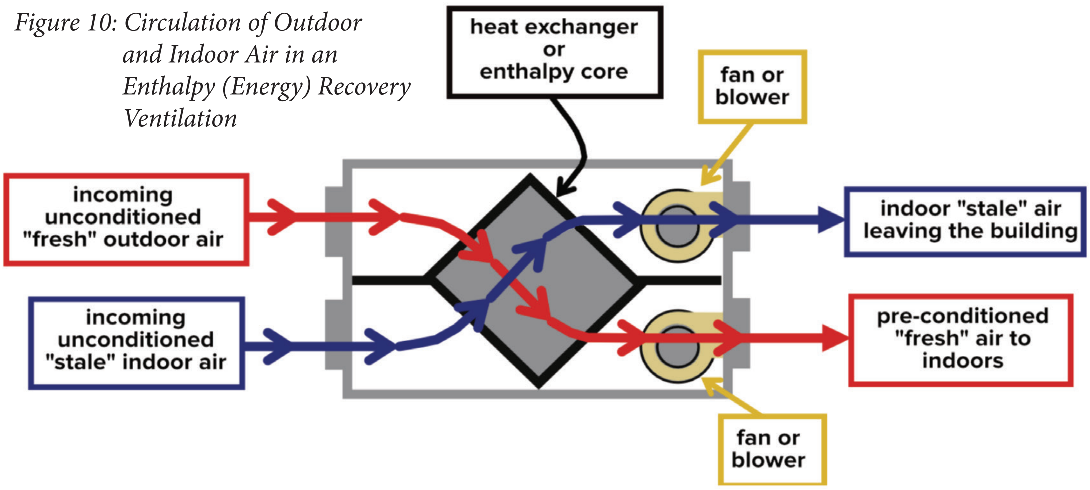
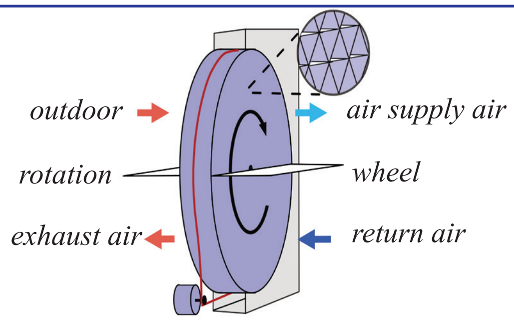


Figure 11: Enthalpy or Heat Recovery Wheel



5.12 Thermal Comfort in Non-Air-Conditioned Buildings

GUIDELINE REFERENCE AND REQUIRED MEASURES

General Principles of Thermal Comfort
The main variables that affect human comfort are as follows:

1. dry bulb temperature
2. relative humidity or wet bulb temperature
3. air movement
4. ventilation
5. thermal radiation from hot surface (ceiling, walls, and glass windows).

To a lesser extent, certain other factors also affect human comfort like indoor air quality.

*(see Section 5.12 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Natural Ventilation by Jack Roof and Roof Ventilator

1. The performance of roof ventilators is usually rated in terms of speed and indoor and outdoor temperature differential to take into account the two natural motive forces of ventilation: thermal force and wind effect.
2. A jack roof has poorer ventilation performance. However, assuming that a jack roof is about 50% as efficient as a cowl ventilator since the windward side of a jack roof does not act as an exhaust opening, the net area of jack roofs required per meter run of a building is about 1.2 m2 for a building width of 18 m.
3. The intake fresh air louver shall be at 1 meter above the floor so that the fresh air with lower temperature pushes up the hot air to the roof ventilator/jack roof ventilator.

5.12.1 Provision for Natural Ventilation and Lighting

GUIDELINE REFERENCE AND REQUIRED MEASURES

Note: The requirements below are subject to compliance with the provisions of Easement of Light and View of the Civil Code of the Philippines, specifically Articles 667 to 673.

1. In natural regulations, it is specified that every building shall have:
   a. natural lighting through windows, skylights, fanlights, doors, and other approved natural light-transmitting media; and
   b. natural ventilation through windows, skylights, fanlights, doors, louvers, or similar ventilation openings.
2. In general, openings facing the sky, street courtyard, or air well shall be considered as acceptable sources of natural lighting and ventilation.
3. In the case of a building other than a factory or warehouse, any part of the building within 9 m from an acceptable opening is considered adequately ventilated by natural means.
4. In the case of a factory or warehouse, the maximum effective coverage of any window and other openings on an external wall is 12 m from the opening, whereas the coverage of any jack roof or other openings on the roof is 9 m, measured horizontally from the opening.
5. In addition, every room in any building shall have natural lighting and ventilation through one or more sources having an aggregate of not less than x percent of the floor space of the room, of which at least y percent shall have an opening to allow free uninterrupted passage of air. The respective values of x and y are given in Table 23 according to the types of occupancy or types of usage of the room.
6. In the case of public garages, two or more sides of the garage shall have an opening for cross ventilation and the area opening will be at least 50% of the area of the wall where it is located.
7. Enclosed parking garage ventilation systems shall automatically detect contaminant levels by using supervisory control and data acquisition (SCADA) or building management systems (BMS); this is a must for energy efficiency. An induction (jet fan) ventilation with an electronically commutated (EC) motor shall be used in basement parking garages due to the following:
   a. Effective dilution of contaminants within the car park environment as compared with the ducted system
   b. The car park is too large and too deep to ventilate naturally.
   c. Slab penetrations can be reduced. No need for ventilation plant rooms.
   d. Capital cost savings can be found through reduced car park height and less site excavation, less concrete and steel.

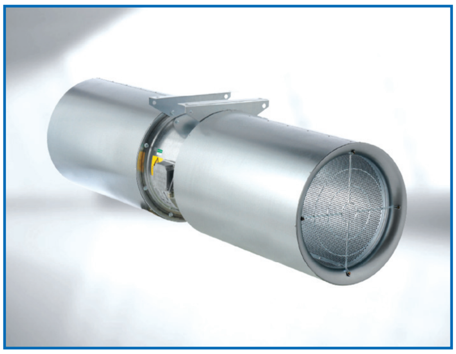
*(see Section 5.12 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

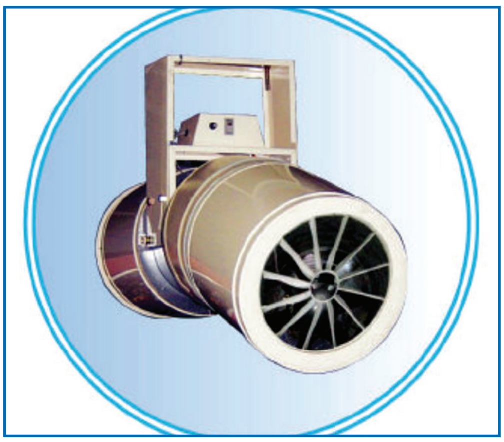
Table 5: Car Park Ventilation Design Guide

	Ducted System	Ductless Jet Fan System
1	Requires extensive ductworks and cannot cover entire ventilation area specially with structural beam hindrances	Better safety level, can extract CO and Smoke ensuring no dead spot. Can maintain acceptable CO level at all times
2	The bigger the parking system, the more ductwork and equipment required'	Optimizes space usage, higher vehicle parking capacity means added revenues
3	Bigger transfer fans and ductworks installed overhead or at group level occupy space which are more prone to accidents.	Optimized system design means lower trust level to overcome static resistance hence lower energy requirements
4	Higher installation cost, more manpower requirement, quality output is on manpower skill level	Easier installation and operation, lower maintenance cost
5	Once installed, ductworks cannot be replace in the event of insufficient ventilation, dead spot cannot be avoided	Highly flexible, can accommodate last minute design changes with very minimal or no cost, simpler wiring
6	On/Off system is scheduled based in historical information, more manual than automatic, higher energy consumption	Control System is intellegent and can be activated or turned off providing ventilation only where needed and necessary.
7	Over time, ductworks become polluted with hard to clean toxic residue, also lowers the floor to ceiling clearance.	Improves the over all aesthetic value of the parking are giving patrons a secure comfortable feeling

Nozzle Jet Fan Single Type with EC Motor

Source: https://shop.systemair.com





Banana Type Jet Fan with EC Motor

https://systemvent.en.ec21.com

Slim Exhaust Fan with EC Motor for Exhaust and Fresh AI

https://gamma-agri.en.made-in-china.com

5.13 Mechanical Ventilation

GUIDELINE REFERENCE AND REQUIRED MEASURES
Where site conditions dictate that the normal requirements for natural lighting and ventilation cannot be met, the building regulations may allow the use of mechanical ventilation as substitute. According to the regulation, the quantity of fresh air supply for mechanical ventilation of any room or space in a building shall be in accordance with the specific rates in Table 24 of Guidelines on Energy Conserving Design of Buildings. Unless justified by exceptional circumstances, the ventilation rate shall not be exceeded by more than 30%. *(see Section 5.13 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

SECTION VI: STEAM AND HOT WATER SYSTEM

6.1 Introduction of Steam and Hot Water System

This section applies to the energy conserving design of steam and hot water services in buildings that include but are not limited to hotels, restaurants, hospitals, and laundry shops. The purpose of this section is to provide the criteria and minimum standards for energy efficiency in the design and equipment selection that will provide energy savings when applied to steam and hot water system. (see Section 6.1 of **Guidelines on Energy Conserving Design of Buildings**)

Design Application

The design application shall be submitted to the Office of the Building Official of the LGU.

Design Documentation

» Load Calculation
» System Design and Sizing
» Mechanical Drawings
» Equipment Schedule
» P & ID

6.2 System Design and Sizing

GUIDELINE REFERENCE AND REQUIRED MEASURES
A. The system with the lowest overall energy usage (considering the heat losses in the calorifier and the circulating loop of a centralized system and the total heat losses from a system of individual storage heater) shall be chosen. B. Steam is more economical compared with electricity. Where steam is available, use steam to generate hot water. 1. Use a heat exchanger to heat water from steam 2. Heat pump may also be used to produce hot water C. When steam is used, a centralized hot water generator shall be placed as near as possible to the steam source to reduce piping heat losses. D. For the generation of steam, use a boiler with an efficiency rating of 85% and above. E. In the absence of steam, use a direct-fired hot water generator with an efficiency rating of 85% and above. F. Use a solar water heater on the rooftop with a 3 kW electric heater back up to be used during prolonged rains. 1. Types of solar water heat absorbers are as follows: a. Copper serpentine type solar hot water heat absorber with a capacity of 300 liters and 150 liters storage capacity b. Vacuum tube absorber-type solar hot water with a capacity of 300 liters and 150 liters storage capacity. 2. This can be installed with a pipe header and a solar water heat absorber in multiples of either 300 liters or 150 liters daily heating capacity with a centralized insulated hot water tank and an equivalent electric heater backup in case of prolonged rains for residential condominiums, hotels, and hospitals. 3. Solar energy use in water heating is for commercial, hotels, hospitals, and medium to high-rise residential building applications. See Table 34, Renewable Energy Ready Solar Water Heating Checklist of Guidelines on Energy Conserving Design of Buildings, 2020 as a guide to its efficient design. 4. Solar water heaters can also be used as pre-heated feed water to steam boilers or calorifier for efficiently producing hot water. *(see Section 6.2 of* ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

6.3 Minimum Equipment Efficiency

GUIDELINE REFERENCE AND REQUIRED MEASURES
All boilers and hot water storage tanks shall meet the criteria in Tables 29, 30, 31 of Guidelines on Energy Conserving Design of Buildings. *(see Section 6.3 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

Hot water storage tanks having more than 2 m3 of storage capacity need to meet the standby loss or heat loss requirements of Table 29 if the tank surface is thermally insulated with suitable insulating material with R= 0.045 m2-°C/W-mm.

6.4 Hot Water Temperature

GUIDELINE REFERENCE AND REQUIRED MEASURES
The maximum hot water supply temperatures shall be as follows: For washing, etc. 45°C For hot bath 45°C For kitchen use 60°C It is recommended that two separate systems be installed when two different temperatures (hot and cold) are required, to minimize piping heat losses. This shall always be done where the demand at the lower temperature is greater than 25% of the demand at higher temperature. *(see Section 6.4 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

6.5 Controls

GUIDELINE REFERENCE AND REQUIRED MEASURES
*(see Section 6.5 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

6.6 Piping Insulation

GUIDELINE REFERENCE AND REQUIRED MEASURES
Circulating Systems The insulation of steam, condensate, and hot water lines shall conform to the requirements in Table 30 Non-circulating System. **Non-circulating System** The first 2.5 m of outlet piping from a storage system that is maintained at a constant temperature and inlet pipe between the storage tank and the heat trap shall be insulated as provided in Table 30, or to an equivalent level as calculated in accordance with Equation 7.1. *(see Section 6.6 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

6.7 Waste Heat Recovery and Utilizations

GUIDELINE REFERENCE AND REQUIRED MEASURES
A. Consider using condenser heat, waste heat, or solar energy to supplement hot water requirements. Recovered waste heat from the chilled water system for water heating where the base requirement is 85 F (29.4 C). To maximize the captured heat without decreasing the chiller plant efficiency, the system shall accomplish the following: 1. Capture sufficient heat for useful purposes 2. Minimize chiller lift and maximize chiller efficiency. 3. Control the hot water temperature without sacrificing the stable plant operation. B. Storage shall be used to optimize heat recovery when the flow of heat to be recovered is out of phase with the demand for hot water. *(see Section 6.7 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

PART III: ELECTRICAL SYSTEMS

SECTION VII: LIGHTING

7.1 Introduction of Lighting

This section shall apply to all the lighting systems and components of spaces and areas of buildings, such as:

1. Interior spaces of buildings;
2. Exterior areas of buildings such as entrances, exits, loading docks, parking areas, etc.;
3. Roads, grounds, and other exterior areas including open-air covered areas where lighting is required and is energized through the building's electrical service.

GUIDELINE REFERENCE AND REQUIRED MEASURES
These set out the minimum requirements for achieving energy-efficient lighting installations. These are generally expressed in terms of illumination level, luminous efficacy, and lighting power density. In the course of selecting an appropriate indoor illumination level for a space, energy efficiency shall be taken into consideration, in addition to other lighting requirements. On the other hand, specific efficiency requirements for each type of lamp, control gear/ballast, and luminaire shall conform to the Minimum Energy Performance (MEP) for Products established by DOE.

Exception

Research laboratories with special lighting requirements is the only exemption.

7.2 Daylighting, Photoelectric Switch and/or Automatic Dimmer Provisions

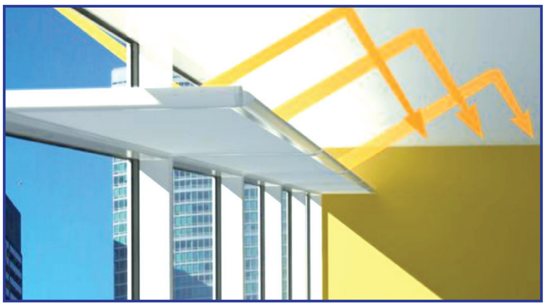
GUIDELINE REFERENCE AND REQUIRED MEASURES
All regularly occupied spaces inside the building shall employ features that can allow daylight into the room space. These can be any or a combination of the other features or daylighting provisions. *(see Sections 7.3.A, 7.5.A, and B of* ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

Design Application

These can be any or a combination of the other features or daylighting provisions:

1. Windows – the window openings shall at least be 10% of the room space floor area as per National Building Code (NBC).

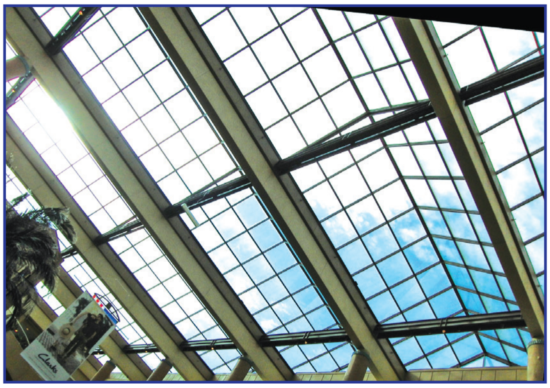
2. Light Shelf



Source: https://www.modlar.com

3. Clerestory

4. Skylight



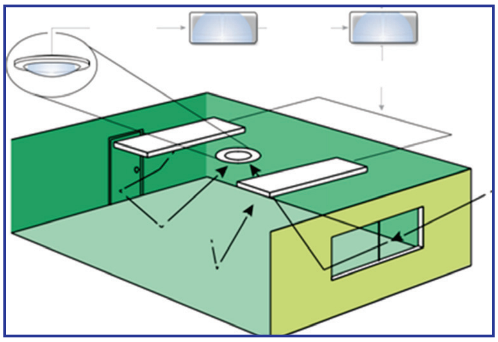
5. Light monitor/light scoop

Source: https://www.lrc.rpi.edu

6. Other devices that can allow daylight inside

Where adequate daylighting is available, local manual or automatic controls such as photoelectric switches or automatic dimmers shall be provided in the day-lit spaces. Controls shall be provided so as to operate rows of lights parallel to the facade/exterior wall. If occupancy sensors are installed in the daylight zone, the occupancy sensor shall override the photoelectric sensor during non-occupancy periods. For residential condominiums, this applies only to common indoor areas with access to daylight.

Source: https://www.pinterest.ph



Source: Philippine Green Building Code User Guide

The light fixtures equipped with photoelectric sensor shall be located approximately at half (½) the depth of the daylight zone. Installed lighting fixtures within the day-lit zones are exempt from using photoelectric sensor if this hinders its intended functions.

7.3 Integrated Lighting and Air Conditioning Luminaires Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES

For buildings with centralized air conditioning equipment, consideration shall be given to integrated lighting and air conditioning systems which use luminaires with heat removal capabilities. (See related requirement in the Air Conditioning and Ventilating System Section of Part 2: Mechanical Systems of the Guidelines.)

(see Section 7.3.D of ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

7.4 Efficient Lighting System/ Equipment Selection Provisions

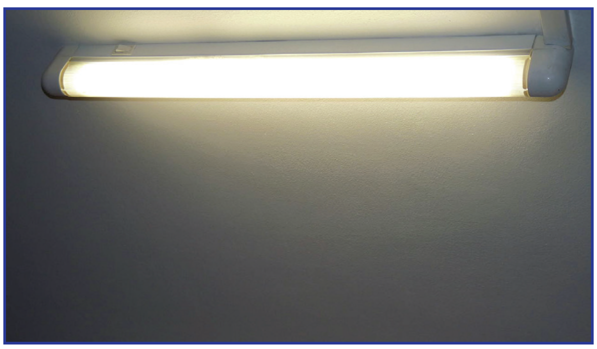
GUIDELINE REFERENCE AND REQUIRED MEASURES

The lighting system shall be designed for expected activity. The designer shall select the most efficient lamps, the proper color rendition, and the desired color appearance appropriate for the type of lighting needed for the space to be lit. The most efficient combination of luminaires, lamps, and ballasts appropriate for the lighting task and for the environment shall be selected so that lamp light output is used effectively. The selected luminaire shall meet the requirements with respect to light distribution, uniformity, and glare control.

If color rendering is comparatively of minor importance, lamp types with Color Rendering Index (CRI) of less than 50 can be used. However, when good color rendering is required, lamp types with CRIs of 50 and above shall be used.

Refer to Table 36 of the Guidelines for the list of the recommended illuminance levels for a particular space and Table 37 for the Efficacy Ranges and Color Rendering Indices (CRI) of the different lamp types. Further, when luminaires are required, the luminaires to be used shall have highly polished or mirror reflectors. Where ballasts are used, these shall be of the electronic type or low loss type with a power factor of at least 85%.

(see Sections 7.3.E, G, H, and I of ***Guidelines on Energy Conserving Design of Buildings, 2020****)*



7.5 Emergency Lighting Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
Buildings with at least ten (10) storeys shall have at least one LED lamp in each corridor, emergency exit, and stairwell per storey. Each elevator shall also have at least one LED lamp (with a light output of at least 500 lumens), which shall always be lit and designed to have a separate circuit from the usual lighting circuit, which is not controllable by a switch and is supplied by the UPS System of the building. *(see Section 7.5 of **Guidelines on Energy Conserving Design of Buildings**)*

7.6 Finishing Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
Light finishes shall be employed to attain the best overall efficiency of the entire lighting system. Dark surfaces shall be avoided because these absorb light. Table 38 of Guidelines on Energy Conserving Design of Buildings, 2020 lists the recommended room surface reflectance. . *(see Section 7.6 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

7.7 Lighting Control Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
Selective switching possibilities shall be provided so that individual, or a specific group of fixtures, can be turned off when not needed, and lighting levels can be adapted to changing needs. Task lighting may be employed to achieve this requirement. Each enclosed space or room shall have at least one control point (e.g., switch) for lighting. Likewise, one lighting control point shall be provided for each task lighting. However, for enclosed areas 10 m2 or larger, the lighting design and/or control device shall be able to reduce lighting by at least 50%, while maintaining a reasonably uniform level of illuminance throughout the area, through the use of dimmers, dual switching of alternate lamps or by switching each luminaire or each lamp. When dimming control of lighting will be needed, rheostat-based dimmers shall not be used; only electronic dimmers are allowed. In determining the total number of control points, use Table 42 of the Guidelines on Energy Conserving Design of Buildings. (*see Section 7.7* of ***Guidelines on Energy Conserving Design of Buildings, 2020***)

Exception

Continuous lighting required for emergency/security purposes.

7.8 Lighting Power Density Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
The total lighting power density (LPD) for the interior and exterior building area types/spaces of buildings shall not exceed the maximum values for a particular building area type/space as specified in Table 39 and 40 of Guidelines on Energy Conserving Design of Buildings. The total building LPD shall be determined by the following formula: $LPDBAT = \frac{S1}{S2}$, where; LPDBAT = Average Lighting Power Density of a Particular Building Area Type/Space (W/m2); S1 = Total Designed Lighting Load Wattage of a Particular Building Area Type/Space (W); S2 = Total Gross Floor Area of a Particular Building Area Type/Space (m2); *(see Section 7.4.A. and B* of ***Guidelines on Energy Conserving Design of Buildings, 2020***)

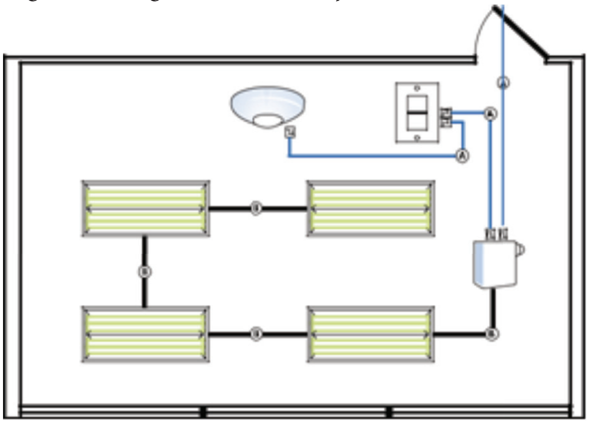
7.9 Occupancy Sensor Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
Occupancy sensors linked to lighting shall be installed in areas with variable occupancy, such as the following areas: 1. Corridors 2. Private offices 3. Storage rooms 4. Common toilets 5. Meeting rooms 6. Stairways 7. Other similar areas *(see Section 7.5.C of* ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

Exception

1. Hospitals and malls for emergency and security lighting

Figure 12: Single-level control layout in a small room



Source: Philippine Green Building Code User Guide)

For covered car parks, minimum of sixty percent (60%) of the lighting shall be controlled by the occupancy sensors.

7.10 Exterior Lighting Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
Exterior lighting not intended for 24 hours continuous use shall be automatically switched off, when not needed through the use of timer, photocell, or a timer-photocell combination but provided with manual override. *(see Section 7.5.I of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

7.11 Hotel/Motel Guest Room Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
Every guest room of hotels and motels shall be equipped with a master switch, which shall be located by the main entry door and may be activated by the insertion (instantaneous) and removal (either instantaneous or with a short time delay) of the room key or any other similar control device that automatically switches on or off the master switch after detecting occupancy or non-occupancy of a room, respectively. *(see Section 7.5.J of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

Continuous lighting required for emergency/security purposes, if applicable.

7.12 Display and Valance Lighting Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
For retail and wholesale stores, feature display and valance lightings shall have separately switched circuits. Each feature display lighting circuit shall be designed to have a total calculated load of not more than 20 amperes. If there are more than four of these feature displays circuits, the display lighting shall be automatically controlled by a programmable timer with provisions for temporary override by store personnel. *(see Sections 7.5.K and L of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

7.13 Lighting Control Location Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES
All lighting controls shall be installed near the point of entry of a particular space and shall be readily accessible to space occupants. Switches for task lighting areas may be mounted as part of the task lighting fixtures. Switches controlling the same load from more than one location shall not be credited as increasing the number of controls to meet the requirements of Table 41 of Guidelines on Energy Conserving Design of Buildings. *(see Sections 7.6.A and B of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

1. Lighting control requirements for spaces, which shall be used as a whole, shall be controlled following with the work activities, and controls may be centralized in remote locations. These areas include public lobbies of office buildings, hotels, and hospitals; retail and department stores and warehouses; storerooms and service corridors under centralized supervision.
2. Manual and automatic control devices may reduce the number of controls required by using an equivalent number of controls from Table 41 of Guidelines on Energy Conserving Design of Buildings.
3. Automatic controls
4. Programmable controls
5. Controls requiring trained operators
6. Controls for safety hazards and security

Design documentation

When applying for a building permit, the following documents, among others, are usually attached to the application:

1. Complete architectural design plans and drawings, including interior design and drawings;
2. Complete mechanical design plans, drawings, and computations;
3. Complete electrical design plans, drawings, and computations;
4. Plans, drawings, and computations of other disciples.

To determine whether the design of the building is compliant with this section of the Guidelines on Energy Conserving Design of Buildings, the Building Official concerned shall require the submission and/or presentation of the following detailed design documents from the complete building design plans submitted:

A. **Architectural Design**
   1. Floor Plan or Roof Plan – showing daylighting provisions and the intended use of the spaces (see Section 7.1)
   2. Building Elevations and Sections – showing daylighting provisions such as windows, light monitors, clerestory, scoops, light shelves, atrium, skylights, etc. (see Section 7.1);
   3. Daylight Provisions Details – detailed drawings of daylighting provisions (see Section 7.1);
   4. Calculations to show that window openings equivalent to at least 10% of the floor space have been provided for all regularly occupied spaces (see Section 7.1);
   5. Technical data of the glass – showing the SHGC value (see Section 7.1);
   6. Reflected Ceiling Plan – showing the location of lights, photosensors and/or occupancy sensors (see Sections 7.1, 7.4, 7.7, and 7.8);
   7. Interior Finishing Design Floor Plan – showing the kind and color of the ceiling, walls and floor finishing of the spaces (see Section 7.5);
   8. Interior Design Floor Plan – showing the types, colors and surfaces of the furnishings (i.e., furniture, appliances, etc.) and the task, accent, ambience, feature display and valance lighting fixtures, details and technical specifications, whichever is applicable. In the event of non-compliance to requirements, justifications for employing dark finishes/surfaces (see Sections 7.5 and 7.11);

9. Exterior Lighting Plan and Drawings – showing location and type of the exterior lighting fixtures, walkway/path lighting, perimeter/security lighting, sports and leisure lighting, etc. (see Sections 7.7 and 7.9).

B. **Mechanical Design**
1. Air conditioning and ventilation system ceiling plan with section drawings (see Section 7.2).
2. For buildings using centralized air conditioning systems with integrated lighting and air conditioning luminaires, integrated lighting and air conditioning luminaire detail drawings (see Section 7.2).

C. **Electrical Design**
1. Interior Lighting Design Floor Plan – showing the layout of the fixed/permanent lighting fixtures, task and emergency lighting, detailed design drawings, circuitry and control (i.e., toggle switches, sensor switches, programmable timer, etc.), calculations (including the LPD computation table per particular building area type/space) and technical specifications of the lighting system. Justification for the non-usage of photosensors since it hinders the intended function of the lighting fixture (see Sections 7.1, 7.3, 7.4, 7.6, 7.7, 7.8, 7.10, 7.11, and 7.12);
2. Exterior Lighting Design Drawings – showing the layout of the permanent lighting fixtures and the power supply and control (i.e., timers, photosensors, occupancy sensors, etc.) circuitry (see Sections 7.1, 7.3, 7.4, 7.7, 7.8, 7.9, and 7.12);
3. For hotels and motels, guest rooms' electrical power and lighting circuitry showing the key activated master switch or other similar control devices (see Section 7.10);
4. Lighting product technical brochure (see Section 7.3);
5. Lighting Control Diagram – showing the control logic of the various sensors and controllers employed (see Sections 7.1 and 7.8);
6. Occupancy sensor/s designed zone/s of coverage (see Section 7.8);
7. Technical Data Sheets (TDS) of the various sensors and controllers employed (see Sections 7.1, 7.6, 7.8, 7.9, and 7.11);
8. UPS design circuitry drawings, calculations, and technical specifications (see Section 7.4).

Construction Documentation

The following documents are needed for the occupancy permit application:
1. As-built interior lighting installation drawings, including emergency lighting;
2. Exterior lighting as-built drawings;
3. Ocular inspection, verification and/or testing report of the completed daylighting provisions, daylight-controlled lighting system/s, occupancy sensors, emergency lighting and UPS installations within the facility with reference to the submitted building permit plans;
4. Ocular inspection and verification report of the finishing within the facility with reference to the submitted building permit plans.
5. Verification of the total count of lighting fixtures and the total wattage of lighting load of the building, which shall be compared to the LPD computation table submitted during building application and the maximum LPD limit for a particular building area type/space as mandated in the Guidelines. (*Philippine Green Building Code*)

6. LPD computation table based on actual installation as-built. (Only if product considered in the design is different from the actual).
7. Product labels/Nameplate labels and technical brochures of the installed lighting devices and equipment.

Operation documentation

Ocular inspection and testing of the emergency lighting system and UPS are needed for the certificate of yearly inspection by the OBO and/or DOE.

SECTION VIII: ELECTRIC MOTORS

This section shall apply to the energy efficiency requirements of electric motors (i.e., AC and DC) utilized inside the building and those within the vicinity of the building that provide service to said building. Covered under these energy efficiency requirements are the following:

1. AC Motors
2. DC Motors
3. Special Purpose Motors

8.1 Minimum Efficiency Performance Requirements for Motors

GUIDELINE REFERENCE AND REQUIRED MEASURES
The performance of a motor shall equal or exceed the nominal full-load efficiency levels given in Table 42 of Guidelines on Energy Conserving Design of Buildings. Minimum efficiency performance requirement (MEPR) for AC motors designed to operate more than 750 hours a year used in residential, commercial, and institutional applications in these guidelines shall be at least IE2 type as shown in Table 43 of Guidelines on Energy Conserving Design of Buildings or whatever minimum energy performance requirement is mandated by the DOE from time to time. The nameplates of these motors shall include not only all the information required by the latest edition of the *Philippine Electrical Code Part 1*, but also the rated full load efficiency and full-load power factor as determined by the latest version of of IEC 60034-2-1 - Standard for electric motors and IEC 60034-30-1 – Classification scheme comprising four levels of motor efficiency ("IE-code"). These shall be the reference standards used in these guidelines. On the other hand, the latest edition of NEMA MG 1, which defines the manufacturing standards for alternating-current (AC) and direct-current (DC) motors shall also be the reference standard to be used in these guidelines.   *(see Sections 8.1.B and C; 8.2.B, C, and D of* ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

Exemptions: The following are exempted from the MEPR:

1. Submersible motors;
2. Motors that are integrated into a system that prevents the individual motor efficiency from being tested;
3. Motors designed to operate at extremely high or low temperatures, in explosive environments (ATEX), or at altitudes above 1000 meters above sea level.

8.2 Motor Sizing Provision

GUIDELINE REFERENCE AND REQUIRED MEASURES
The type and the size of the squirrel-cage induction motor shall be selected only after an accurate determination of the starting and running requirements of the load have been made, taking into account the following factors: 1. Maximum overload expected 2. Ambient conditions 3. Power supply conditions 4. Future expansion 5. Deterioration of the driven load 6. Duty cycle 7. Speed In cases where a higher kW rating is necessary due to special requirements of the application, the motor rating may be increased but shall not exceed 125% of the calculated maximum load to be served. If this rating is not available, the next higher rating may be selected. *(see Section 8.1.D of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

8.3 Variable Speed/Frequency Drive Provision and Total Harmonic Distortion Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
All blowers, fans, and pumps requiring speed control operation shall use variable speed/frequency drives. All motors of cooling towers, domestic pumps and mechanical equipment over five (5) kW used for variable speed applications shall utilize high-efficiency motors (at least IE2), in accordance with Table 43 of Guidelines on Energy Conserving Design of Buildings, coupled with variable speed/frequency drives. Since VSD/VFD produces harmonics. VSD/VFD equipment to be fitted to motors shall have a Total Harmonic Distortion (THD) rating of less than 5%. *(see Sections 8.1.E, 8.3.B, 8.6.F, and H of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

1. Kitchen ventilation fans and non-centralized air conditioning systems. However, said fans and air-conditioning systems shall comply with the MEPP mandated by DOE.

8.4 Energy Performance Requirements for Cooling Systems

GUIDELINE REFERENCE AND REQUIRED MEASURES
For cooling systems using motors, either the Energy Efficiency Factor (EEF) or the Cooling Seasonal Performance Factor (CSPF) shall be the measure of energy performance that shall apply. EEF shall apply to all applicable refrigeration systems, while CSPF shall apply to all applicable air conditioning systems. Please refer to the Mechanical Systems Section of the Guidelines for the Minimum Energy Performance (MEP) requirements for refrigerating and air conditioning systems, as mandated by the DOE. *(see Section 8.2.F of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

8.5 Soft Starter Provision

GUIDELINE REFERENCE AND REQUIRED MEASURES
Soft starters with energy optimization shall be used in starting all simple constant speed operation applications of motors. All motors of cooling towers, domestic pumps and mechanical equipment over five (5) kW used for constant speed applications shall utilize high efficiency motors (at least IE2), in accordance with Table 43 of Guidelines on Energy Conserving Design of Buildings, and fitted with soft starters with energy optimization. *(see Sections 8.3.A, B. and 8.6.H of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

8.6 Pump Provision

GUIDELINE REFERENCE AND REQUIRED MEASURES
A pump shall be properly sized for its application to attain a flow near peak efficiency maintaining a flow between 80% and 100% of the Best Efficiency Point (BEP). Further, for maximum performance, correctly apply the suction and discharge dimensions. *(see Section 8.6.A of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

8.7 Overhead Water Tank/s Provision

GUIDELINE REFERENCE AND REQUIRED MEASURES

All buildings with at least ten (10) storeys shall be provided with overhead or elevated water tank/s with a total capacity of 120% of the calculated average daily water demand of the building.

*(see Section 8.6.G of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

1. Buildings below 10 storeys

8.8 Escalators and Moving Ramps/Walkways Operations and Motor Drive Provisions

GUIDELINE REFERENCE AND REQUIRED MEASURES

Escalators and moving ramps/walkways shall reduce speed when no traffic is detected for a maximum period of one and a half (1-1/2) minutes and stop or go on standby mode after five (5) minutes of no activity. This can be achieved through the use of energy-efficient AC motors (IE2 or higher) coupled with VSD/VFD or DC inverter drives and sensors installed under the top or bottom landing areas, which activates a programmable control device/equipment (e.g., Programmable Logic Controller) that determine when to reduce speed and turn the power off or on and go on standby mode when the programmed condition is met.

(see Sections 8.7.A–C of ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

8.9 Elevator Motor Drive Provision

GUIDELINE REFERENCE AND REQUIRED MEASURES

All buildings that have elevators shall be designed to have elevators run by motors coupled to a Variable Voltage and Variable Frequency (VVVF) drive.

(see Section 8.8.A of ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

Exception

1. Hydraulic elevators and buildings are not required to have elevators.

8.10 High-Capacity Escalator and Elevator Requirement

GUIDELINE REFERENCE AND REQUIRED MEASURES

For airports, train stations, high-rise (i.e., 10 storeys or higher) buildings and the like, with high-capacity escalators and elevators that travel long downward distances, its escalators and elevators shall have motors equipped with VSDs/VFDs coupled with line regenerative drives.

(see Sections 8.7.D and 8.8.B of ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

Exception

1. Low-capacity escalators and escalators with short downward travel distances.

8.11 Elevator Lighting Requirements

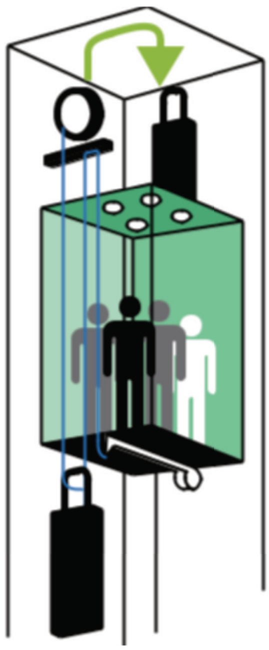
GUIDELINE REFERENCE AND REQUIRED MEASURES
Elevator car, including display and emergency, lighting shall use lamps with efficacies, across all fittings in the car, of at least 80 lumens/watt. *(see Section 8.8.C of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

8.12 Elevator Operations Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES

The elevator/s shall operate in a standby mode. All lighting of the elevator car, except the emergency lighting, shall switch off when no activity has been detected for a maximum period of five (5) minutes; said duration may be adjusted, depending on the demand. This can be achieved through the use of sensors and programmable control device/equipment (e.g., Programmable Logic Controller) of the elevator, which determines when to turn the power off or on and go on standby mode when the programmed condition is met.

Source: https://electrification.us.abb.com



Source: https://www.forms-surfaces.com

*(see Sections 8.8.D and E of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

1. The emergency light inside the elevator car, powered by the UPS of the building, shall not turn off, even when the elevator has no activity.

Design Documentation

When applying for a building permit, the following documents, among others, are usually attached to the application:

1. Complete architectural design plans and drawings, including interior design and drawings;
2. Complete mechanical design plans, drawings and computations;
3. Complete electrical design plans, drawings and computations;
4. Plans, drawings and computations of other disciples.

To determine whether the design of the building is compliant with this section of the Guidelines on Energy Conserving Design of Buildings, the Building Official concerned shall require the submission and/or presentation of the following detailed design documents from the complete building design plans submitted:

A. **Architectural Design**
   1. Floor Plan – showing the layout of all the motor-driven equipment and systems, such as pumps, escalators, moving ramps/walkways, elevators, blowers, etc. and all the air conditioning and refrigeration systems (see Sections 8.3, 8.4, 8.5, 8.6, 8.8, 8.9, and 8.10);
   2. Building Section Drawings – showing the height and vertical locations of elevators and escalators (see Sections 8.8, 8.9, and 8.10);
   3. Roof Plan – showing the location of the water tank/s (see Section 8.7);
   4. Single Line or Schematic Diagram – showing the water lines of potable and/or non-potable water, whichever is applicable, and the capacity callout of the water tank/s (see Section 8.7);
   5. Water tank detailed drawings and technical specifications (see Section 8.7).

B. **Mechanical Design**
   1. Floor Plan – showing the layout of all the motor-driven equipment and systems, such as pumps, escalators, moving ramps/walkways, elevators, blowers, etc. and all the air conditioning and refrigeration systems, as well as the computations to determine the motor capacities and, with respect to pumps, their proper sizes and their technical data sheets and or brochure (see Sections 8.3, 8.4, 8.5, 8.6, 8.8, 8.9, and 8.10);
   2. Technical Data Sheets and/or brochures of the VSD/VFD/s to be fitted to motors used for variable speed applications and the Soft Starter/s to be fitted to motors used for constant speed applications (see Sections 8.3, 8.4, 8.5, 8.6, 8.8, 8.9, and 8.10);
   3. Technical Data Sheets and/or brochures of the motors to be installed (see Sections 8.1, 8.2, 8.8, 8.9, and 8.10);
   4. Mechanical Equipment Schedule – showing the description of operations of escalators, moving ramps/walkways and elevators (see Sections 8.8 and 8.12);
   5. Process control diagrams of escalators, moving ramps/walkways and elevators (see Sections 8.8 and 8.12).

(continuation)

C. **Electrical Design**

1. Floor Plan – showing the single line diagram of the power supply and control circuitry, load calculations, required sizes of wires/cables and circuit protection, riser diagram and the technical and efficiency specifications of the motors (see Sections 8.3, 8.4, 8.5, 8.6, 8.8, 8.9, and 8.10);
2. Technical Data Sheets and/or brochures of the line regenerative drives that will be coupled to the VSD/VFDs for high-capacity elevators and escalators (see Section 8.10);
3. Lighting Plan of the Elevator Car – showing the locations of the display and car lightings and emergency lighting, the lighting circuitries and control, the lighting technical specifications and the load calculation table (see Section 8.11);

Construction Documentation

The following document is needed for the occupancy permit application:

1. Ocular inspection and verification report of the nameplates of all the motors, VSD/VFDs, line regenerative drives, soft starters, installed within the facility with reference to the submitted building permit plans (see Sections 8.1, 8.3, 8.5, 8.8, 8.9, and 8.10);
2. Ocular inspection and verification report of the energy labels on all the applicable cooling and lighting systems installed within the facility (see Section 8.4);
3. Ocular inspection, testing and verification report of all the pumps, especially fire pumps, installed within the facility comparing the pumps' nameplates, which shall contain all electrical parameters and mechanical information, with the submitted building permit plans (see Section 8.6);
4. As-built plan and shop drawings of the actual rooftop water storage system installation (see Section 8.7);
5. Ocular inspection and verification report of the completed rooftop water storage system with reference to the submitted building permit plans (see Section 8.7);
6. As-built plans, shop drawings and process control diagrams of the actual elevator, escalator and moving ramps/walkway system installed within the building (see Sections 8.8, 8.9, 8.10, and 8.12);
7. Ocular inspection, testing and verification report of the completed elevator, escalator and moving ramps/walkway system with reference to the relevant provisions under this Building Guidelines (see Sections 8.8 and 8.12);
8. As-built plans and shop drawings of the actual elevator car lighting installation (see Sections 8.11 and 8.12);
9. Ocular inspection, testing and verification report of the installed elevator and the lighting system of the elevator car with reference to the relevant provisions under this Building Guidelines (see Sections 8.11 and 8.12).

SECTION IX. ELECTRIC POWER AND DISTRIBUTION

This section applies to the energy efficiency requirements for transformers and energy conservation requirements of the building's distribution systems.

9.1 Transformer Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
All transformers that are to be part of the building's electrical system shall have efficiencies not lower than 98%. Furthermore, the high (voltage) side of the main transformer of the building shall be connected in delta, while the low (voltage) side shall be connected in wye, with its neutral is available for grounding.

(see Sections 9.2.A and F of ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

9.2 Power Factor Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
The average power factor of all the loads served by the transformers at any time shall not be less than what is required in the latest edition of the *Philippine Distribution Code (PDC)*. In cases where load power factors are below this value, capacitors or power factor improving devices shall be provided so that automatic or manual correction can be made. When capacitor banks are installed and the Computed Harmonic Contamination Index (CHCI) of a building surpasses 15%, the capacitor bank shall be equipped with detuned filters to protect the capacitors to be damaged by the effects of harmonics. CHCI shall be computed by the following formula:
CHCI = kW (harmonic loads) / kW (total load) x 100
(see Section 9.2.B of ***Guidelines on Energy Conserving Design of Buildings, 2020****)*

9.3. Transformer Loading Requirement

GUIDELINE REFERENCE AND REQUIRED MEASURES
Transformer load grouping schemes shall be so designed such that the main transformer/s is loaded to not less than 60% of its full load ratings, and that no-load circuits or partially loaded circuit combinations shall be minimized as much as possible. *(see Section 9.2.C of **Guidelines on Energy Conserving Design of Buildings**)*

9.4 Circuit Breaker and Disconnect Switch Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
Transformers located inside a building shall have sufficient ventilation and have direct access from the road for ease of maintenance at all times. The ambient temperature within the transformer vault/room shall be controlled in such a way that it will not exceed 30oC. *(see Section 9.2.D of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.5 Transformer Vault/Room Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
In compliance with the *Philippine Distribution Code*, disconnect switch/es and circuit breaker/s shall be provided at the primary (supply) side of the transformer to allow electrical disconnection during no load period. *(see Section 9.2.E of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Exception

1. Buildings where the main transformer/s is not enclosed in a vault/room

9.6 Wire/Cable Size Provision

GUIDELINE REFERENCE AND REQUIRED MEASURES
In the calculation of the wire sizes to be used, the designer shall follow the procedure specified in the latest edition of the Philippine Electrical Code (PEC), Part I, considering the factors stated therein to arrive at the minimum acceptable wire size. *(see Section 9.3.A of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.7 THD and TDD Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
The design of Total Harmonic Distortion (THD) and Total Demand Distortion (TDD) for a three-phase circuit at the connection point of the building to the distribution system shall not exceed the limits specified in the *Philippine Distribution Code (PDC)*, which is 5%. *(see Section 9.3.B of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.8 Maximum Current Unbalance Requirement

GUIDELINE REFERENCE AND REQUIRED MEASURES
For three-phase, four-wire circuits with single-phase loads, the maximum current unbalance (unbalance single-phase loads distribution) shall not cause the voltage to unbalance at the distribution system to exceed the limits specified in the *Philippine Distribution Code*, which is 2.5%. *(see Section 9.3.C of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.9 Lightning and Transient Voltage Surge Protection Requirement

GUIDELINE REFERENCE AND REQUIRED MEASURES
All buildings shall install systems to protect their facilities from the effects of lightning and transient voltage surges, which complies with the relevant provisions in the latest edition of the PEC Part 1. *(see Section 9.3.D of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.10 Electrical and Similar Room/s Environmental Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
Electrical vaults/rooms, switchgear rooms, generator rooms, in-door substations, control rooms, relay rooms, battery rooms, metering rooms, SCADA and Telecommunications rooms and other similar rooms, shall have sufficient natural or mechanical ventilation to keep the room temperatures below 30oC and the relative humidity at the range of 75-95% non-condensing. *(see Section 9.3.E of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.11 Electric Vehicle (EV) Parking with Charging Stations Provision

GUIDELINE REFERENCE AND REQUIRED MEASURES
Private and public buildings and establishments covered by these guidelines and pursuant to *Republic Act No. 6541*, otherwise known as the *National Building Code of the Philippines*, shall designate dedicated parking slots for the exclusive use of Electric Vehicles (EVs). The number of dedicated parking slots shall be proportional to the total number of parking slots within the building or establishment as mandated by said law. Further, all designated EV parking areas shall be provided with charging stations or electric vehicle supply equipment (EVSE) for use in charging the EVs. Construction of the EVSE shall comply with all the relevant local standards for electrical connection. EVSEs shall be installed close to the required power source. For locations with multiple EVSEs, installation of a separate meter or sub-metering for each EVSE, isolated from the rest of a building's energy usage, shall be designed. The raceway(s) shall originate at a service panel or subpanel(s) serving the area, and shall terminate near to the proposed location of the charging equipment and into listed suitable cabinet(s), box(es), enclosure(s) or equivalent. Plan design shall be based on 40-ampere minimum branch circuits. *(see Section 9.3.G of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.12 Uninterruptible Power Supply (UPS) System Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
All buildings with at least ten (10) storeys shall have a UPS System with enough capacity to power the emergency/security lighting load of all the corridors, emergency exits, stairwells, elevators, parking spaces, and perimeter areas of a building for at least one (1) hour (back-up time). The UPS System shall be of the most efficient design/configuration for the capacity required. Please refer to Table 18 of Guidelines on Energy Conserving Design of Buildings. The total harmonics generated by the UPS System shall not exceed 5%. *(see Section 9.3.H of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.13 Emergency/Standby Generator Set Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
Buildings with elevators are required to have emergency generator sets with the adequate standby power ratings/capacities to supply power to, at least, the elevators and the various emergency and safety systems of the building for a limited duration (i.e., enough time to evacuate persons trapped inside the elevators) during commercial power outages. Further, an automatic transfer switch (ATS) shall be installed to transfer the power source from the usual local power utility to the emergency/back-up power source, after a short delay, during commercial power interruptions. The generator set's fuel consumption at 100% rated capacity shall not go over 0.28 liters per kWh. Accordingly, every generator set shall be equipped with fuel flow meter and electric power meter. *(see Section 9.3.I of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.14 Power Metering Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
Covered buildings shall have metering facilities capable of measuring voltage, current, power factor, power quality, maximum demand and energy consumption. In addition, feeder metering facilities shall be provided. Whenever possible, a feeder circuit shall serve only a particular group of loads sharing the same function for better monitoring and control. These loads can be grouped as follows: 1. Lighting Load 2. Chiller 3. Air Handling Units, Unitary Air Conditioning Systems 4. Other Motor Loads (exhaust fan, pumps, etc.) In multiple tenant buildings, each tenant unit shall have a provision for measuring the tenant's energy consumption. Energy meters and instrument transformers utilized for billing purposes shall have an accuracy class rating of at least 0.5. Otherwise, such devices shall have an accuracy class rating of at least 1.0. Further, adequate working space in front of the electrical panels and meters shall be provided. *(see Section 9.3.J of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.15 Building Management System

GUIDELINE REFERENCE AND REQUIRED MEASURES
Buildings are encouraged to install Building Management Systems (BMS), with analytics and optimization software, to have centralized monitoring and control of the many individual systems within the building. To prevent hackers from entering the system, BMS with internet connections shall be protected y a firewall to prevent hackers from entering the system. *(see Section 9.4 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.16 Smart Home System

GUIDELINE REFERENCE AND REQUIRED MEASURES
Residential dwelling buildings, such as condominiums, are encouraged to employ smart home technologies in every home unit, which shall be equipped with sensors, devices and appliances that are connected to the Internet of Things (IoT) can be remotely monitored, controlled and accessed by the homeowner. Smart home systems shall be protected from possible hackers through the use of hardware and/or software solutions. *(see Section 9.5 of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.17 Inspection and Thermal Scanning Requirement

GUIDELINE REFERENCE AND REQUIRED MEASURES
During the testing and commissioning phase of the various building systems, inspection and thermal scanning shall be conducted on all transformers, panel boards, conductors and connectors to check for hot spots. *(see Section 9.6.A of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

9.18 Regular Inspection, Maintenance, Monitoring and Energy Audit Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
Buildings shall conduct annual inspection and maintenance of its electrical systems, such as thermal scanning of the transformers, panel boards and conductors to check for hot spots, which are sources of losses in a distribution system and, at the same time, possible causes of electrical fires. Buildings, at the onset of operation, shall monitor and record their monthly energy consumption in order to establish a baseline value. Covered buildings shall conduct a regular energy audits of their facilities. *(see Sections 9.6.A, B, and C of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Design documentation

When applying for a building permit, the following documents, among others, are usually attached to the application:

1. Complete architectural design plans and drawings, including interior design and drawings;
2. Complete mechanical design plans, drawings and computations;
3. Complete electrical design plans, drawings and computations;
4. Plans, drawings and computations of other disciples.

To determine whether the design of the building is compliant with this section of the Guidelines on Energy Conserving Design of Buildings, the Building Official concerned shall require the submission and/or presentation of the following detailed design documents from the complete building design plans submitted:

A. **Architectural Design**

1. Detailed Floor Plan and Layout – showing the location of the main transformer vault/room within the building, layout of the vault/room, location of the temperature sensor/s and vault/room natural and artificial ventilation details (see Section 9.5);
2. Detailed Floor Plan and Layout – showing the location of the electrical vault/room, switch-gear room, generator room, in-door substation, control room, relay room, battery room, metering room, computer room, telecommunications room, and other similar rooms, within the building, layout of the vault/room, location of the temperature and humidity sensors and vault/room natural and artificial ventilation details (see Section 9.10);

B. **Mechanical Design**

1. Detailed Floor Plan and Layout – showing the layout, design and calculations of the mechanical ventilation system of the main transformer vault/room, electrical vault/room, switchgear room, generator room, in-door substation, control room, relay room, battery room, metering room, computer room, telecommunications room, and other similar rooms, (see Sections 9.5 and 9.10);
2. Mechanical Equipment Schedule or Process Control Diagram – showing the description of the operation of the mechanical ventilation of the main transformer vault/room and all similar electrical vaults/rooms (see Sections 9.5 and 9.10);
3. Supplier's technical data sheet of the artificial (mechanical) ventilation the main transformer vault/room and all similar electrical vaults/rooms (see Sections 9.5 and 9.10);

C. **Electrical Design**

1. Technical datasheet or brochure of the transformer/s (see Sections 9.1 and 9.3);
2. Power factor computation of the total loads served by the main transformer and underlying assumptions (see Section 9.2);
3. Power factor correction computation and assumptions to determine the capacity of the power factor correction device/equipment required, if applicable (see Section 9.2);
4. CHCI computation (see Section 9.2);
5. Technical data sheet or brochure of the power factor correction device/equipment, if applicable (see Section 9.2);
6. Technical data sheets or brochures of all motor and lighting loads (see Section 9.2);
7. Main transformer capacity calculation and assumptions (see Section 9.3);
8. Single line diagram of the service entrance and high voltage side of the main transformer/s (see Section 9.4);
9. Technical data sheets or brochures of the main circuit breaker and disconnect switches (see Section 9.4);
10. Detailed Floor Plan and Layout – showing the layout, single line diagram, load schedule of the main transformer vault/room (see Section 9.5);
11. Technical data sheets and/or brochures of the electrical wires and cables, emergency generator set/s, automatic transfer switch, energy meter, instrument transformers (i.e., CT and VT), Building Management System (if applicable) and Smart Home System (if applicable) (see Sections 9.6, 9.13, 9.14, 9.15, and 9.16);
12. Supplier's technical data sheets and/or brochures of the electronic ballasts, self-ballasted lamps (CFL and LED), VSDs/VFDs, UPS, inverter appliances, DC drives (see Section 9.7);
13. Detailed load schedule per phase of the main distribution circuit (see Section 9.8);
14. Design drawings, calculations, technical specifications and technical data sheets and/or brochures of the lightning protection system and surge suppression/protection system (see Section 9.8);
15. Detailed Plan and Layout of the EV Parking/Charging Spaces – showing the location and specifications of the EVSE, design of the raceway/s and calculations to substantiate the design and protection of the EV supply system, to include the rating of equipment and any on-site distribution transformers to ensure sufficient capacity to simultaneously charge all required EVs at full-rated amperage (see Section 9.11);
16. Detailed plan of the UPS supplied circuits, particularly for emergency lighting, capacity calculations, technical specifications and technical data sheets and/or brochures of the UPS (see Section 9.12);
17. Technical data sheets and/or brochures of the BMS, if applicable (see Section 9.15);
18. Technical data sheets and/or brochures of the Smart Home System, if applicable (see Section 9.16);

Construction Documentation

The following documents are needed for the occupancy permit application:

1. As-built Electrical Plans and Shop Drawings - showing the building's service entrance, electrical system, main transformer/s installation, power factor correction device/equipment (if applicable), electrical wires and cables, emergency generator set/s, automatic transfer switch, energy meters, instrument transformers (i.e., CT and VT), UPS, lightning and surge protection, EVSEs and VSDs/VFDs (see Sections 9.1, 9.2, 9.3, 9.4, 9.6, 9.7, 9.8, 9.9, 9.11, 9.12, 9.13, and 9.14);
2. Ocular inspection, verification and testing report of the installed main transformer/s, electrical system of the building, line disconnect switch, switchgear and power factor correction device/equipment (if applicable), electrical wires and cables, emergency generator set/s, automatic transfer switch, energy meters, instrument transformers (i.e., CT and VT), UPS, lightning and surge protection, EVSEs and VSDs/VFDs, with reference to the submitted building permit plans (see Sections 9.1, 9.2, 9.3, 9.4, 9.6, 9.7, 9.8, 9.9, 9.11, 9.12, 9.13, and 9.14);
3. Photos of the nameplates of all installed transformer/s, power factor correction device/equipment (if applicable), motors, UPS, lightning and surge protection, EVSEs, VSDs/VFDs, emergency generator set/s, energy meters, instrument transformers and mechanical ventilation system, if applicable (see Sections 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 9.9, 9.10, 9.11, 9.12, 9.13, and 9.14);
4. As-built detailed architectural and mechanical plans and shop drawings of the building's main transformer vault/room and other similar electrical vaults/rooms (see Sections 9.5 and 9.10);
5. Ocular inspection, verification and testing report of the installed natural and mechanical ventilation and other similar electrical vaults/rooms, with reference to the submitted building permit plans (see Sections 9.5 and 9.10);
6. Thermal scanning report during testing and commissioning of the building's entire electrical system (see Section 9.17).

Operation Documentation

The following documents are needed for the certificate of yearly inspection by the OBO and/or DOE:

1. Ocular inspection and testing of the UPS (see Section 9.12);
2. Annual thermal scanning report (see Section 9.18);
3. Annual monthly fuel consumption and energy generation report of the emergency/standby generator set/s (see Section 9.13);
4. Annual energy consumption report (see Section 9.18);
5. Annual energy audit report (see Section 9.18)

SECTION X: RENEWABLE ENERGY (RE) SYSTEMS AND EQUIPMENT

10.1 RE Power Supply System Requirement

GUIDELINE REFERENCE AND REQUIRED MEASURES
Buildings shall install RE power supply systems within their facility, whenever it is technically feasible, either at their rooftops, façades, grounds and/or roofed parking spaces. Solar PV power supply systems shall employ either grid-tied inverters or hybrid inverters, equipped with active harmonic filters and surge protection. *(see Sections 10.1.A and E of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

10.2 RE Power Supply System Capacity Provision

GUIDELINE REFERENCE AND REQUIRED MEASURES
RE power supply system capacity can be sized to either supply partially the energy requirements of the facility (own use), or supply entirely the energy requirements of the facility (Net Zero Energy Building) or, aside from satisfying its own power requirements, sell the excess energy to the local power utility (Net Metering, which, presently, is up to 100 kW only but may be raised by ERC in the future). *(see Section 10.1.B of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

10.3 RE Power Supply System Design Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
The RE power supply system shall be designed and installed in accordance with the relevant provisions of the latest editions of the Philippine Electrical Code Part 1, the Philippine Distribution Code, applicable rules and regulations issued by ERC and the Office of the Building Official and by the rules and interconnection procedures established by the local distribution utility under which franchise the building is covered. *(see Section 10.1.C of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

10.4 RE Power Supply System Metering Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
The RE power supply systems shall be equipped with at least two (2) meters; one measuring, among others, the quantity of RE power being supplied to the building, and the other measuring the quantity of commercial power (i.e., from the local electric utility) being supplied to the building. *(see Section 10.1.F of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

10. 5 Annual Energy Requirements

GUIDELINE REFERENCE AND REQUIRED MEASURES
Covered buildings shall source, initially, a minimum of one percent (1%) of their projected annual energy requirements (subject to adjustments by the DOE from time to time) from RE sources through the availing of and/or installation of any or a combination or all of the following: 1. RE Power Supply Systems 2. Solar Water Heaters 3. Solar Cooling Systems 4. Solar-Powered Lighting Systems 5. Any other similar system or equipment 6. Green Energy Option Program (GEOP) *(see Sections 10.1.D. and H. and 10.2.A, B and C of **Guidelines on Energy Conserving Design of Buildings, 2020**)*

Design Documentation

When applying for a building permit, the following documents, among others, are usually attached to the application:

1. Complete architectural design plans and drawings, including interior design and drawings;
2. Complete mechanical design plans, drawings and computations;
3. Complete electrical design plans, drawings and computations;
4. Plans, drawings and computations of other disciples.

To determine whether the design of the building is compliant with this section of the Guidelines on Energy Conserving Design of Buildings, the Building Official concerned shall require the submission and/or presentation of the following detailed design documents from the complete building design plans submitted:

A. Architectural Design
   1. Detailed Roof, Facade and/or Grounds Plan and Layout – showing the locations of the RE power supply system, the solar water heater, solar cooling system and/or solar LED street lights of the building, whichever is applicable (see Sections 10.1 and 10.5).

B. Mechanical Design
   1. Detailed Roof Plan and Layout – showing the layout, design drawings, calculations and technical specifications of the solar water heater/s, if applicable (see Section 10.5);
   2. Detailed Floor and/or Roof Plan and Layout – showing the layout, design drawings, calculations and technical specifications of the solar cooling system/s, if applicable (see Section 10.5);
   3. Technical data sheets and/or brochures of the solar water heater and solar cooling system, whichever is applicable (see Section 10.5).

C. Electrical Design
   1. Single line diagram/s showing the building's internal distribution system, including its connection to the local power utility, transformers, UPS, emergency and RE power supply systems, protection system and metering with their ratings, whichever is applicable (see Sections 10.1, 10.2, 10.3, and 10.4);
   2. Detailed design of the RE power supply system, which includes drawings, single line diagrams, calculations (especially, of wires and cables sizes, among others) and technical specifications and its connection to the building's distribution system (see Sections 10.1, 10.2, 10.3, and 10.4);
   3. Detailed design of the solar LED street lights, if applicable (see Section 10.5);
   4. Technical data sheets and/or brochures of the solar PV panels, inverter/s, solar cables, combiner boxes and metering, if applicable (see Sections 10.1, 10.2, 10.3, and 10.4);
   5. Technical data sheets and/or brochures of the solar LED street lights, if applicable (see Section 10.5).

Operation Documentation

The following documents are needed for the certificate of yearly inspection by the OBO and/or DOE:

1. Compliance report to the mandatory annual energy requirement in 10.5 of this section.

Construction Documentation

The following documents are needed for the occupancy permit application:

1. As-built Architectural, Mechanical and Electrical Plans and Shop Drawings – showing the RE power supply system, solar water heater, solar cooling system and/or solar LED street lights of the building, whichever is applicable (see Sections 10.1, 10.2, 10.3, 10.4, and 10.5);
2. Ocular inspection and verification report of the installed RE power supply system, solar water heater, solar cooling system and/or solar LED street lights of the building, whichever is applicable, about the submitted building permit plans (see Sections 10.1, 10.2, 10.3, 10.4, and 10.5];
3. Green energy option (GEOP) power supply contract, if applicable (see Section 10.5).

Acknowledgement

The Department of Energy (DOE) extends our sincere gratitude to all energy experts, government partners, professional associations, and building stakeholders in the preparation of the Guidelines on Energy Conserving Design of Buildings, 2020 Edition and this User Manual. These documents benefited greatly from their invaluable inputs and their active participation in discussions.

The Guidelines were updated through a consultative process facilitated by the DOE Energy Utilization Management Bureau (DOE-EUMB) under the leadership of Director Patrick Aquino and his team. The following actively contributed in content development through technical working group meetings and public consultations: Institute of Integrated Electrical Engineers of the Philippines, Inc. (IIEE), Philippine Society of Mechanical Engineers (PSME), and ENPAP 4.0 along with experts from the Department of Public Works and Highways (DPWH), Department of Environment and Natural Resources (DENR), DOE-Lighting and Appliance Testing Laboratory (DOE-LATL), Manila Electric Company (MERALCO), Philippine Lighting Industry Association (PLIA), Philippine Green Building Initiative (PGBI), Philippine Green Building Council (PGBC), and United Architects of the Philippines (UAP).

Special thanks to DOE Senior Undersecretary Jesus Cristino Posadas, DPWH Executive Director Johnson Domingo, and European Union (EU) Programme Manager Ileana Miritescu for their support and guidance. We would also like to thank the EU-Access to Sustainable Energy Programme (ASEP) and their experts for their steadfast technical assistance.

We dedicate these Guidelines and User Manual to all building stakeholders who endeavour to make energy efficiency and conservation a way of life.

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