



Technical Specification

ISO/TS 23764

Methodology for achieving non- residential zero-energy buildings (ZEBs)

*Méthodologie pour la réalisation de bâtiments non résidentiels
énergie zéro*

**Second edition
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Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Stepwise approach toward ZEB	2
4.1 General	2
4.2 Planning phase	3
4.2.1 Determining the ZEB stage target: ZEB Ready, nearly ZEB, or (net) ZEB	3
4.2.2 Reference primary energy consumption and reduction rate targets	4
4.3 Design phase	5
4.3.1 General	5
4.3.2 Setting the outcome	5
4.3.3 Passive design	6
4.3.4 Active design	6
4.3.5 Selection of building materials, equipment and systems	7
4.3.6 Forecast of primary energy consumption and energy supply for attaining the targets	9
4.4 Construction phase	9
4.4.1 General	9
4.4.2 Construction plan	9
4.4.3 Construction and inspection	10
4.4.4 Final check and verification (as built)	10
4.5 Operations and management	10
4.5.1 Fine tuning	10
4.5.2 Understanding the primary energy consumption	10
4.5.3 Comparison between planned primary energy consumption and actual measurements	10
4.5.4 Optimizing the energy consumption	10
4.5.5 Measurement and feedback	11
5 Examples of evaluations on ZEB	11
Annex A (informative) (net) ZEB evaluation in Japan	12
Annex B (informative) (net) ZEB evaluation in Malaysia	21
Annex C (informative) (net) ZEB evaluation in Singapore	25
Annex D (informative) Nearly ZEB evaluation in Indonesia	31
Annex E (informative) ZEB Ready evaluation in Japan	36
Annex F (informative) Examples of buildings with additional equipment or facilities	44
Bibliography	45

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 205, *Building environment design*.

This second edition cancels and replaces the first edition (ISO/TS 23764:2021), which has been technically revised.

The main changes are as follows:

- Clause 2 reference removed;
- Annexes substantially revised or added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document aims to apply a methodology for achieving a zero-energy building (ZEB).

Since the Paris Agreement was adopted in the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, all member countries (including emerging countries) have been required to set a target for reducing their greenhouse gas emissions by 2020 and later. In all countries, reducing energy consumption is the most effective means of mitigating greenhouse gas emissions.

The building sector takes a 30 % share of the world's energy consumption, and this contribution appears to be increasing^[8]. Therefore, reducing the greenhouse gas emissions from this sector is an important global issue. Ultimately, the energy consumption of the building must be reduced and balanced by renewable energy to create a (net) ZEB. Such advanced cases have already been constructed.

Although the ultimate goal of achieving ZEBs is clearly understood, its realization has been limited by practical barriers such as high initial investment. However, as the life cycle of buildings is long, the design and construction of more energy-efficient buildings is considered as a present attempt rather than a future one for greenhouse gas reduction. Hence, accelerating the movement toward ZEBs is an immediate urgency.

From this perspective, this document advocates a step-by-step realization approach for (net) ZEBs. Its aim is to accelerate the ZEB movement and describe the practical realization of ZEBs. Namely, this document proposes a practical ZEB approach and outlines the basic considerations during the complete process of ZEB realization, from design to the operation and maintenance stages.

To accelerate the reduction of greenhouse gases, this document aims to contribute policies and/or guidelines for disseminating ZEBs that suit the conditions of individual countries, especially those of emerging countries undergoing rapid urbanization.

To assist understanding of the contents of this document, the following four ZEB examples are included as annexes:

- a) (net) ZEB results of evaluating a ZEB office building that is superior in terms of comfort and health, a ZEB integrated warehouse, and a ZEB office building with interactive exhibition gallery and a renovation centre (see [Annexes A, B and C](#));
- b) nearly ZEB results of evaluating a ZEB retail complex (see [Annex D](#));
- c) ZEB Ready results of an urban medium-sized office (see [Annex E](#)).

NOTE 1 One example (net) ZEB ([Annex A](#)) is SUSTIE Building.

NOTE 2 Three examples ([Annex B, C and D](#)) toward realizing ZEB were selected from the cases awarded in the ASEAN Energy Award

NOTE 3 The ZEB Ready example, the KT Building, was selected from the Net Zero Energy Building Advanced Case Collection published by The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan (SHASE).

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Methodology for achieving non-residential zero-energy buildings (ZEBs)

1 Scope

This document provides a basic step-by-step approach for achieving non-residential (net) zero-energy buildings (ZEBs). It also describes the basic concept of ZEBs and the items for consideration in this approach.

The following are within the scope of this document:

- application to non-residential buildings;
- annual energy consumption of a ZEB (this includes the operating consumption of the building and excludes the energy consumed by the manufacturing of materials and equipment, and the energy consumed during construction);
- renewable energy supply (this can be on-site or off-site, depending on the policy and conditions of the country in which the supply is installed);
- application to any climate zone.

The following are out of the scope of this document:

- recommendations or suggestions for the adoption of any specific technologies or equipment, or both, and materials that are expected to be continuously innovated (however it does stipulate the technologies for selection);
- specific methods or calculation formulae for design;
- commissioning methods.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

ZEB Ready

building that prospectively achieves the criteria of (net) ZEB through enhanced insulation suited to building use and climate, exterior surface and shading for suppressing the load, high-efficiency energy-conservation equipment and optimization of energy consumption by data integration and verification

3.2

nearly ZEB

building that almost achieves the criteria of *(net) ZEB* (3.3), with an annual primary energy consumption of almost zero using renewable energy while meeting the criteria of *ZEB Ready* (3.1)

3.3

(net) ZEB

building in which the annual primary energy consumption of the building is effectively reduced to zero (net zero) through energy conservation and energy creation with maintaining a comfortable indoor environment, while meeting the criteria of *ZEB Ready* (3.1)

4 Stepwise approach toward ZEB

4.1 General

The stepwise approach toward ZEB from ZEB Ready to (net) ZEB follows a plan→do→check→act (PDCA) process that is consistent within many standards. This process is explained in [Figure 1](#).

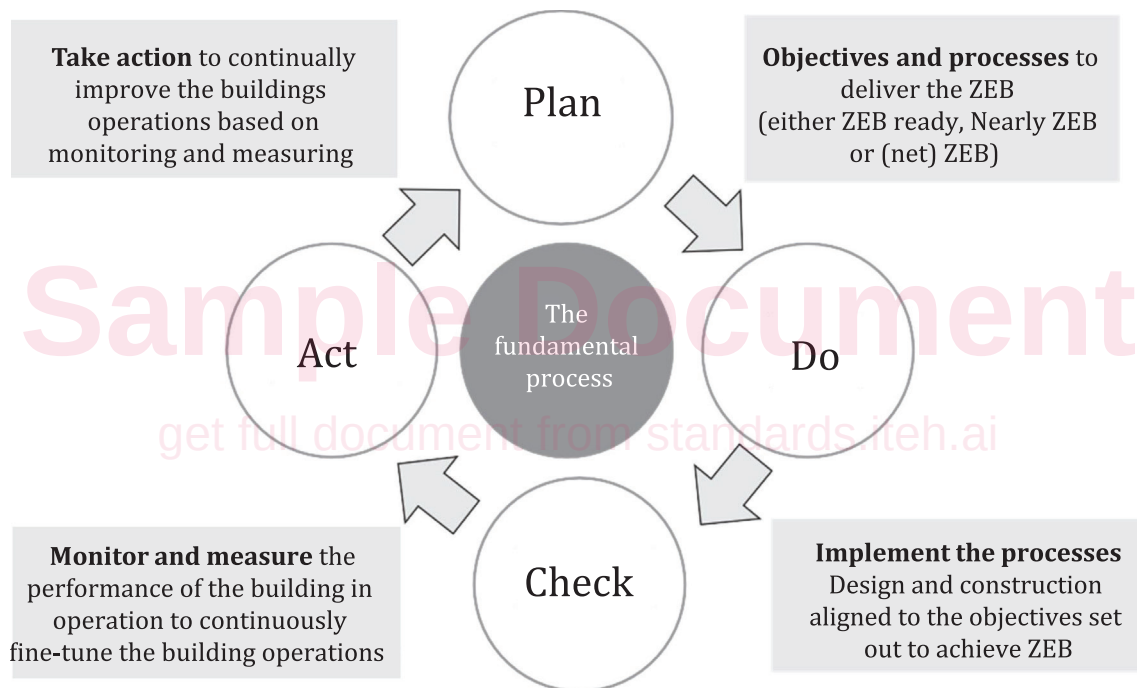


Figure 1 — Key process for achieving ZEB — PDCA (Plan, Do, Check, Act)

This clause describes this approach in detail in consideration of six core elements listed in [Figure 2](#).

Six core elements of ISO/TS 23764

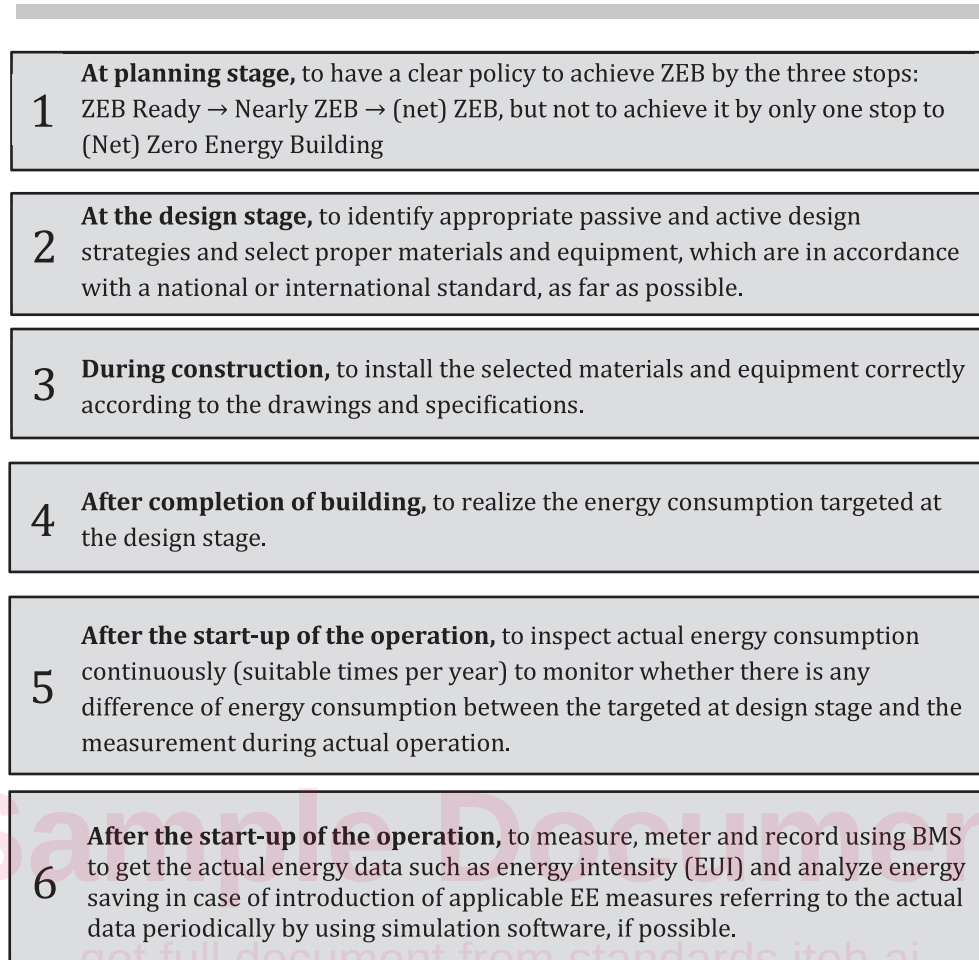


Figure 2 — Six core elements for achieving non-residential ZEBs

4.2 Planning phase

4.2.1 Determining the ZEB stage target: ZEB Ready, nearly ZEB, or (net) ZEB

In general, achieving a (net) ZEB requires a sharp reduction in energy consumption, without the reduction in quality of the indoor and outdoor environments, with the inclusion of renewable energy to offset the remaining energy consumed through the building activities.

The planning and design of a ZEB requires the generation and use of renewable energy. However, this should be considered after reducing the energy consumption as far as possible by a passive design approach, an active design approach including selection of energy-efficient active systems, and deployment of energy management systems that facilitate optimized building energy performance.

Immediately achieving a (net) ZEB may be prevented by regional and climatic circumstances, building typology, and other circumstances beyond the project team's control. To accommodate these limitations, this document adopts a three-tiered nomenclature for ZEB:

- a) A ZEB Ready building meets the following condition:
 - 1) The primary energy consumption is reduced by a predetermined amount ($\alpha\%$) or more from the reference primary energy consumption, excluding renewable energy.
- b) A nearly ZEB building meets both of the following conditions:
 - 1) The primary energy consumption is reduced by a predetermined $\alpha\%$ or more from the reference primary energy consumption, excluding renewable energy.
 - 2) The primary energy consumption is reduced by $\beta\%$ or more (less than 100 %) from the reference primary energy consumption, including renewable energy.
- c) A (net) ZEB meets both of the following conditions:
 - 1) The primary energy consumption is reduced by a predetermined $\alpha\%$ or more from the reference primary energy consumption, excluding renewable energy.
 - 2) The primary energy consumption is reduced by 100 % or more from the reference primary energy consumption, including renewable energy.

4.2.2 Reference primary energy consumption and reduction rate targets

The reference primary energy consumption (EP_0) in [Figure 3](#) should be calculated by adding the primary energy consumption of the air conditioners, ventilators, lighting equipment (including task lighting), hot water supply equipment, the elevators and escalators, and other energy consuming equipment in the building. Additional equipment other than equipment related to the building's functions for the building operation should not be included in the primary energy consumption. [Annex F](#) shows examples of buildings where additional equipment will be installed. This shall be calculated according to the energy efficiency standards of buildings, while considering the climatic impact on the construction site. The annual primary energy consumption per unit of floor area and the floor area in a standard model building may be used to calculate the reference primary energy consumption in different countries. When appropriate, the reference primary energy should be revised in accordance with technological advancements on building materials and energy-efficient equipment, and with the level of maturity of the energy-conservation scheme.

Reduction rate targets for primary energy consumption should be determined in the three stages: ZEB Ready, nearly ZEB, and (net) ZEB. The energy-efficiency improvement should first support equipment that consumes energy (toward ZEB Ready). Once that target has been met, the total primary energy consumption should be reduced by encouraging electric-power generation from renewable energy sources.

$$\text{Target of } \alpha\% \text{ for ZEB Ready} \leq (1 - EP_{\text{cal}}/EP_0) \times 100$$

$$\text{Target of } \beta\% \text{ for nearly ZEB} \leq (1 - (EP_{\text{cal}} - EP_{\text{gen}})/EP_0) \times 100$$

$$\text{Target for (net) ZEB, } 100 \% \leq (1 - (EP_{\text{cal}} - EP_{\text{gen}})/EP_0) \times 100$$

where

EP_0 is the reference primary energy consumption (MJ/year);

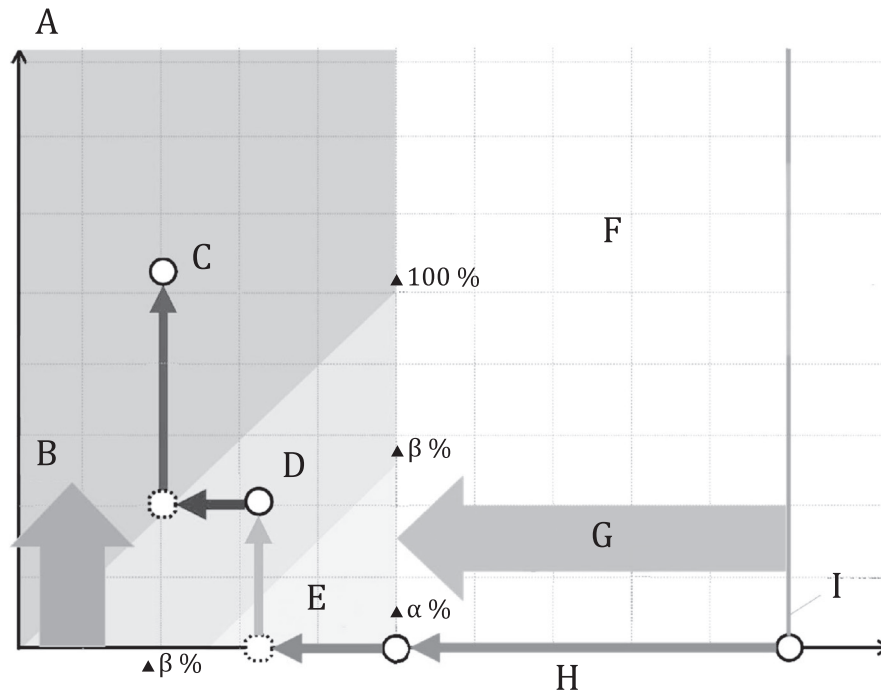
EP_{cal} is the primary energy consumption (MJ/year);

EP_{gen} is the energy supply (renewable energy) volume (MJ/year).

Primary energy consumption is annual consumption and is not defined in detail in this document.

The reduction-rate targets $\alpha\%$ and $\beta\%$ should be set by individual countries, although β should be larger than α . Multiple α and β values may be set at different levels.

The reference primary energy consumption EP_0 , the target values of α and β , and other parameters may be revised in accordance with technological advancements.



Key

- A Energy supply (MJ/year) (Renewable energy) (EP_{gen})
 - B Energy independence : Introduction of renewable energy
 - C (net) ZEB
 - D Nearly ZEB
 - E ZEB Ready
 - F Energy saving : Reduction of primary energy consumption through energy efficiency and conservation (required)^a
 - G Reduction rate of energy consumption: $\blacktriangle \alpha\%$
 - H Energy consumption (MJ/year) (EP_{cal})
 - I Reference primary energy consumption (MJ/year) (EP_0)^b
- NOTE 1 The target of the energy consumption reduction from the reference primary energy consumption is set in accordance with regional circumstances and adopted as a standard.
- NOTE 2 A reference building can be determined in accordance with regional circumstances and its energy consumption is defined as the reference energy consumption.
- NOTE 3 Reduction rate targets, $\alpha\%$ and $\beta\%$, are to be set by individual countries.

Figure 3 — Energy supply versus energy consumption

4.3 Design phase

4.3.1 General

An evaluation method for energy performance equivalent to ISO 52000-1 can be used. The matters stated below should be considered for specific design methods.

4.3.2 Setting the outcome

Defining the project's performance at the briefing stage is important. If the constraints on and opportunities for setting design goals for environmental sustainability are considered at the onset of a building project, a holistic total building performance is ensured. Thus, feasibility studies and assessments of the available

options and benchmarking of similar projects provide the project team with a realistic grounding of the achievable ZEB level.

The project brief formalizes the sustainability targets and estimates the building lifespan and operational cycles. Early consultations and studies ensure that the targets are achievable and that the post completion goals (against which the building will be judged) are clearly stated

An integrative design process encourages a collaborative framework for setting the building- performance benchmarks and targets. Through this process, the project team is obliged to regularly review the design goals across disciplines and can address and negotiate among the various needs of all stakeholders to achieve the ZEB target.

4.3.3 Passive design

Passive strategies are fundamental in the design of energy-efficient buildings, as they maximize the climatic response to the site context, reduce the load on “active systems,” and provide a comfortable indoor environment. The typical passive-design principles are as follows (the list is non-exhaustive):

- Building orientation, massing and form:
Positioning the building to manage solar gain and optimize natural lighting while considering wind.
- Building envelope and material selection:
Utilizing materials and design strategies that minimize heat gains and effective insulation, while ensuring good ventilation to maintain a comfortable indoor environment.
- Use of natural ventilation:
Designing strategically placed openings and pathways to facilitate airflow, improving indoor air quality and thermal comfort. Natural ventilative cooling can save cooling energy under optimal conditions, thereby reducing the need and sizing of “active systems” like mechanical cooling.
- Maximum use of free heating or cooling:
Incorporating features like thermal mass and shading devices to capitalize on natural heating and cooling opportunities.
- Design of daylighting (while minimizing visual discomfort).
Optimizing window placement, size and glazing to maximize natural light while minimizing glare and heat gain, thus reducing reliance on artificial lighting.

4.3.4 Active design

4.3.4.1 Energy users

Typical active systems or building services are mechanical systems, e.g. air conditioning, heating, mechanical ventilation, lighting, vertical transportation, pumping, and other unregulated energy source equipment, which provide the bulk of the energy consumption in a building. The focal strategies for achieving a low energy building are as follows (the list is non-exhaustive):

- Correct sizing of equipment such as air-conditioning systems and heating systems: This strategy ensures the proper allocation of the building loads, avoiding over- or under-provision that would reduce the operational efficiency.
- Selection of high efficiency systems and technologies: Adoption of high-efficiency equipment, e.g. lighting, heating, and cooling systems, mechanical ventilation systems, vertical transportation systems, hot water systems. Equipment should be energy-labelled and provided with certified (tested) performance data. The control systems using sensors are also applied for those types of equipment.

- Selection of systems with high efficiency over the operational range: For example, air-conditioning systems should operate with high efficiency over a range of loads under capacity control, e.g. inverter technology for the compressors. Fans and pumps should operate under variable flows and speeds.
- Use of energy recovery systems: Converting waste energy to useful energy reduces the load on other systems. An example is heat recovery for air conditioning or heating systems.

4.3.4.2 Energy management system

A building or energy management system (BMS) can monitor and manage all mechanical and electrical services in a building. These systems improve the energy efficiency by tailoring the appliances to real needs and saving operation and maintenance costs while improving the occupancy comfort. Among the fastest-growing and dynamic ZEB-focused technologies are smart building technologies. By tapping into the Internet of Things, advanced sensors, and big data analytics, smart technologies have shown potential for significant savings through demand control, optimization, and predictive maintenance.

Strategies for energy management systems include the following (the list is non-exhaustive):

- Energy monitoring and visualization: This strategy provides occupants with an easy, accessible visualization of the energy consumption indices by area and the use/load, trend, cost, and target/benchmark. Related to this ideal of openly sharing the building data, open standards are required to future-proof the building's management system and to facilitate data exchange between subsystems. Furthermore, if the end users can access the monitored information, they are more likely to partake in engagement programs and make behavioural changes.
- Demand control systems: Occupancy-based controls can match the building services to the building use, facilitating energy savings and optimization of systems while maintaining high indoor environmental quality. For example, demand control ventilation strategies such as carbon dioxide sensors will help regulate the quantity of fresh air and ventilation in accordance with the space requirements.
- Integration and analytical systems: These systems integrate the sensor data for optimizing the workflow or maintaining high performance and energy efficiency in a building, providing an informed and effective operation in the building. By using automation data and behavioural science, building professionals can optimize the equipment and their related processes to maintain the equipment efficiency and building comfort requirements.

4.3.4.3 Renewable energy

Renewable energy sources are required to generate or offset the energy used by building systems. Renewable energy sources include (but are not limited to) solar (photovoltaics) and wind power.

4.3.5 Selection of building materials, equipment and systems

4.3.5.1 General

The building materials, equipment, and systems should be selected in the design phase. The selected items should have obtained performance certification, e.g. energy efficiency certification, appropriate to the regional circumstances, or which conform to the standards in the country of construction. To meet ZEB targets, high-efficiency equipment and systems are required.

To achieve an overall balance, the selected materials, equipment, and systems should also optimize the costs.

4.3.5.2 Selection of building materials

- Load reduction:
 - Enhancement of the thermal insulation for the exterior surface of the building and control for solar radiation.

- Selection of the materials with high thermal insulation performance for the exterior walls, roofs, floors, windows, and other openings.
- Introduction of the items that properly control the solar radiation from windows (glazing with excellent shading performance, window shades, eaves and the equivalent).
- Use of natural energy:
 - Utilization of natural ventilation (cooling).
EXAMPLE 1 Automatic windows, opening of ceiling spaces by the stack effect.
 - Utilization of daytime sunlight.
EXAMPLES 2 Construction of openings, neighbouring buildings, and topographic features on the sunlight side, light shelves, light duct systems.

4.3.5.3 Selection of equipment and systems

4.3.5.3.1 Air-conditioning equipment

- Selection of heat-source type: The heat-source system can be centralized or distributed.
- Selection of a model with high partial-load properties that adjusts the partial load efficiency in accordance with the load change (compressor inverter and other equipment).
- Consideration of following energy-conservation technologies for a central heat-source system: Control of the number of heat sources, free cooling systems, large temperature-differential water supply systems, variable flow control for cooling water pumps, pump capacity control (using an inverter) and boiler efficiency.
- Consideration of the following energy-conservation technologies for the load side equipment: Variable blow control for air conditioners, total heat exchangers, air-conditioning systems that separate the latent and sensible heat, fresh-air intake controls that respond to CO₂ concentration, and unused energy sources such as underground heat, underground water, and temperature differences in river water.

4.3.5.3.2 Lighting equipment

- Utilizing high efficiency lighting systems
 - Designing and installing solid state lighting systems.
 - Designing quality daylighting
 - Maximizing daylight availability,
 - Providing quality views for all occupants,
 - Limiting daylight excessiveness.
 - Incorporating lighting controls that adjust to daylight availability, occupancy sensing, lumen depreciation, and personal dimming.
 - Optimizing illuminance
 - Designing to CIE/ISO, i.e. include reference to the ISO/CIE 8995 series.

4.3.5.3.3 Hot water supply equipment:

- Reduction of energy consumption by employing the following hot-water saving systems: High-efficiency heat pump units for the hot water supply, a hot-water heater with latent heat recovery, solar panels for hot water generation and automatic faucets for washbasins.

4.3.5.3.4 Elevators and escalator

- Consideration of the following energy-conservation technologies for elevators and escalators:
 - For elevators: Variable-voltage variable-frequency control, sleep mode, power regeneration control, group control.
 - For escalators: Automatic operation (sensor-based start and stop operations).

4.3.5.3.5 DC distribution system

- Reduction of energy conservation loss from DC to AC by introduction of DC distribution system along with the DC power resources, DC loads, and the AC loads driven by DC power.

4.3.6 Forecast of primary energy consumption and energy supply for attaining the targets**4.3.6.1 General**

In a ZEB, the designed energy consumption must be compared with the actual energy consumption during operation on a system-by-system basis. This is important for re-monitoring the energy consumption and making improvements. Therefore, the methods of energy management and building operation shall be determined during the design phase.

4.3.6.2 Forecast of primary energy consumption

The primary energy consumption of the equipment, e.g. air conditioning, ventilation, lighting, hot water supply, and elevators and escalators, should be forecasted in the design phase. The forecasted energy consumption of the air-conditioning equipment should be based on the annual hourly loads plus the partial load characteristics under the thermal load, which depend on the climatic circumstances and the building characteristics. The primary energy consumption should be estimated using calculation software that considers the above-mentioned matters.

4.3.6.3 Forecast of renewable energy supply

Renewable energy facilities should be installed as electric-power supplies in the target building. The actual supply should account for fluctuations in solar radiation imposed by location, season, time, climate, installation conditions, and other circumstances, as well as DC/AC conversion loss (power conditioner) and other losses.

4.4 Construction phase**4.4.1 General**

Construction should follow the prescribed use of the building materials and selected equipment.

4.4.2 Construction plan

Once the design phase is complete, the correct procurement strategy that ensures the fully implemented design and performance should be studied. A construction plan using the building materials and selected equipment should be created during the construction phase in accordance with the specifications and design drawings. The construction plan should include the following items:

- Construction overview;
- Project schedule;
- On-site organization chart;
- Safety management;