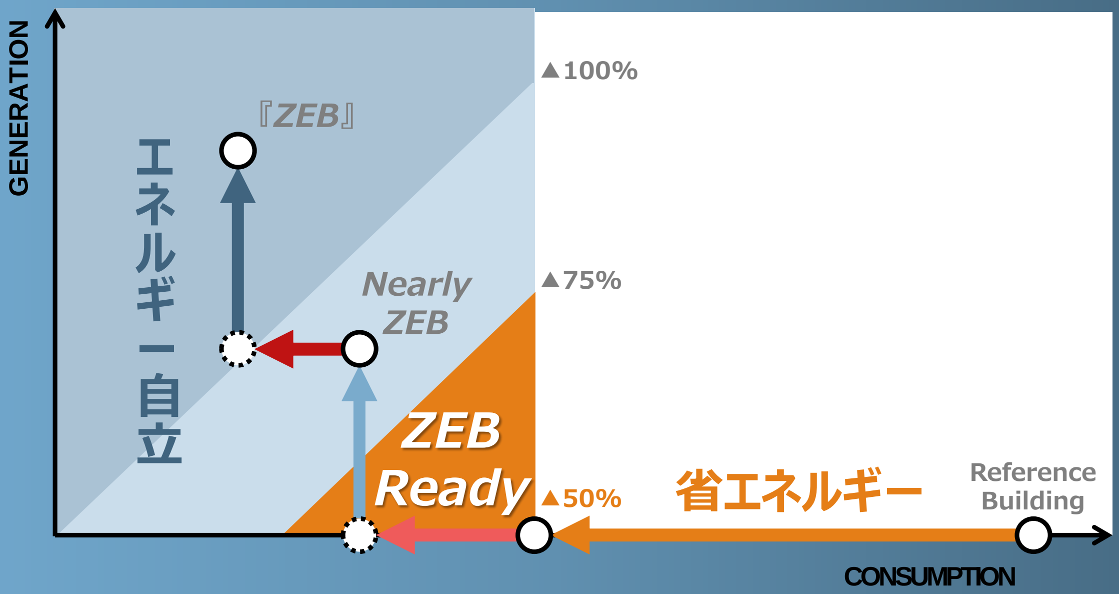
Ver. 1

Future Direction of Environmental Buildings

ZEB Design Guidelines

ZEB Ready for Medium-scale Establishments



Edited and written by: ZEB Roadmap Follow-up Committee

April 2018
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Toward the “age of ZEB”

In the near future, the age will come when “ZEB (Net Zero Energy Building)” becomes an important factor in the building sector of our country.

In its 5th Evaluation Report, the IPCC (Intergovernmental Panel on Climate Change) warns that the building sector accounted for 32% of the world energy consumption in 2010 and, if no measures are taken to improve the situation, the energy consumption of the building sector will be doubled or even tripled by 2050. Because buildings have longer service life than industrial products and require long time until the manifestation of their energy saving effects, urgently taking effective measures is extremely important.

Under the circumstance, the “Basic Energy Plan” approved by the cabinet in 2014 set a goal of realizing ZEB with newly built public buildings by 2020 and with newly built buildings on average by 2030.

It is also important to develop building environments enabling people to stay comfortably without forcing them too hot environments to maintain their intellectual productivity and health conditions. There is strong correlation between indoor environments and intellectual productivity. The investigation of the number of telephone calls answered at a call center by our research group clarified that the productivity of the call center was reduced by 2% with an increase in a room temperature by about 1 degree Celsius.

In Japan, ZEB is defined as the promotion of renewable energy use, etc. on the basis of the simultaneous pursuit of “securing comfortable indoor environments” and “extreme saving of energy.” In terms of quantitative classification, achieving energy saving of 50% or more through designed implementation of measures is classified as “ZEB Ready,” achieving net energy saving of 75% or more with the utilization of renewable energy is classified as “Nearly ZEB,” and achieving energy saving of 100% is classified as “ZEB.”

Although there are many issues for the realization and dissemination of ZEB, there have also been many successful front-runners of ZEB throughout the country recently as a result of combining excellent building plans and a variety of advanced technologies.

On the basis of these advanced cases, the “ZEB Design Guidelines” to be published this time explain the concepts of designing and adopting technologies to achieve “ZEB Ready” (energy saving rate of 50%) as clearly as possible by introducing specific model cases as a first step toward further dissemination of ZEB by business operators engaging in building development.

Also, the “ZEB Design Guidelines” are expected to be of much practical help because these Guidelines have been established in a manner that compiles as many specific descriptions as possible including input and output results of energy consumption performance calculation programs used for model case studies.

It will be our great pleasure if the ZEB Design Guidelines help business operators gain better understanding of the design concept for realizing ZEB, priorities of element technologies, calculation processes, energy saving effects, and expected construction costs and motivate themselves to advance into the design and construction of ZEB.

Finally, we would like to express our deep gratitude to the members of the ZEB Roadmap Follow-up Committee and many other concerned persons for their great cooperation and support in the establishment of the ZEB Design Guidelines.

ZEB Design Guidelines <ZEB Ready for Medium-scale Establishments>
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Introduction

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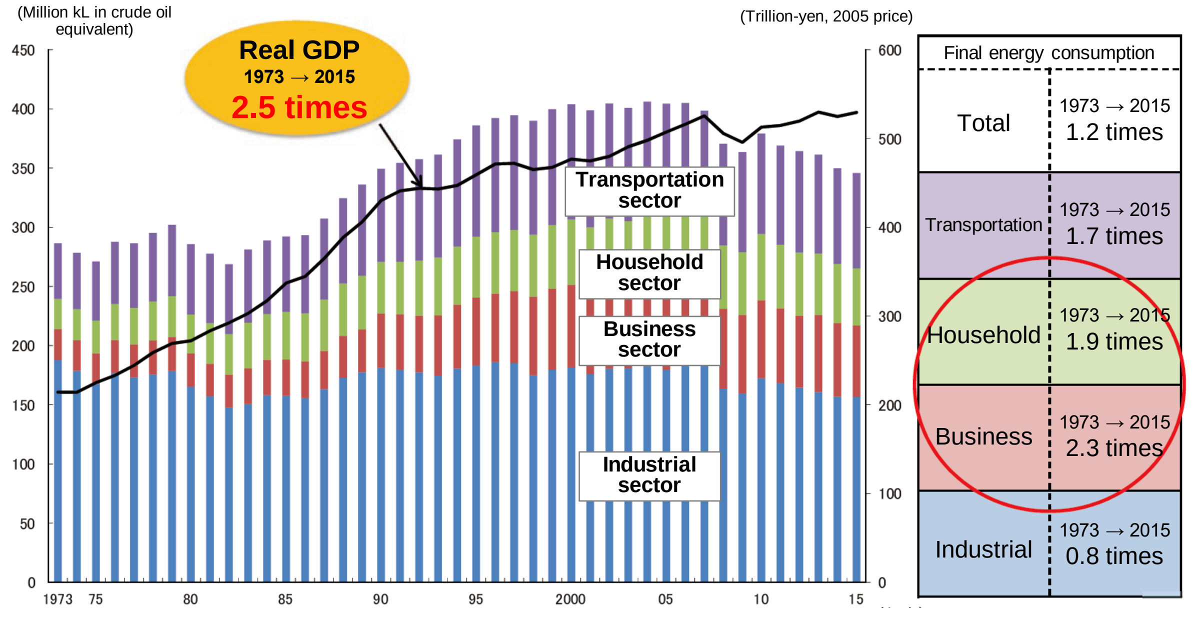
Chapter 1 Introduction

1.1 Issues on and Direction toward the Energy Saving of Nonresidential Buildings

Necessity of Energy Saving of Nonresidential Buildings

- In Japan, the civilian sector (business and household sectors) accounts for more than 30% of final energy consumption. Since the past oil crisis, the energy consumption by the industrial sector has been reduced by about 20% despite the GDP growth by 2.5 times while the energy consumption by the civilian sector has been significantly increased (by 2.9 times and 2.0 times in the case of the business and household sectors respectively). Because the civilian sector has had remarkable increase in energy consumption compared to other sectors, the promotion of thorough energy saving in the civilian sector is one of the urgent issues in Japan. Also, experiencing the tight power supply situation after the Great East Japan Earthquake and the destabilization of energy costs due to the changes in the international situations, it has been strongly recognized that the energy independence of buildings is of importance from the standpoint of securing energy security.

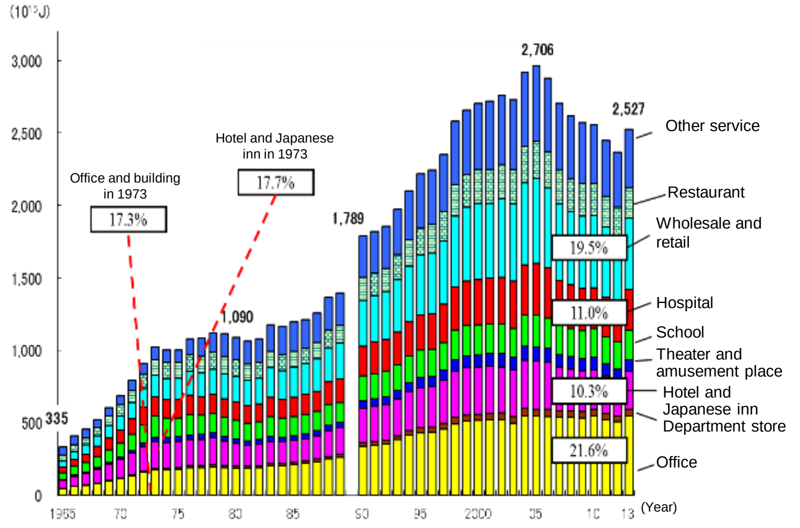
Trend of energy consumption in Japan



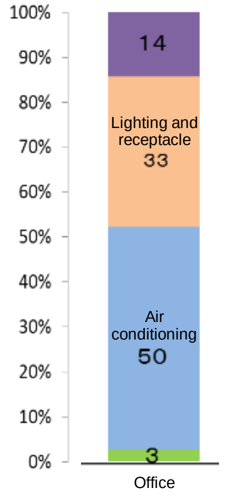
Source: Comprehensive Energy Statistics, Annual Report on National Accounts, EDMC Handbook of Japan's & World Energy & Economic Statistics

- When viewing the energy consumption of the business sector by nine large categories, “Office” and “Wholesale and Retail” are the categories that account for a large share of recent energy consumption. The percentage of buildings in recent energy consumption varies depending on their use purposes. In the case of the category of “Office,” air conditioning and lighting, in particular, account for a substantial fraction of energy consumption.

Trend of energy consumption by business sector and category



Percentage of office in energy consumption



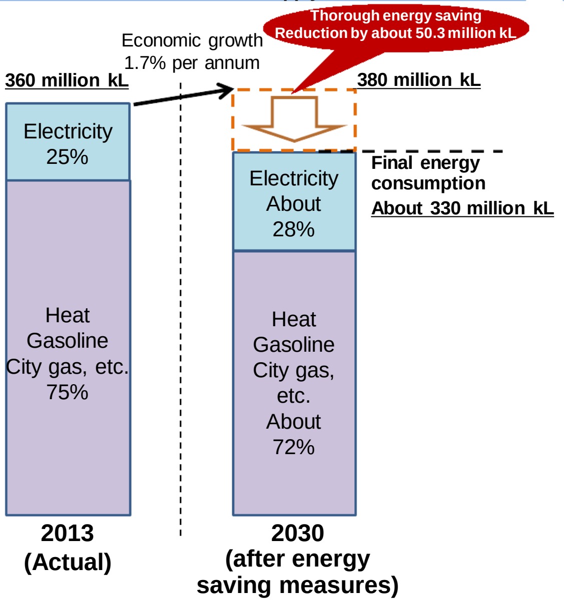
Source: Comprehensive Energy Statistics, Annual Report on National Accounts, EDMC Handbook of Japan's & World Energy & Economic Statistics

Trend of Government Policies for Energy Saving

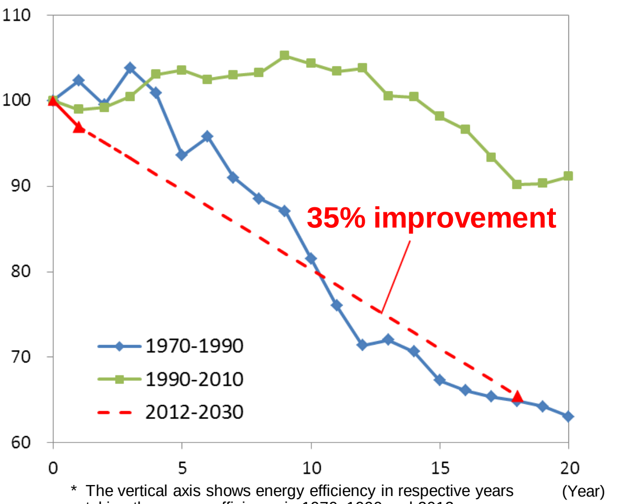
- Regarding the long-term perspective of energy demand and supply, the government has set a goal of reducing the final energy demand by 50.3 million kL in crude oil equivalent by 2030 through the implementation of thorough energy saving measures while achieving annual economic growth of 1.7%.
- In order to achieve the goal, the energy efficiency (final energy consumption/real GDP) needs to be improved to the level (35%) after the oil crises (1970 to 1990).
- For houses and buildings, thorough energy saving measures shall be promoted through mandatory compliance with the energy efficiency standards when they are newly constructed and the realization and dissemination of ZEB and ZEH.

Final energy demand and supply in the long-term perspective of energy demand and supply as well as improvement in energy efficiency

Final energy demand in the long-term perspective of energy demand and supply



Improvement in energy efficiency



* The vertical axis shows energy efficiency in respective years taking the energy efficiency in 1970, 1990 and 2012 as a base of 100.

Promotion of thorough energy saving in houses and buildings

Mandatory compliance with the energy efficiency standards based on the Building Energy Efficiency Act [New buildings]

■ Stepwise introduction of the mandatory compliance with the energy efficiency standards for new houses and buildings by 2020

(The formulation of the Building Energy Efficiency Act and the enforcement of the mandatory compliance with the energy efficiency standards for large-scale nonresidential buildings from 2017)

Promotion of zero energy houses and buildings [New buildings/existing buildings]

■ Increase in the number of ZEH (net zero energy house) to a level accounting for the majority of new orders houses received by housing makers and building contractors by 2020

■ Achievement of a goal of realizing ZEB (net zero energy building) with newly built public buildings by 2020

→ Verification and promotion through subsidies, etc.

Introduction of the top runner standards for building materials [New buildings/existing buildings]

■ Introduction and dissemination of building material top runner system

(rock wool insulation materials, glass wool insulation materials, extruded polystyrene foam, sashes, multiple glass + rigid urethane foam (sprayed-in-place products)

Promotion of energy saving renovation [Existing buildings]

■ Twofold increase in energy saving renovation by 2020

■ Promotion of the renovation of existing houses into ZEH in the future

→ Promotion through subsidies, etc.

Source: The Agency of Natural Resources and Energy

Trend of the Energy Efficiency Standards for Nonresidential Buildings

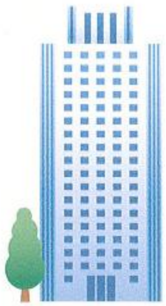
- The “Act on the Improvement of Energy Consumption Performance of Buildings (Building Energy Efficiency Act)” was formulated on July 8 in 2015 for the purpose of enhancing energy saving performance of buildings through the integrated implementation of the following two measures:

  ① Regulatory measures such as mandatory compliance with the energy efficiency standards for large-scale buildings; and
  ② Incentive measures such as a labeling system certifying the compliance with the energy efficiency standards and the granting of special floor-area ratios for buildings complying with voluntary standards

Overview of the Building Energy Efficiency Act

① Regulatory measures (Mandatory) — April 1 2017

■ Mandatory compliance with the energy efficiency standards and mandatory evaluation of compliance — **Newly established**

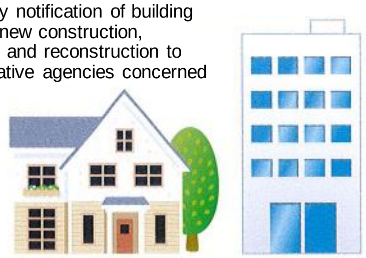


- Nonresidential buildings with floor areas of 2,000 m² or more

When newly constructed, buildings are obliged to comply with the energy consumption performance standards (energy efficiency standards) and undergo the evaluation of compliance with the standards.

■ Notification
- Buildings with floor areas of 300 m² or more

Mandatory notification of building plans for new construction, extension and reconstruction to administrative agencies concerned



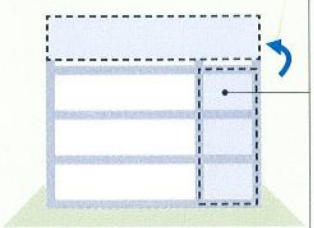
House　Nonresidential building

There may be instructions or orders in the case of noncompliance.

■ Housing Top-runner Program

② Incentive measures (Voluntary) — April 1 2016

■ Certification of performance improvement plans and granting of special floor-area ratios — **Newly established**

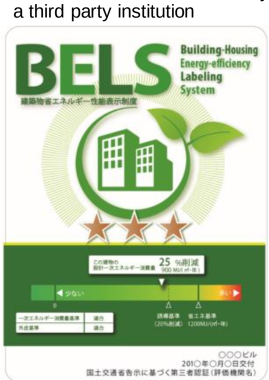


Floor areas for the equipment necessary to improve energy consumption performance exceeding the floor areas allowed for ordinary buildings
‖
Exclusion

(Certification by administrative agencies)

■ Labeling System for Energy Saving* — **Newly established**

Publicity of the achievement of energy consumption performance higher than a standard level ⇒ Evaluation by a third party institution



Publicity of the compliance of an existing building to the standards ⇒ Certification by an administrative agency

◎ Other necessary measures (establishment of a Minister’s certification system to evaluate new technologies (newly established))

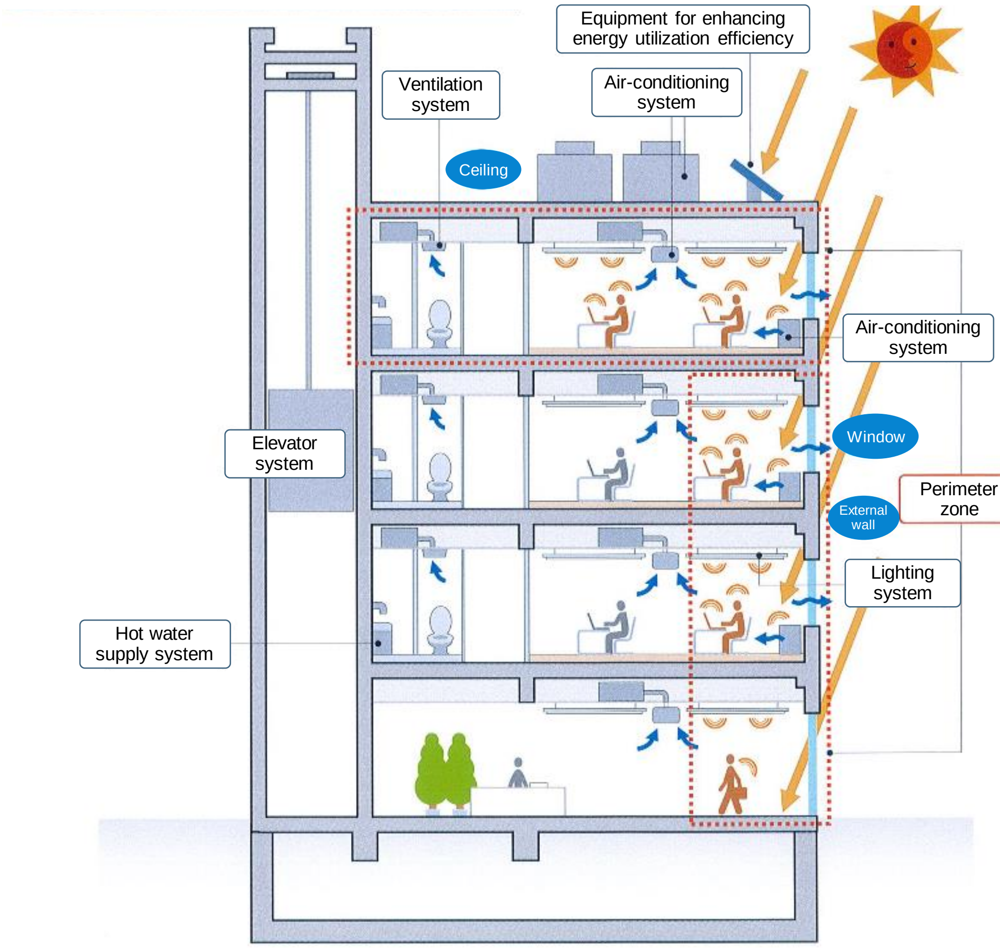
Source: Partial modification of the “Overview of the Act on the Improvement of Energy Consumption Performance of Buildings (Building Energy Efficiency Act)” by the Ministry of Land, Infrastructure, Transport and Tourism and the Institute for Building Environment and Energy Conservation (IBEC)

Overview of the Energy Efficiency Standards for Nonresidential Buildings

- The following two standards are used for evaluating the energy efficiency performance of nonresidential buildings:

  ① a standard to evaluate the envelope performance (PAL*) of windows, external walls, etc. on nonresidential buildings; and
  ② a standard to evaluate primary energy consumption of equipment.

Image of the envelope performance (PAL*) and primary energy consumption



● Envelope performance (PAL*)

◎Annual thermal load coefficient of perimeter zone

$$PAL^* = \frac{\text{Annual thermal load of perimeter zone on each floor (MJ/year)}}{\text{Total floor area of perimeter zone (m}^2\text{)}}$$

◎The annual sum of heating and cooling thermal loads made up of the following four types of thermal sources:
① temperature difference between external air and perimeter zone;
② solar radiation from external walls and windows etc.;
③ heat generated in perimeter zone; and
④ heat of intake external air on the basis of temperature/humidity difference between the intake external air and perimeter zone and the amount of intake external air

● Primary energy consumption

+ primary energy consumption of air-conditioning system
+ primary energy consumption of ventilation system
+ primary energy consumption of lighting system
+ primary energy consumption of hot water supply system
+ primary energy consumption of elevator
+ primary energy consumption of others (OA system)
- reduction in primary energy consumption through the use of equipment for enhancing energy utilization efficiency

= primary energy consumption

● What is a perimeter zone?

The indoor space within a horizontal distance of 5 m from a center line of a wall exposed to external air on each floor, the indoor space on the floor immediately below a roof and the indoor space immediately above the floor exposed to external air.

Source: "Overview of the Act on the Improvement of Energy Consumption Performance of Buildings (Building Energy Efficiency Act)" by the Ministry of Land, Infrastructure, Transport and Tourism and the Institute for Building Environment and Energy Conservation (IBEC)

Trend of ZEB (Net Zero Energy Building)

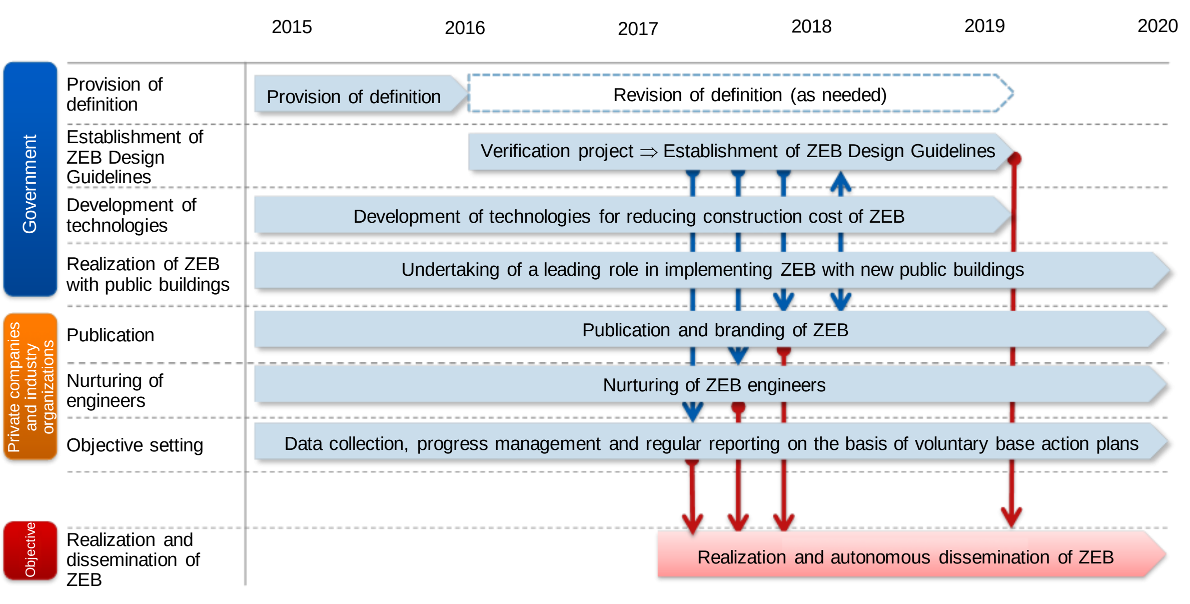
- With the growing attention to ZEB (Net Zero Energy Building) as a building capable of realizing significant energy saving without degrading the quality of indoor and outdoor environment, the following policy objectives have been set in the “Basic Energy Plan” (approved by the cabinet in April 2014):

  ① realization of ZEB with new public buildings by 2020; and
  ② realization of ZEB with new buildings on average by 2030.

- Also, in the “Long-term Perspective of Energy Demand and Supply” developed in July 2015, the achievement of the energy saving amount set as a goal by 2030 is based on the “promotion and dissemination of buildings having advanced energy efficiency performance through the efforts to realize ZEB.” In this way, as the realization and dissemination of ZEB are the key factors for the fundamental improvement of the energy demand and supply in our country and can produce extremely large social benefit, it is desired that the goal of the Basic Energy Plan will be reliably achieved.

- In order to develop the road map toward the achievement of the above goals, the ZEB Roadmap Examination Committee was established with the implementation of the verification and deliberation of the current situations and issues of ZEB and the direction toward the solutions for the issues as the objectives. After the discussions on the definition of ZEB, the issues on the realization and dissemination of ZEB, and the direction toward the solutions for the issues, the committee published the road map in December 2015 (http://www.meti.go.jp/press/2015/12/20151217002/20151217002-1.pdf).

Road map toward the realization and dissemination of ZEB



Source: “Definition of ZEB, Future Policies, etc. Determined in the ZEB Roadmap Examination Committee,” the Agency of Natural Resources and Energy

- Also, the mandatory compliance of buildings with the energy efficiency standards as well as the realization and dissemination of ZEB have been stipulated as the countermeasures against global warming to be strongly promoted to achieve the greenhouse gas reduction target set under the Paris Agreement.

Definition of ZEB

- According to the ZEB Definition Examination Subcommittee under the Technical Committee of Air-Conditioning System in the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, ZEB is defined as follows.

  ZEB is a building which makes the annual balance between the energy demand and supply (or indexes obtained by multiplying the energy demand and supply by coefficients) in operation phase (or balance between energy consumption and generation or external energy supply) almost zero or positive (energy supply larger than energy demand) by utilizing renewable energy in addition to achieving significant energy saving through load control, utilization of natural energy, enhancement of energy efficiency of equipment system, etc. without degrading the quality of indoor and outdoor environments.

- Following the above definition, the ZEB Roadmap Examination Committee redefined ZEB as <u>a building aiming at making the annual balance between the consumption and supply of primary energy zero by enhancing its energy independence to the extent possible through the introduction of effective utilization of renewable energy in addition to realizing significant energy saving in a manner that controls energy loads through advanced building design, proactively utilizes natural energy by adopting passive technologies, and introduces high efficiency equipment systems while maintaining the quality of indoor environments</u>. Accordingly, the Committee classified ZEB into the following three categories based on which the ZEB Design Guidelines have been established.

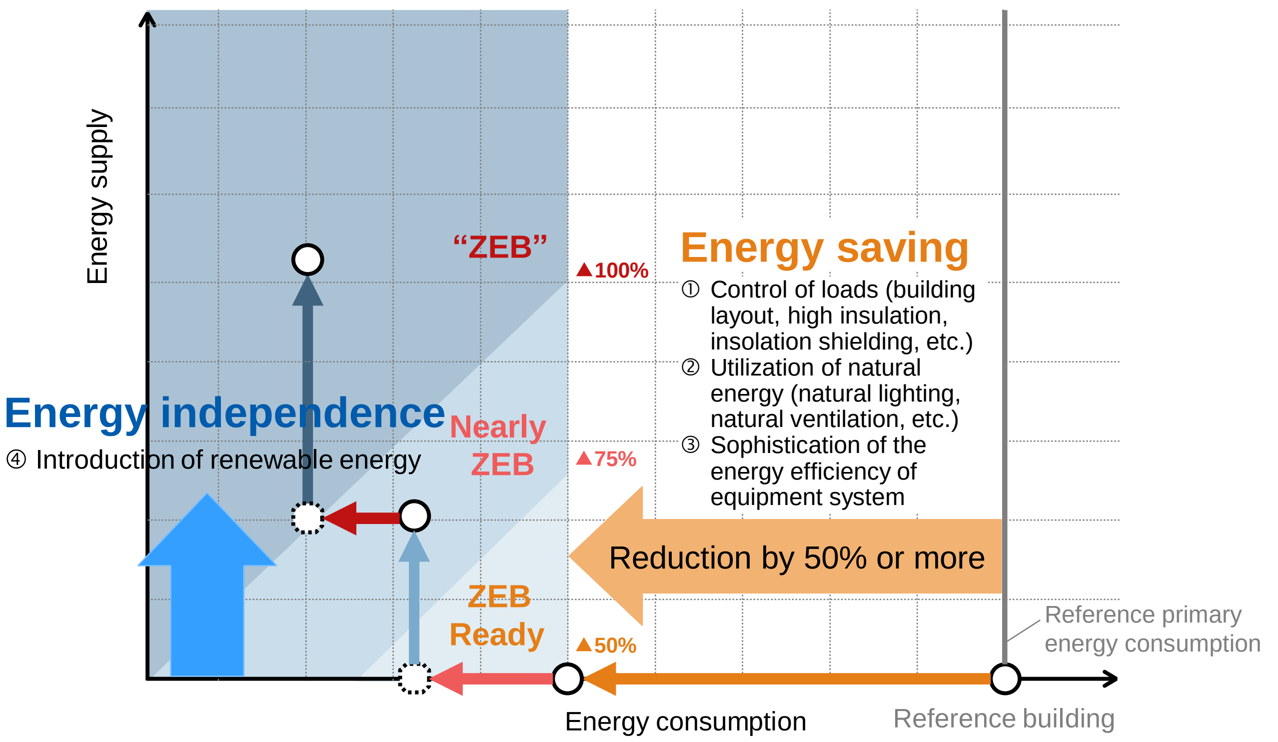
	Qualitative definition	Quantitative definition (determination criterion)
"ZEB"	A building which achieves zero or negative net annual primary energy consumption	• A building satisfying all the criteria ① and ② below: ① Reduction in reference primary energy consumption by 50% or more (excluding renewable energy) ② Reduction in reference primary energy consumption by 100% or more (including renewable energy)
Nearly ZEB	A building which achieves annual primary energy consumption close to zero while satisfying the requirements of ZEB Ready as the building almost equivalent to "ZEB"	• A building satisfying all the criteria ① and ② below: ① Reduction in reference primary energy consumption by 50% or more (excluding renewable energy) ② Reduction in reference primary energy consumption by 75% or more and less than 100% (including renewable energy)
ZEB Ready	A building which is provided with a super-insulated envelope and high-efficiency energy saving equipment as an advanced building to be ready for "ZEB"	• A building complying with the reduction in reference primary energy consumption by 50% or more excluding renewable energy

- The design of ZEB has put particular importance on the concept of using a hierarchy approach in a manner that combines the sophistication of a building envelope which has a long service life and is difficult to repair with the sophistication of building equipment while optimizing architectural methods (passive methods) such as heat insulation, insolation shielding, utilization of natural ventilation and daylight. This concept has been incorporated in the abovementioned definition and classification of ZEB.

- Here, the building systems subject to the calculation of reduction in primary energy consumption is an air-conditioning system stipulated in the 2016 energy efficiency standards and other systems than the air-conditioning system such as ventilation, lighting and hot water supply systems as well as an elevator system (other primary energy consumption is excluded). Also, the primary energy consumption subject to evaluation is not the one in operation phase but the one in design phase and the calculation of primary energy consumption needs to follow the methods stipulated in the 2016 energy efficiency standards.

- Furthermore, the renewable energy subject to evaluation is limited to that utilized in premises (on site) including captive use and electric power selling; however, the renewable energy subject to a full amount selling system is excluded from the evaluation from the viewpoint of ZEB aiming at energy independence.

Approach toward ZEB (Image)



Calculation and Evaluation Methods for ZEB

- Calculation program: Energy consumption of a building shall be calculated using the program (hereinafter referred to as the "energy consumption performance calculation program") which is compliant with the 2016 energy efficiency standards and has been released on the webpage of the Building Research Institute.

- The evaluation of ZEB uses BEI (Building Energy Index) which is a ratio of the primary energy consumption of a building when designed to that of a reference building on the basis of the energy consumption performance calculation program. A building is evaluated to achieve ZEB (including ZEB Ready) when BEI ≤ 0.50.

- However, the building systems subject to the calculation of reduction in primary energy consumption are an air-conditioning system stipulated in the 2016 energy efficiency standards and other systems than the air-conditioning system such as ventilation, lighting and hot water supply systems as well as an elevator system (excluding other primary energy consumption).

$$\text{BEI} = \frac{\text{Design primary energy consumption} - \text{other primary energy consumption} + \text{equipment to enhance energy utilization efficiency (photovoltaic power generation, etc.)}}{\text{Reference primary energy consumption} - \text{other primary energy consumption}}$$

- Here, please note that the renewable energy considered in BEI calculation is limited to that utilized in premises (on site) including captive use; in contrast, the renewable energy subject to electric power selling is included in the calculation and evaluation of ZEB.

1.2 Purposes and Scope of Application of the ZEB Design Guidelines

Issues on the Realization and Dissemination of ZEB and the Position of These Guidelines

- The factors considered to prevent the realization and dissemination of ZEB are as follows:

  ① Although there have been the promotions of several policies and measures for the realization and dissemination of ZEB by the government and industry organizations through the development of individual element technologies deemed to be able to significantly improve energy efficiency performance, the method for designing ZEB by combining these individual element technologies has not been fully established and shared in the construction industry.

  ② Another factor is the lack of evaluation of the feasibility of ZEB within the range of economic rationality because of no case studies on the construction costs allowing ZEB to be realized.

- Although there are many issues to be solved for the realization and dissemination of ZEB, designing and constructing ZEB is the prerequisite to achieve energy saving goals such as the long-term perspective of energy demand and supply. Also, some forward-thinking business operators have already realized ZEB throughout the country by devising design methods and combining advanced technologies.

- On the basis of these advanced cases of ZEB, these Guidelines have been established to explain the design methods for ZEB Ready (with energy saving rate of 50%) and assist those owners (local governments, private companies, other organizations and individuals) making efforts to realize and disseminate ZEB and those corporations (design firms, general contractors, consulting firms, etc.) supporting the realization of ZEB. Thus, it is expected that these Guidelines are effectively utilized in the proactive efforts to realize and disseminate ZEB.

- The main edition introduces design (structure and equipment) specifications to realize ZEB Ready (energy saving rate of 50%) and a calculation example based on the energy consumption performance calculation program with an office building having total floor area of 10,000 m^2 as a model case of medium-scale office buildings.

- In this connection, please note that these Guidelines introduce the technologies deemed to contribute to reducing energy consumption of buildings in operation phase to the extent possible; however, these contents are intended to be used in the design of buildings and do not guarantee that buildings designed according to these Guidelines can satisfy the requirements for ZEB Ready when they are put into actual operation.

Main edition

Separate edition for small-scale offices

Separate edition for elder care and welfare facilities

Separate edition for supermarkets/ home centers

Separate edition for hospitals

How to Use the ZEB Design Guidelines

- When designing ZEB using these Guidelines, it is recommended to refer to Chapter 2 first to confirm the direction of energy saving design toward ZEB and the priorities of element technologies on the basis of the case study on the model building (architectural plan, passive technologies, air-conditioning system, lighting system, ventilation system, hot water supply system, elevator system, etc.) and to better understand the concept to realize ZEB.

- Then, reference can be made to Chapters 3 to 6 to confirm the following items with respect to the technologies contributing to the realization of ZEB which can be used as information for making decisions on ZEB.
  - Concept of and approach to ZEB Ready and introduction of technologies contributing to the realization of ZEB Ready
  - Method for evaluating ZEB Ready through the energy consumption performance calculation program
  - Targets for energy saving effects
  - Approximate targets for the increments in construction costs

- Also, for the design examples of ZEB, reference can be made to Chapter 7 accordingly.

	Contents for the design and study of ZEB	Specific study item	
I. Understanding of given conditions and design policy	a. Study on ZEB design policy	• Direction of energy saving design toward ZEB Priorities of element technologies, etc.	Chapter 2
	b. Understanding of the availability of natural energy in surrounding area	• Availability of natural ventilation • Availability of sunlight • Availability of solar heat, etc.	Chapter 2
II. Design modeling <Evaluation in design phase>	a. Study on building energy saving technologies (passive technologies)	• Envelope insulation • Insolation shielding • Utilization of natural ventilation • Utilization of daylight • Layout plan (atrium, void, etc.)	Chapter 3
	b. Study on system energy saving technologies (active technologies)	• Air-conditioning system • Lighting system • Ventilation system • Hot water supply system • Elevator system	Chapter 4
	c. Study on renewable energy technologies	• Photovoltaic power generation • Wind power generation	Chapter 5
III. Design modeling <Evaluation in operation phase>	a. Study on system energy saving technologies (active technologies)	• Substation systems, receptacles • Energy management	Chapter 6
IV. Understanding of design examples	a. Design examples of ZEB	• Examples of ZEB oriented buildings	Chapter 7
	b. Reference information on the model building	• Reference information on the model building including approximate construction cost, etc.	Chapter 7

Chapter 2

Design Process and Element Technologies for the Realization of ZEB

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2.1 Architectural and Equipment Planning Policy for ZEB

- The basic concept of Net Zero Energy is that the energy consumed in premises or inside a building with air-conditioning, lighting, ventilation, hot water supply, etc. is almost equal to the energy generated in the premises through photovoltaic power generation, etc.

- In order to achieve Net Zero Energy, it is important to take the following measures for a reference building (with energy consumption corresponding to the 2016 energy efficiency standards): ❶ first is to control loads on a building by enhancing heat insulation of a building skeleton and utilizing natural energy; ❷ second is to realize thorough energy saving through the introduction of energy saving technologies; and ❸ last is to balance the energy consumption with the introduction of renewable energy such as solar energy to the extent possible.

- Those buildings achieving Net Zero Energy are defined as "energy independent buildings" in the "ZEB Study Group (Energy Independent Building Study Group)" centered around Nikken Sekkei Research Institute. The design processes of Net Zero Energy buildings are largely classified into the "passive design," the "active design" and the "management" after the completion of buildings.

Passive design

- Passive design is a design method required first for controlling loads on a building by keeping ambient and indoor environments appropriately and then proactively utilizing and appropriately controlling natural energy such as sunlight and wind.
  - ① Appropriate control of ambient environment: Optimization of building layout, building plan and exterior plan
  - ② Control of loads: Reinforcement of insulation of a building envelope and reduction in internal heat generation
  - ③ Utilization of natural energy: Utilization of natural light and ventilation
  - ④ Appropriate control of indoor environment: Optimization of warmer, air quality and light environments

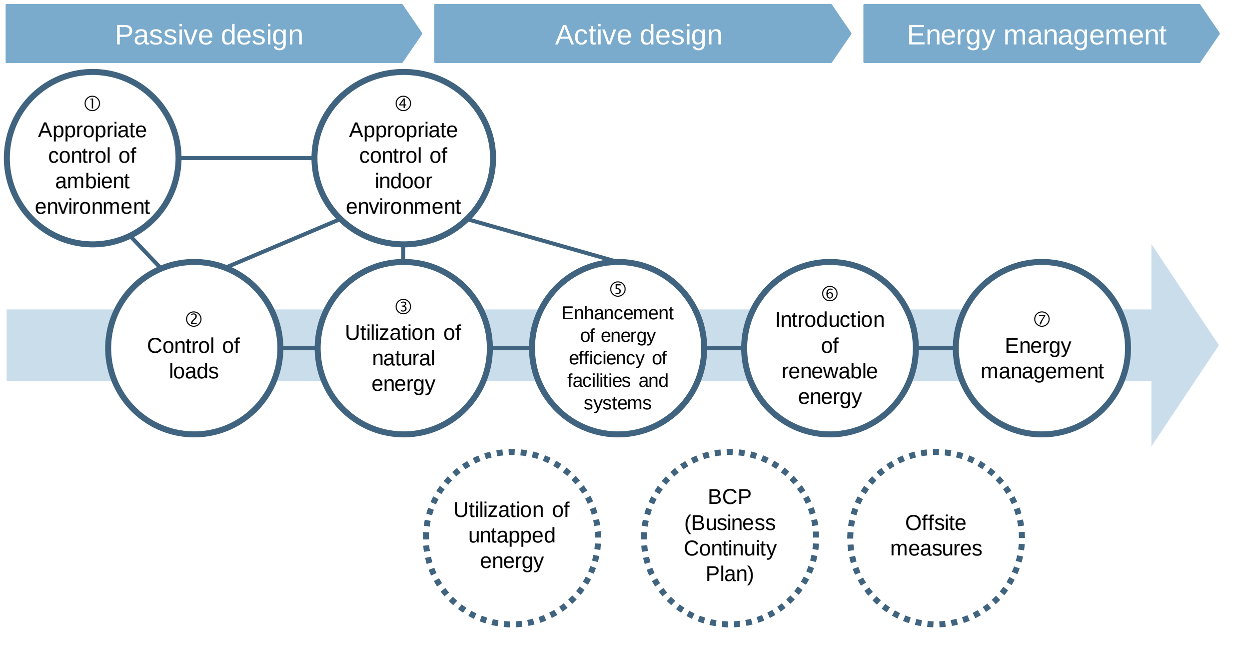
Active design

- Active design is a design method to introduce renewable energy after minimizing energy consumption through the introduction of high-efficiency equipment systems and possible utilization of untapped energy (temperature difference energy using groundwater or river water).
  - ⑤ Enhancement of energy efficiency of facilities and systems: Enhancement of energy efficiency of air-conditioning, ventilation, heat source system, lighting and hot water supply systems
  - ⑥ Introduction of renewable energy: Photovoltaic and wind power generation

Energy management

- In order to appropriately operate Net Zero Energy buildings for a long period of time, it is necessary to apply life cycle energy management to these buildings throughout their service life.
  - ⑦ Energy management: Utilization of BEMS (Building Energy Management System) and implementation as well as visualization of life cycle energy management

Architectural and Equipment Planning Policy for ZEB (Image)



Source: Hideharu Niwa, *Energy Independent Buildings*, Kousakusha Co., Ltd., 2013

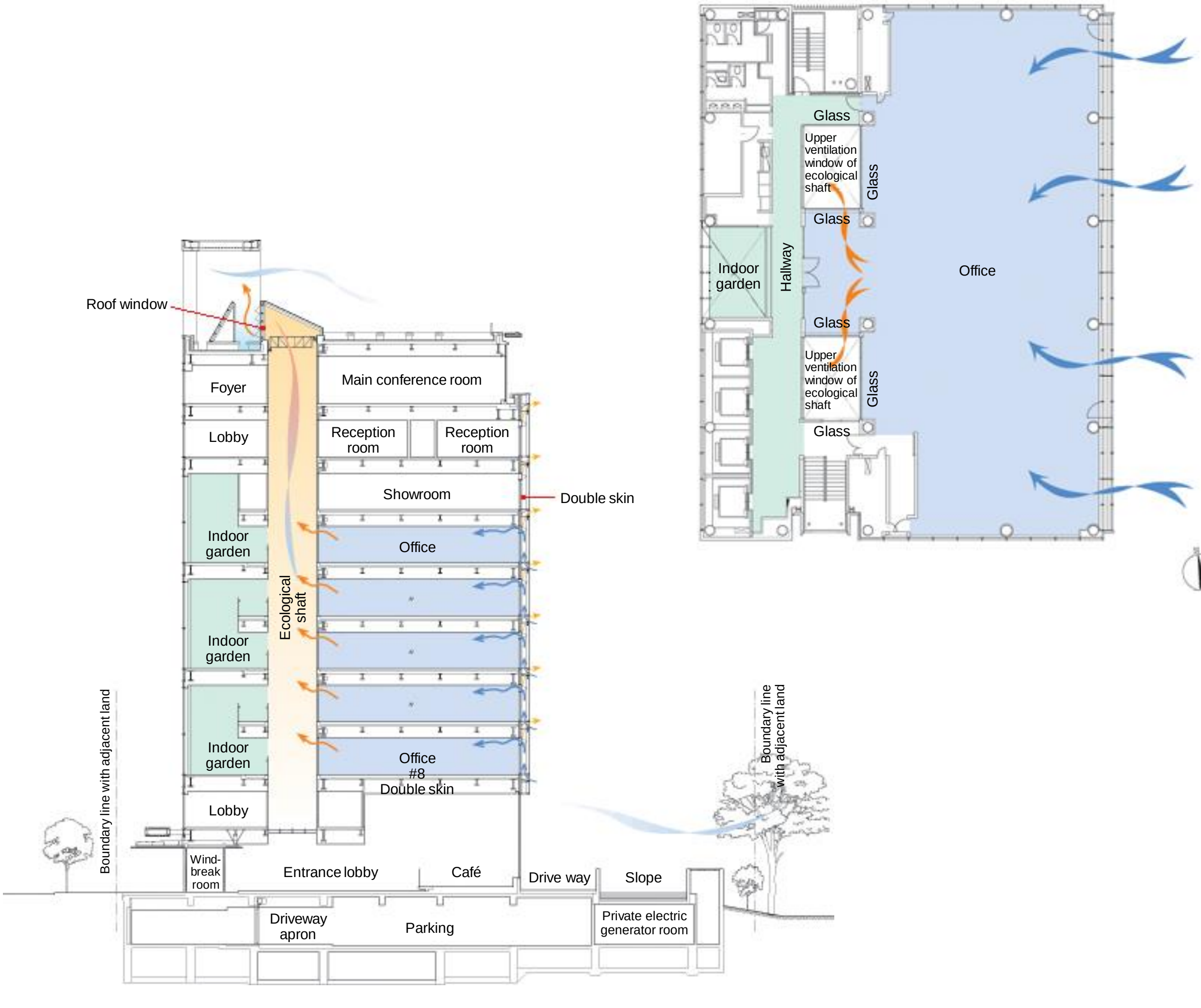
Architectural and Equipment Planning Policy for ZEB

Appropriate Control of Ambient Environments (Building Layout)

- Achieving ZEB requires the control of a variety of environmental loads through the proactive introduction of passive design. In order to optimize natural energy and protect a building from the influence of the natural energy as needed, it is imperative that a building layout and building plan are in harmony with the weather conditions specific to a site.

- For example, there is a case of a building with its layout and shape determined in accordance with a slope topography so as to utilize upslope wind from sea as a source of natural ventilation of the building. Similarly, when utilizing sunlight or studying the possibility to introduce insolation shielding, it is necessary to take into account the fact that insolation angles and intensities vary depending on regions, azimuth directions, seasons and times.

Image of building layout and building plan suitable for utilizing natural ventilation



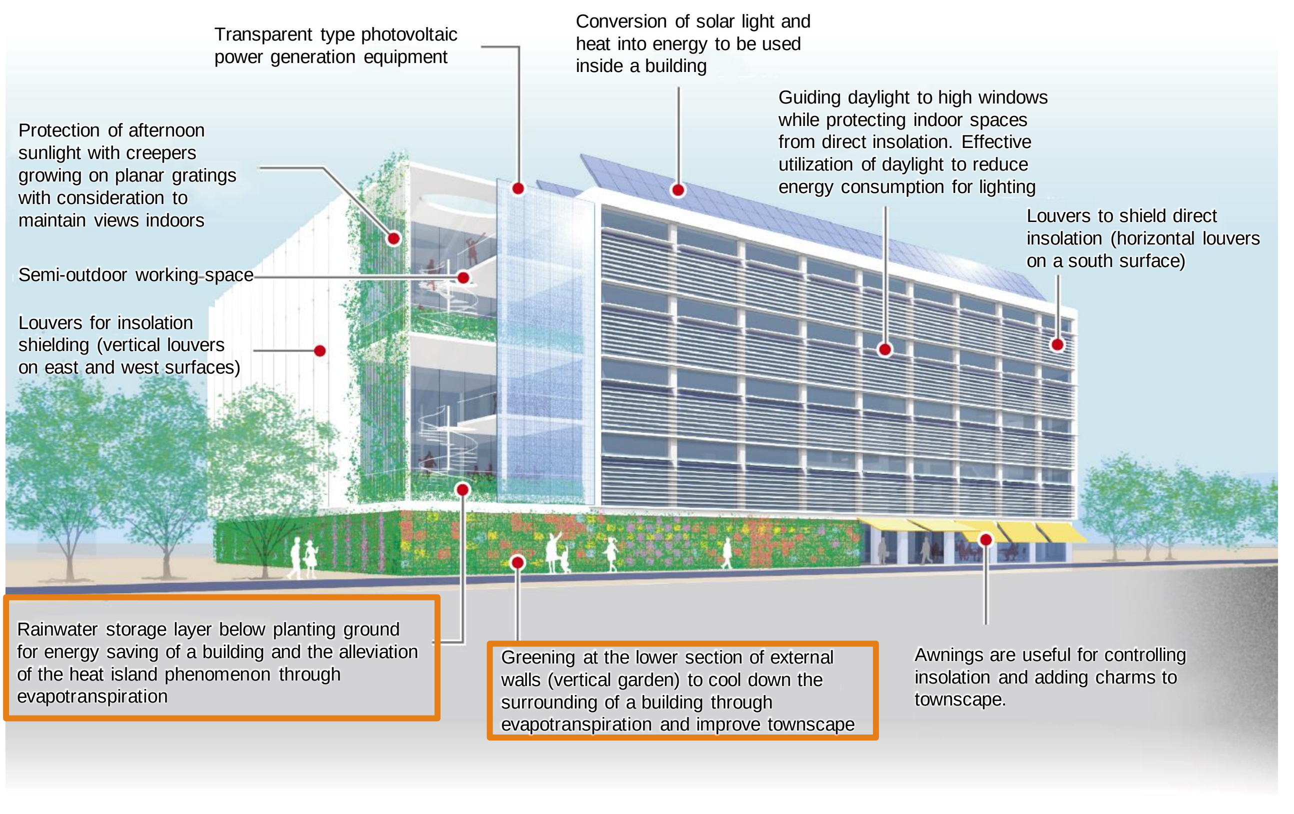
Source: “Environmental Conscious Buildings,” Special Topic of KAJIMA Digest in January 2003 edition, Kajima Corporation

Architectual and Equipment Planning Policy for ZEB

Appropriate Control of Ambient Environments (Exterior Plan)

- Although energy saving efforts in an outdoor space do not have significant direct effects on the reduction in energy consumption inside a building, cooling down premises with plants and water bodies enables the building to take in comfortable wind.
- Also, controlling ambient environments plays a considerable role in: curbing the heat island phenomenon in the vicinity and a surrounding region; creating green spaces and beautiful townscape; and alleviating influences on ecosystem.
- In addition to the exterior planning with plants and water bodies, the followings are considered to be effective measures to cool down premises without accumulating heat.
  - Enhancement of heat transfer through ventilation: A building layout and arrangement of ventilation passages not blocking natural wind
  - Enhancement of heat dissipation through transpiration: Greening of premises, a roof terrace, and external walls, utilization of water-retaining paint, etc.
  - Enhancement of heat dissipation through radiation: Utilization of high reflective paint on external walls and roof surface, provision of an open space to increase a sky factor, etc.

Image of appropriate exterior plan



Source: "Toward the Realization of ZEB," Special Topic of KAJIMA Digest in October 2011 edition, Kajima Corporation

Column

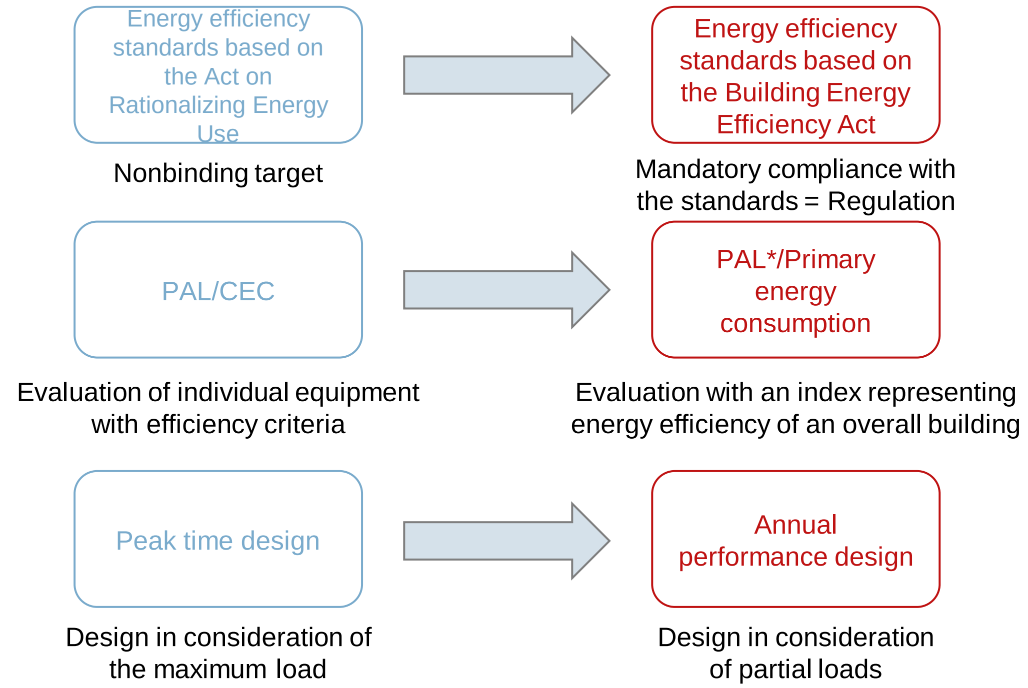
Case Study on Appropriate Control of Loads and Optimization of Equipment Capacity

The following is the excerption from the article "Selection methods to optimize equipment capacity" by Masato Miyata of the National Institute for Land and Infrastructure Management in the monthly *Kenchiku Gijuts*, September 2016, pp. 112-118.

- When planning building equipment system in consideration of the enhancement of energy efficiency performance, it is important to appropriately select equipment having capacity suitable for a planned building in addition to introducing high performance equipment. In a case of designing ZEB, the first design step is to optimize the loads of equipment by devising a building plan followed by the selection of equipment which has capacity just enough to undergo the loads. Then, the next design step is to consider the enhancement of its efficiency and the control to optimize its operation. The final design step is to study the possibility to introduce renewable energy.

- The concept of "optimizing the loads of equipment to curb the introduction of excessive equipment" has not been commonly shared by all designers. In the conventional building equipment plan, designers have put priority on providing a building with equipment having well enough capacity to undergo the maximum load (peak load) required by an owner as a design condition. However, considering the decision of the Ministry of Land, Infrastructure, Transport and Tourism requiring buildings to be mandatory in compliance with the energy efficiency standards with annual primary energy consumption used as evaluation indexes, it can be said that the time has come to design buildings on the basis of not only peak time performance but also annual energy consumption performance (annual performance design).

Shift to energy saving design (Image)



- Conventional peak time design is to achieve "design on the safe side" by providing a building with equipment having surplus capacity; however, excessive surplus capacity causes an increase in annual energy consumption which is defined as "design on the dangerous side" from the viewpoint of annual performance design. Thus, there may be a case where peak time design and annual performance design produce solutions contradicting each other and equipment designers are asked how to reach compromise between peak time and annual performance design.

- In order to achieve real energy saving in annual performance design, it is important to reconsider the necessity of the concept of "peak load." In order to be on the safe side in peak time design, the correct approach is to select equipment having surplus capacity to be calculated on the basis of weather conditions and internal heat generation conditions deemed to be most severe. Thus, when designing a building capable of reducing annual primary energy consumption, it is necessary to consider how to incorporate the concept of "peak load" which is the essential in the conventional building equipment plan (including envelope performance plan) in annual performance design.

Source: *Kenchiku Gijuts*, September 2016

- In order to understand the level of energy saving effect obtainable through the appropriate control of loads and optimization of equipment capacity, a case study is conducted with a 7-story office building having a total floor area of 10,308 m^2 as a model.

- Reference Case (01) has following specifications:
    - Wall insulation material: extruded polystyrene foam heat insulation board (Type 1) (25 mm thick)
    - Window glass: single plate glass (8 mm thick) with blind
    - Window area ratio (a ratio of window area to envelope area): 30%
    - Heat source equipment: air-cooled heat pumps, 2 units (cooling COP of 3.24 and heating COP of 3.42)
    - Primary pump: WTF (pump capacity/electric power consumption) 44.0
    - Secondary pump: 2 units (with quantity control), temperature difference between outgoing and incoming heat medium of 7°C, variable water volume control (minimum flow ratio of 60%), WTF (pump capacity/electric power consumption) 22.0
    - Air conditioner: ATF (air-conditioning capacity/electric power consumption) 7.0

- Reference Case (01) is to be compared with the following comparative cases with some values changed from Reference Case (01) so as to evaluate the effects of “controlling loads (improvement in insulation at opening and shielding performance)” and “optimizing equipment capacity (sensible heat correction factors and correction factors when selecting equipment capacity)” on annual primary energy consumption.

Case	Structure		Opening (window)			Internal heat generation			External air intake amount	Existence of total heat exchanger	Sensible heat correction factor		Correction factor when selecting equipment capacity			
	External wall	Internal wall	Overall heat transfer coefficient	Shade factor	Window area ratio	Lighting	Equip-ment	Office worker			Cooling	Heating	K1	K2	K3	K3
	W/ m^2K	W/ m^2K	W/ m^2K	-	%	W/m^2	W/m^2	person/ m^2	m^3/h· person		-	-	-	-	Cooling	Heating
01	1.00	1.96	4.9	0.62	0.3	20	20	0.2	30	Yes	1.15	1.21	1.05	1.05	1.05	1.1
02	ditto	ditto	2.2	0.39	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto
02a	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	1.05	1.1	ditto	ditto	ditto	ditto
02b	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	1.05	1.1	1	1	1	1
03	ditto	ditto	ditto	ditto	ditto	12	12	0.1	ditto	ditto	ditto	ditto	1.05	1.05	1.05	1.1
03a	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto
03b	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	1	1	1	1

Control of loads

Optimization of equipment capacity

- The following is the comparison result between Reference Case (01) and respective comparative cases to examine the effects of “controlling loads (improvement in insulation at opening and shielding performance)” and “optimizing equipment capacity (sensible heat correction factors and correction factors when selecting equipment capacity)” on annual primary energy consumption.

Case	Maximum value of hourly load		Required capacity of heat source equipment (for 2 units)		Calculation result		
	Cooling	Heating	Cooling	Heating	① Design primary energy consumption	② Reference primary energy consumption	BEI/AC Note (①/②)
	kW	kW	kW/unit	kW/unit	MJ/m^2/year	MJ/m^2/year	—
01	1,040	526	664	335	1,164	1,173	1.00
02	968	457	618	291	1,087	ditto	0.93
02a	914	444	583	283	1,046	ditto	0.90
02b	ditto	ditto	504	245	1,029	ditto	0.88
03	591	303	377	193	802	ditto	0.69
03a	555	290	354	184	772	ditto	0.66
03b	ditto	ditto	306	160	781	ditto	0.67

Note: BEI/AC is the BEI (Building Energy Index) representing a ratio of the primary energy consumption of a planned building to that of a reference building on the basis of energy consumption performance calculation program calculated exclusively for air-conditioning system.

Source: *Kenchiku Gijuts*, September 2016

* The specifications of the energy consumption performance calculation program allow “equipment capacity” to be input but do not allow “sensible heat correction factor” and “correction factor when selecting equipment capacity” to be directly input. Thus, the above case study result is preferably read as an important reference when studying “equipment capacity.”

2.2 Element Technologies for ZEB

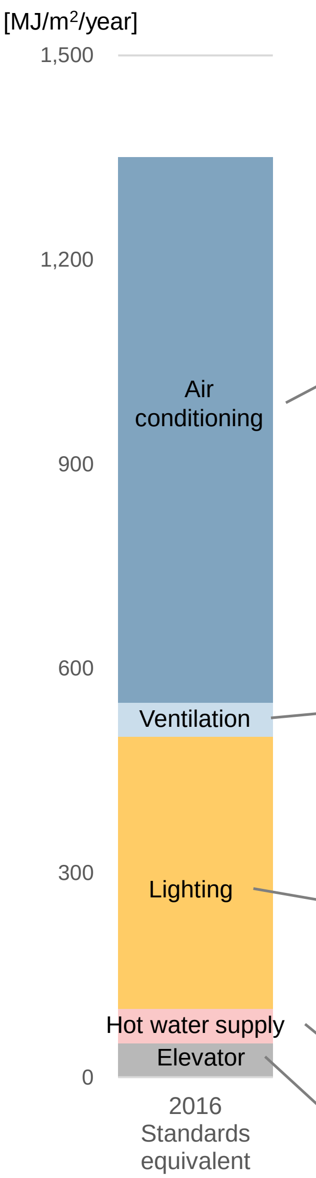
- In the primary energy consumption (excluding PCs and OA equipment) of a typical office building, air-conditioning system and lighting system account for 800 MJ/m^2/year (about 60% of the total) and 400 MJ/m^2/year (about 30% of the total) respectively.

- Thus, in the case of an office building, it is preferable to put priority on the reduction in the primary energy consumption due to air-conditioning system (by 45 to 50% as a target) through: the control of air-conditioning loads inside the building by introducing of a super-insulated envelope (insulation materials and windows) and insolation shielding technologies; and the introduction of natural ventilation as well as high-efficiency air-conditioning systems.

- Regarding lighting system accounting for the second largest energy consumption next to air-conditioning system, it is preferable to reduce the primary energy consumption due to lighting system (by 50 to 80% as a target) through the introduction of high-efficiency lighting system such as LED lamps while proactively adopting a building plan and technologies appropriately utilizing daylight.

BEFORE 2016 Standards equivalent

Specifications complying with 2016 Energy Efficient Standards (Target)



Building specifications/Technology introduced (Target for Group 6 of the insulation area classification)
<Envelope performance> • Roof insulation: extruded polystyrene foam insulation board, 50 mm thick • Eternal wall insulation: extruded polystyrene foam insulation board, 50 mm thick • Window: single transparent plate glass, 8 mm thick
<Use of passive technology> • Nothing special
<Heat source and cooling tower> • Type of central heat source: air-cooled heat pump chiller (Cooling COP of 3.24 and heating COP of 3.42)
<Pump> • Quantity control with two pumps and inverter control • Delivery of water with temperature difference of 7°C • Variable water volume control (minimum flow ratio of 60%)
<Air conditioner> • General air conditioning • Constant air volume control, total heat exchanger, and external air cut control
<Equipment> • Standard motor
<Control> • Nothing special
<Use of passive technology> • Nothing special
<Equipment> • Office: high frequency fluorescent lamp • Backup space: high frequency fluorescent downlight
<Control> • No control
• Installation of individual hot water supply system (electrical) for wash-basin in toilet • No water saving function • Standard insulation specifications
• AC feedback control

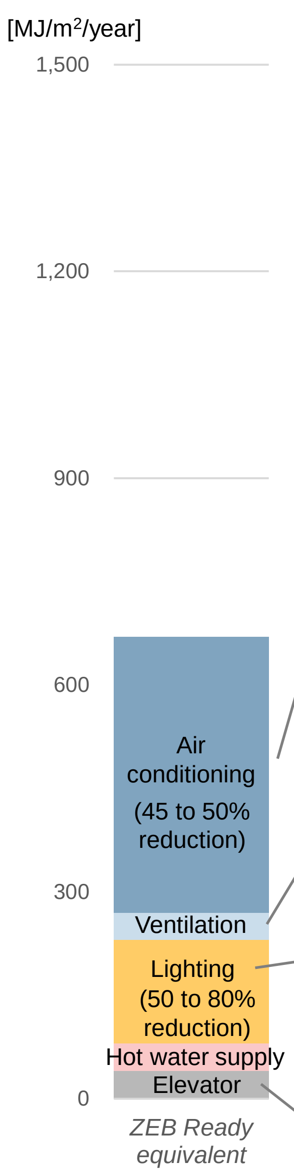
* Above values are set on the assumption that the model building has a rentable rate of about 70%.

- As a result of designing a building which realizes ZEB Ready (energy saving rate of 50%) using an energy saving calculation program, the “Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017),” such a building is considered to have the following specifications with respect to: a building plan; passive technologies; and air-conditioning, lighting, ventilation and hot water supply, and elevator systems.

- What follows in Chapters 3 to 5 are the detail descriptions about the followings with particular focus on the technologies used in the case studies in these Guidelines: “Introduction of the concept of and approach to ZEB Ready and technologies contributing to the realization of ZEB Ready”; “Method for designing ZEB Ready with the energy consumption performance calculation program”; “Targets of energy saving effects”; and “Targets of the increments in construction costs.”

AFTER ZEB Ready equivalent

Specifications for an office building to realize ZEB Ready (Target)



Building specifications/Technology introduced (Example) (Including those technologies which cannot be evaluated with the energy consumption performance calculation program)
<Improvement in envelope performance> • High performance insulation material, super-insulated and high insolation shieling window, canopy, blind, etc.
<Use of passive technology> • Natural ventilation system, cool heat trench (earth thermal utilization), etc.
<Enhancement of the efficiency of heat source and cooling tower> • High-efficiency heat source equipment, heat storage system, medium temperature water utilization system, quantity control, high-efficiency cooling tower, inverter control, free cooling, etc.
<Enhancement of the efficiency of pump> • High-efficiency air-conditioning pump, variable water volume control, large temperature difference small flow rate pump, etc.
<Enhancement of the efficiency of air conditioner and sophistication of control> • High-efficiency packaged air conditioner, high-efficiency air conditioner, total heat exchanger, external air cooling system, external air cut, external air cooling, variable air volume control, zero energy band control, desiccant air-conditioning system, hybrid air-conditioning system, floor air-conditioning system, etc.
<Enhancement of the efficiency of equipment> • High-efficiency fan, inverter control, etc.
<Sophistication of control> • Temperature control, blower control, CO_2 concentration control, control with motion sensor, etc.
<Use of passive technology> • Natural lighting system, etc.
<Enhancement of the efficiency of equipment> • High-efficiency lighting (LED), etc.
<Sophistication of control> • Motion detection control with motion sensor, daylight utilization control, automatic on-off control based on luminous detection, time schedule control, initial illuminance correction control, task ambient lighting system, zoning control, etc.
• High-efficiency water heater (mounted with heat pump and latent heat recovery function), automatic faucet of wash basin, super-insulated piping, system for local hot water supply to toilet wash basin and kettle room, etc.
• Variable voltage variable frequency control, power regenerative control, group supervisory control, etc.

* Above values are set on the assumption that the model building has a rentable rate of about 70%.

2.3 Outline of the Case Study in These Guidelines

Implementation Policy of the Case Study

- In the case study of these Guidelines, a building satisfying ZEB Ready (energy saving rate of 50%) is designed using the energy consumption performance calculation program in a manner that clarifies the specifications for: required envelope insulation; insolation shielding; and air-conditioning, lighting, ventilation, hot water supply, and elevator systems.

- A calculation model was selected in a manner that: first referred to a model office building (total floor area of 10,000 m^2) shown in "Calculation and Determination Methods based on the 2013 Energy Efficiency Standards and their Commentaries (I. Nonresidential Building)";

  ① modified the model office building so as to have a building plan adopting full height design (increase in the area ratio of an opening to an external wall) which has been frequently used in recent office buildings; and

  ② enhanced the envelope insulation performance so as to comply with the building energy consumption performance standards on the basis of the building plan mentioned ① above.

  ③ Then, with the calculation model obtained through the processes of ① and ② above, the specifications of a building satisfying ZEB Ready (energy saving rate of 50%) were calculated assuming the cases where the model is provided with high-efficiency equipment and control which can be evaluated with the energy consumption performance calculation program.

Implementation policy of the case study

- Assumption of hull height design which has been frequently used with recent office buildings
(➡ increase in an area ratio of an opening to an external wall)

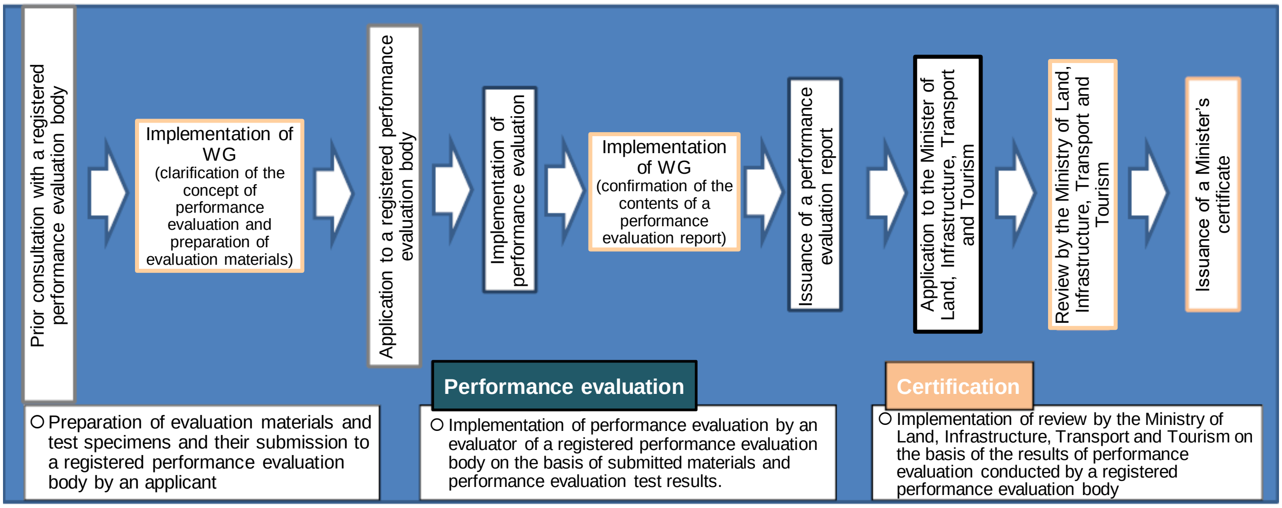
- Enhancement of envelope insulation performance so that a model has design primary energy consumption equivalent to the reference primary energy consumption
(➡ assumption of double-glazed glass)

- A building satisfying ZEB Ready (energy saving rate of 50%) is designed in a manner that clarifies the specifications for: required envelope insulation; insolation shielding; and air-conditioning, lighting, ventilation, hot water supply, and elevator systems.

Column Minister's Certification System (Certification of buildings provided with special structures and equipment)

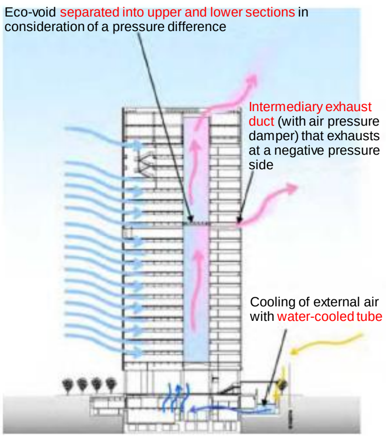
- The system is to evaluate new technologies which cannot be evaluated with the current energy efficiency standards and to certify that buildings using new technologies satisfy the standards. The Minister of Land, Infrastructure, Transport and Tourism certifies that buildings have performance equivalent to those complying with the energy efficiency standards on the basis of the performance evaluation by a registered building energy consumption performance evaluation body. With the certificate of the Minister, those buildings subject to compliance certificate can be granted with special treatment to regard them as the buildings which have received the issuance of compliance certificate.

- The certification process is as follows.
  ① Performance evaluation: technical evaluation to confirm the energy saving performance of a building to which an application is made.
  The evaluation is carried out by a registered performance evaluation body certified by the Minister of Land, Infrastructure, Transport and Tourism.
  ② Certification: the Minister of Land, Infrastructure, Transport and Tourism certifies on the basis of the performance evaluation report issued by a registered performance evaluation body.



- The example of the evaluation process of technologies which have not been standardized is as follows.

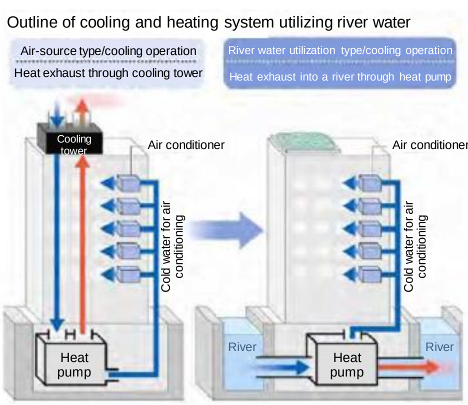
[Eco-void (utilization of natural ventilation)]



[Factors making immediate standardization difficult]
- Energy saving effects are dependent on outdoor conditions (distances to neighboring buildings and prevailing wind directions).
- Accurate calculation of ventilation volume is not available with existing technologies.
- The methods for controlling start and stop as well as the intensity of wind force have not been generalized and largely vary.

[Reasons for the availability of individual certification]
- Individual investigation and analysis of (wind direction and ventilation volume) enable energy saving effects and performance to be evaluated.

[Utilization of river water]



[Factors making immediate standardization difficult]
- Estimation of temperature fluctuation at an arbitrary location under the ground or in a river is not available with existing technologies.
  → It is necessary to take into account the water temperature fluctuation specific to a concerned river and the rise and fall of tides.

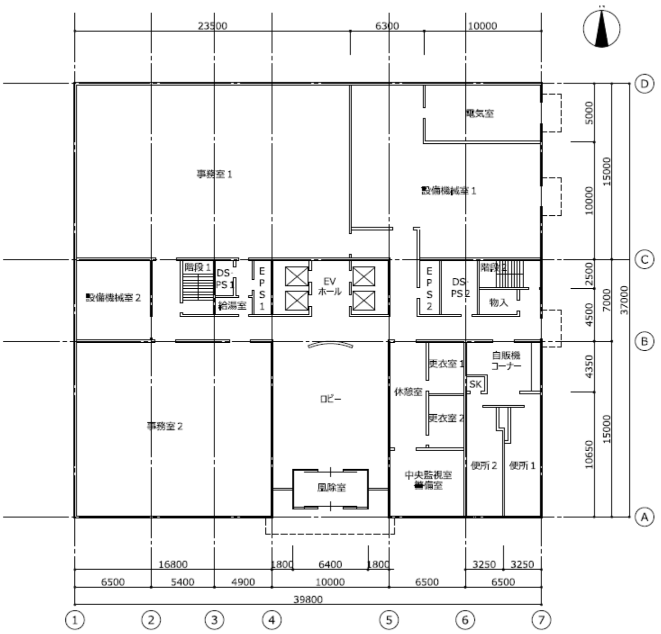
[Reasons for the availability of individual certification]
- Individual investigation and analysis (investigations on temperatures and water levels) enable energy saving effects and performance to be evaluated.
  → When temperature conditions of river water is clarified, the evaluation on a safe side becomes easily available.

Source: Modification of the material by the Ministry of Land, Infrastructure, Transport and Tourism

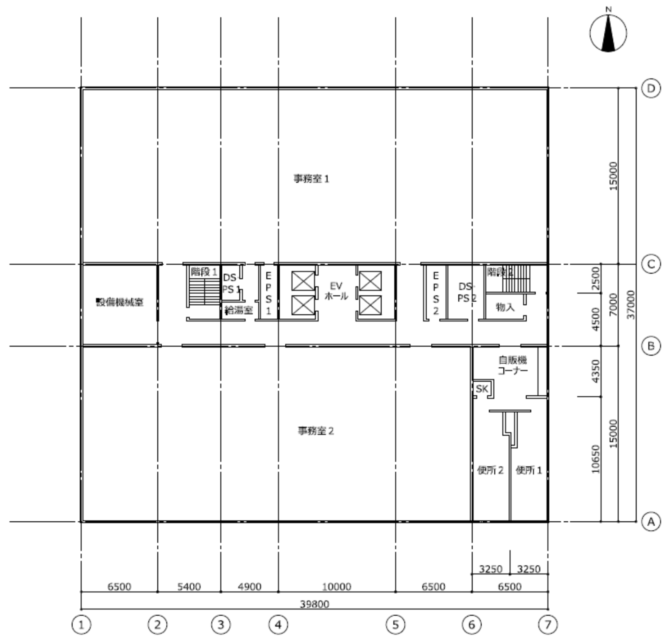
Building Plan

- The case study in these Guidelines is based on the following building plan.
  - Location: Chiyoda-ku, Tokyo (corresponding to Group 6 of the insulation area classification)
  - Structure: Steel-frame, steel-reinforced concrete (SRC) structure
  - Number of stories: 7 stories above the ground
  - Site area: 5,000 m^2
  - Building area: 1,423 m^2
  - Total floor area: 10,105 m^2

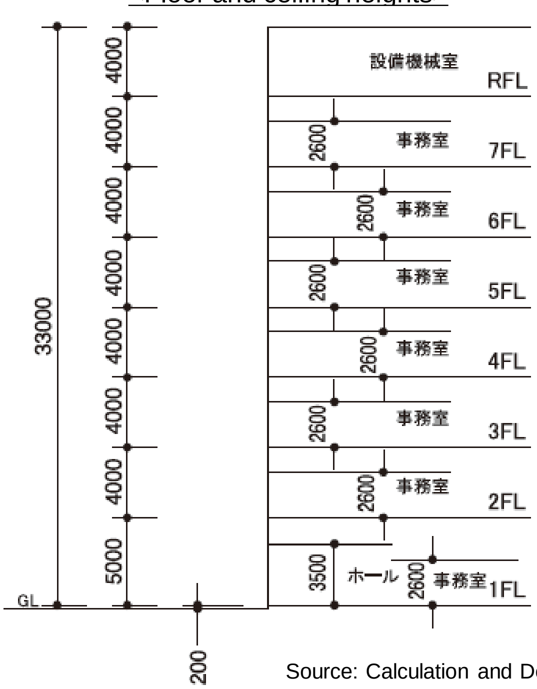
<1F Plan View>



<2F–7F Plan View>



<Floor and ceiling heights>



Source: Calculation and Determination Methods based on the 2013 Energy Efficiency Standards and their Commentaries (I. Nonresidential Building)

Design Conditions

- The operating time and loads of respective types of rooms were set on the basis of the following assumptions.
- The case study in these Guidelines assumes that the “reference preset illuminance” of an “office” is 500 lx not 750 lx when designing a building satisfying ZEB Ready (energy saving rate of 50%).

Room name	Assumed operating time and load	Annual air-conditioning hours	Reference value of heat generated by lighting system	Reference number of persons in unit area	Reference value of heat generated by equipment	Intake rate of fresh external air	Annual ventilation time	Reference preset ventilation method	Reference preset ventilation frequency	Reference preset ventilation flow rate	Reference preset total pressure loss	Annual lighting time	Reference preset illuminance	Reference power consumption by lighting system	Annual number of days of hot water supply	Reference preset hot water usage
		h/year	W/m^2	persons/m^2	W/m^2	m^3/m^2·h	h/year	-	times	m^3/m^2·h	Pa	h/year	lx	W/m^2	days/year	L/person/day
Office	Typical office. Hot water use for hand wash	3,374	12	0.1	12	5.0	0	-	-	0.0	0	3,133	750	16.3	241	3.8
Central control room	Operation 24 hours a day, 365 days a year	8,760	20	0.15	30	4.0	0	-	-	0.0	0	8,760	500	13.7	365	3.8
Changeroom or warehouse	Ventilation frequency of 5 times (Type 3), hot water use for bath and shower	3,374	15	0.3	0	4.0	3,133	Type 3	5	13.5	300	3,133	300	6.6	241	62
Hallway	—	3,133	15	0.03	0	2.5	0	-	-	0.0	0	3,133	200	8	0	0
Lobby	Hot water use for face and hand wash	3,133	15	0.03	0	2.5	0	-	-	0.0	0	3,133	500	17.9	241	3.8
Toilet	Ventilation frequency of 15 times (Type 3)	3,133	15	0.03	0	2.5	3,133	Type 3	15	40.5	300	3,133	300	12	0	0
Machine room	Electromechanical room with standard heat generation. Ventilation frequency of 5 times (Type 1) on the assumption of 24-hour ventilation	0	0	0	0	0.0	8,760	Type 1	5	13.5	300	200	200	4.9	0	0
Electric room	Electromechanical room with large heat generation. Ventilation frequency of 10 times (Type 1) on the assumption of 24-hour ventilation	0	0	0	0	0.0	8,760	Type 1	10	27.0	300	200	200	4.9	0	0
Kettle room	Non-air-conditioned room with ventilation frequency of 5 times (Type 3)	0	0	0	0	0.0	2,000	Type 3	5	13.5	300	1,000	300	6.6	0	0

Outline of Building Specifications and Equipment Introduced

- The case study in these Guidelines assumes the following building specifications and equipment introduced in each of “Case A. 2016 standard equivalent” and “Case B. ZEB Ready.”
- The followings are the estimation results obtained by using only those technologies to which the energy consumption performance calculation program can be applicable. Thus, please note that there exist a variety of other combinations of technologies.

Study case		Case A: 2016 Standard equivalent	Case B: ZEB Ready
		Performance equivalent to the energy efficiency standards	A model with the energy consumption reduced to a level 50% of the energy efficiency standards by applying a variety of energy saving methods to Case A
Envelope	Window specifications	Equivalent to double-glazed glass (a single sheet of Low-E glass, dry air, insulation shielding type, 10 mm hollow layer: coefficient of overall heat transmission of 2.0 W/m^2K, solar heat gain coefficient of 0.40)	Equivalent to double-glazed glass (a single sheet of Low-E glass, heat insulation gas, insulation shielding type, 12 mm hollow layer: coefficient of overall heat transmission of 1.6 W/m^2K, solar heat gain coefficient of 0.40)
			Horizontal canopy (0.6 m, 1.4 m above a window)
	Roof insulation	Extruded polystyrene foam insulation board, Type 1, 50 mm	Extruded polystyrene foam insulation board, Type 3, 100 mm
	External wall insulation	Extruded polystyrene foam insulation board, Type 1, 25 mm	Extruded polystyrene foam insulation board, Type 3, 50 mm

Study case			Case A: 2016 Standard equivalent	Case B: ZEB Ready
			Performance equivalent to the energy efficiency standards	A model with the energy consumption reduced to a level 50% of the energy efficiency standards by applying a variety of energy saving methods to Case A
Air conditioning	Heat source	Central	Absorption chiller (city gas)	Absorption chiller (variable cooling water flow rate, city gas)
		COP	Cooling 1.10, heating 0.87	Cooling 1.35, heating 0.88
		Water delivery temperature	Cooling 7, heating 55	Cooling 7, heating 55
		Number of units	2	2
		Cooling tower and pump	Power consumption of cool water pump: 11 kW/unit, power consumption of cooling tower fan: 5.5 kW/unit	Power consumption of cool water pump: 11 kW/unit, power consumption of cooling tower fan: 5.5 kW/unit
		Number of units	2	2
		Individual	Packaged air conditioner (air cooled type)	Packaged air conditioner (air cooled type)
		COP	Cooling 4.1, heating 4.7	Cooling 4.1, heating 4.7
		Number of units	4	4
	Water delivery	Temperature difference	5°C	7°C
		Control	Two pump operation method, constant flow control	Two pump operation method, quantity control, rotation control (60%)
		Number of units	4	4
	Air delivery	Indoor unit	① Cooling capacity: 5.6 kW/unit, heating capacity 6.3 kW/unit (1 unit) Design maximum external air flow rate: 1,290 m^3/h/unit ② Cooling capacity: 3.6 kW/unit, heating capacity 4.0 kW/unit (3 units) Design maximum external air flow rate: 960 m^3/h/unit	① Cooling capacity: 5.6 kW/unit, heating capacity 6.3 kW/unit (1 unit) Design maximum external air flow rate: 1,290 m^3/h/unit ② Cooling capacity: 3.6 kW/unit, heating capacity 4.0 kW/unit (3 units) Design maximum external air flow rate: 960 m^3/h/unit
		Indoor unit control	Constant air volume control	Constant air volume control, external air cut, external air cooling ① Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 200 m^3/h/unit) (1 unit) ②-1 Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 150 m^3/h/unit) (2 units) ②-2 Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 300 m^3/h/unit) (1 unit)
		FCU	• Cooling capacity: 6.8 kW/unit, heating capacity 6.8 kW/unit (1 unit) Design maximum external air flow rate: 1,020 m^3/h/unit • Cooling capacity: 2.7 kW/unit, heating capacity 2.6 kW/unit (7 units) Design maximum external air flow rate: 360 m^3/h/unit	• Cooling capacity: 6.8 kW/unit, heating capacity 6.8 kW/unit (1 unit) Design maximum external air flow rate: 1,020 m^3/h/unit • Cooling capacity: 2.7 kW/unit, heating capacity 2.6 kW/unit (7 units) Design maximum external air flow rate: 360 m^3/h/unit
		FCU control	Constant air volume control	Constant air volume control
		Air conditioner	① Cooling capacity: 52 kW/unit, heating capacity 29 kW/unit (1 unit) Design maximum external air flow rate: 6,100 m^3/h/unit ② Cooling capacity: 41 kW/unit, heating capacity 21 kW/unit (1 unit) Design maximum external air flow rate: 5,100 m^3/h/unit ③ Cooling capacity: 87 kW/unit, heating capacity 43 kW/unit (5 units) Design maximum external air flow rate: 10,000 m^3/h/unit ④ Cooling capacity: 75 kW/unit, heating capacity 36 kW/unit (5 unit) Design maximum external air flow rate: 8,800 m^3/h/unit ⑤ Cooling capacity: 95 kW/unit, heating capacity 47 kW/unit (1 unit) Design maximum external air flow rate: 11,600 m^3/h/unit ⑥ Cooling capacity: 82 kW/unit, heating capacity 39 kW/unit (1 unit) Design maximum external air flow rate: 10,100 m^3/h/unit	① Cooling capacity: 52 kW/unit, heating capacity 29 kW/unit (1 unit) Design maximum external air flow rate: 6,100 m^3/h/unit ② Cooling capacity: 41 kW/unit, heating capacity 21 kW/unit (1 unit) Design maximum external air flow rate: 5,100 m^3/h/unit ③ Cooling capacity: 87 kW/unit, heating capacity 43 kW/unit (5 units) Design maximum external air flow rate: 10,000 m^3/h/unit ④ Cooling capacity: 75 kW/unit, heating capacity 36 kW/unit (5 units) Design maximum external air flow rate: 8,800 m^3/h/unit ⑤ Cooling capacity: 95 kW/unit, heating capacity 47 kW/unit (1 unit) Design maximum external air flow rate: 11,600 m^3/h/unit ⑥ Cooling capacity: 82 kW/unit, heating capacity 39 kW/unit (1 unit) Design maximum external air flow rate: 10,100 m^3/h/unit
		Air conditioner control	Constant air volume control	VAV (minimum air volume ratio of 50%): for all 14 units above External air cut, external air cooling ① Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 1,800 m^3/h/unit) (1 unit) ② Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 1,300 m^3/h/unit) (2 units) ③ Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 3,000 m^3/h/unit) (1 unit) ④ Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 2,500 m^3/h/unit) (1 unit) ⑤ Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 3,000 m^3/h/unit) (2 units) ⑥ Total heat exchanger (total heat exchange efficiency: 60%, design air volume: 2,500 m^3/h/unit) (1 unit)

Study case			Case A: 2016 standard equivalent Performance equivalent to energy efficiency standards	Case B: ZEB Ready A model with the energy consumption reduced to a level 50% of the energy efficiency standards by applying a variety of energy saving methods to Case A
Ventilation	Static pressure		250 Pa	250 Pa
	Blower	Toilet	Design air volume: 700 m^3/h, rated output: 0.146 kW	Design air volume: 700 m^3/h, rated output: 0.146 kW
		Control		JIS C4212 High-efficiency induction motor
		Warehouse	Design air volume: 100 m^3/h, rated output: 0.021 kW	Design air volume: 100 m^3/h, rated output: 0.021 kW
		Control		JIS C4212 High-efficiency induction motor
		Kettle room	Design air volume: 300 m^3/h, rated output: 0.063 kW	Design air volume: 300 m^3/h, rated output: 0.063 kW
		Control		JIS C4212 High-efficiency induction motor
		Machine room	Design air volume: 900 m^3/h, rated output: 0.188 kW	Design air volume: 900 m^3/h, rated output: 0.188 kW
		Control		JIS C4212 High-efficiency induction motor, temperature control
		Machine room (1F ①)	Design air volume: 4,100 m^3/h, rated output: 0.854 kW	Design air volume: 4,100 m^3/h, rated output: 0.854 kW
		Control		JIS C4212 High-efficiency induction motor, temperature control, with inverter
		Machine room (1F ②)	Design air volume: 1,100 m^3/h, rated output: 0.229 kW	Design air volume: 1,100 m^3/h, rated output: 0.229 kW
		Control		JIS C4212 High-efficiency induction motor, temperature control, with inverter
		Machine room (roof)	Design air volume: 2,000 m^3/h, rated output: 0.417 kW	Design air volume: 2,000 m^3/h, rated output: 0.417 kW
		Control		JIS C4212 High-efficiency induction motor, temperature control, with inverter
		Electric room	Design air volume: 2,500 m^3/h, rated output: 0.521 kW	Design air volume: 2,500 m^3/h, rated output: 0.521 kW
		Control		JIS C4212 High-efficiency induction motor, with inverter
		Resting room	Design air volume: 400 m^3/h, rated output: 0.083 kW	Design air volume: 400 m^3/h, rated output: 0.083 kW
		Control		JIS C4212 High-efficiency induction motor
	Fan efficiency		40%	40%

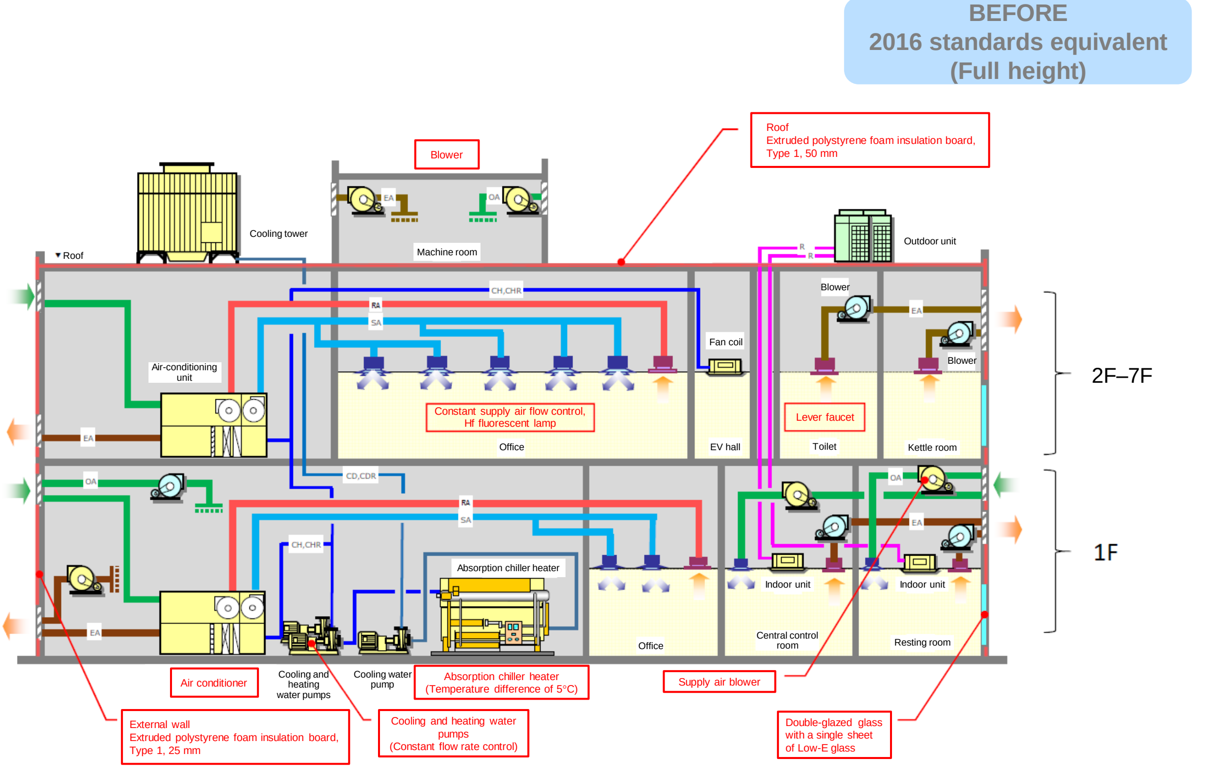
Study case		Case A: 2016 standard equivalent Performance equivalent to the energy efficiency standards	Case B: ZEB Ready A model with the energy consumption reduced to a level 50% of the energy efficiency standards by applying a variety of energy saving methods to Case A
Lighting	Hallway	Hf (2,400 lm/35 W), 258 units	LED (2,400 lm/19.2 W), 258 units
	Lobby	Hf (5,500 lm/87 W), 24 units	LED (5,500 lm/19.2 W), 24 units
	Central control room	Hf (4,950 lm/48 W), 10 units	LED (4,950 lm/31 W), 10 units
	Changeroom or warehouse	Hf (4,950 lm/48 W), 25 units	LED (4,950 lm/31 W), 25 units
	Toilet	Hf (2,400 lm/35 W), 140 units	LED (2,400 lm/7.4 W), 140 units
	Control		Motion detection control
	Machine room	Hf (4,950 lm/48 W), 91 units	LED (4,950 lm/31 W), 91 units
	Kettle room	Hf (4,950 lm/48 W), 7 units	LED (4,950 lm/31 W), 7 units
	Control		Motion detection control
	Electric room	Hf (4,950 lm/48 W), 5 units	LED (4,950 lm/31 W), 5 units
	Office	Hf (4,950 lm × 2/95 W), 1,239 units	LED (5,040 lm/47 W), 1,625 units
	Control		Office luminous detection control, time schedule control, initial illuminance correction control

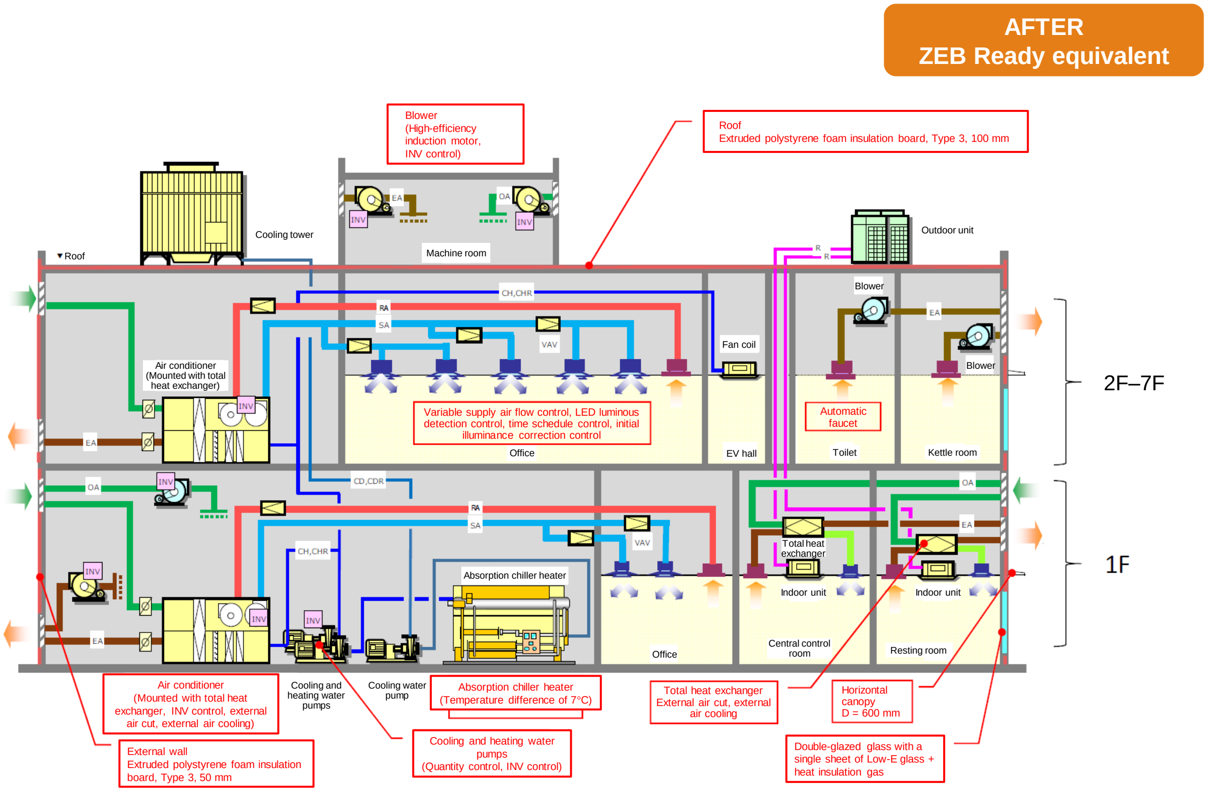
Study case		Case A: 2016 standard equivalent Performance equivalent to energy efficiency standards	Case B: ZEB Ready A model with the energy consumption reduced to a level 50% of the energy efficiency standards by applying a variety of energy saving methods to Case A
Hot water supply	Equipment	Storage type electric water heater for local hot water supply (Rated heating capacity: 1.1 kW, heat source efficiency: 0.37)	Storage type electric water heater for local hot water supply (Rated heating capacity: 1.1 kW, heat source efficiency: 0.37)
	Hot water saving equipment	Not applicable	Automatic hot water faucet
	Insulation	30 mm (< 40 A)	30 mm (< 40 A)

Study case		Case A: 2016 standard equivalent Performance equivalent to the energy efficiency standards	Case B: ZEB Ready A model with the energy consumption reduced to a level 50% of the energy efficiency standards by applying a variety of energy saving methods to Case A
Elevator	Equipment	Capacity: 800 kg, Speed: 60 m/min	Capacity: 800 kg, Speed: 90 m/min
	Control	AC feedback control	VVVF (with power regeneration, gearless)

Schematic Diagrams of Systems

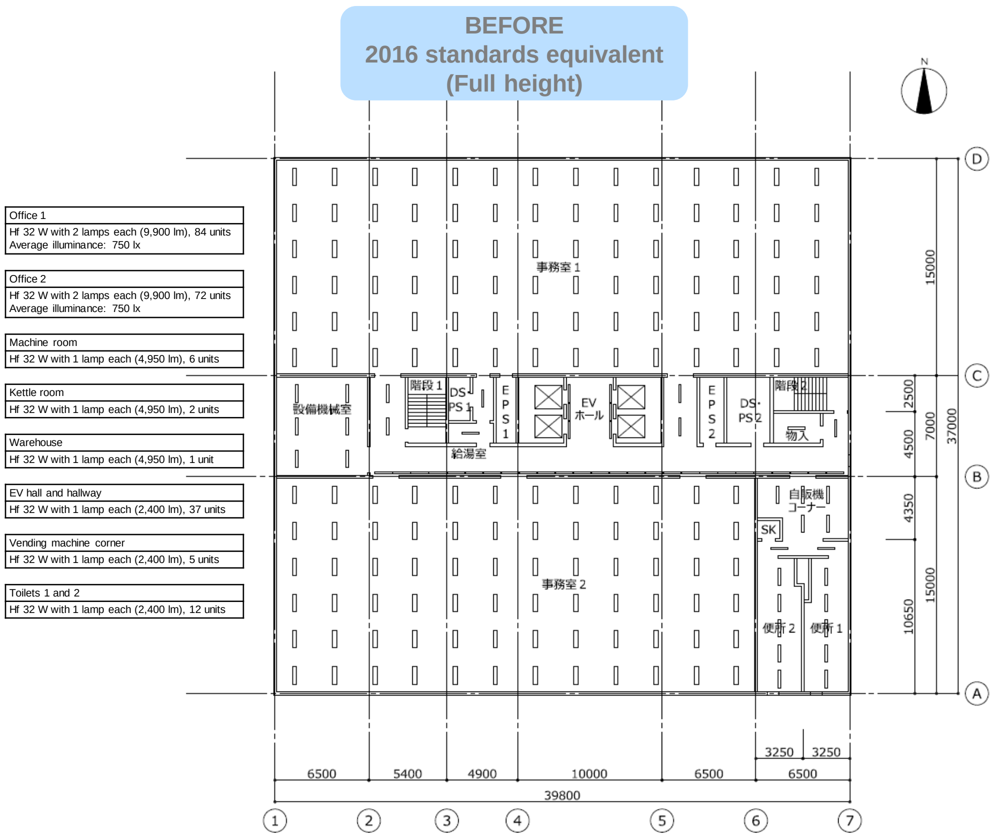
- The schematic diagrams of the systems of "Case A: 2016 standard equivalent" and "Case B: ZEB Ready" are as follows.

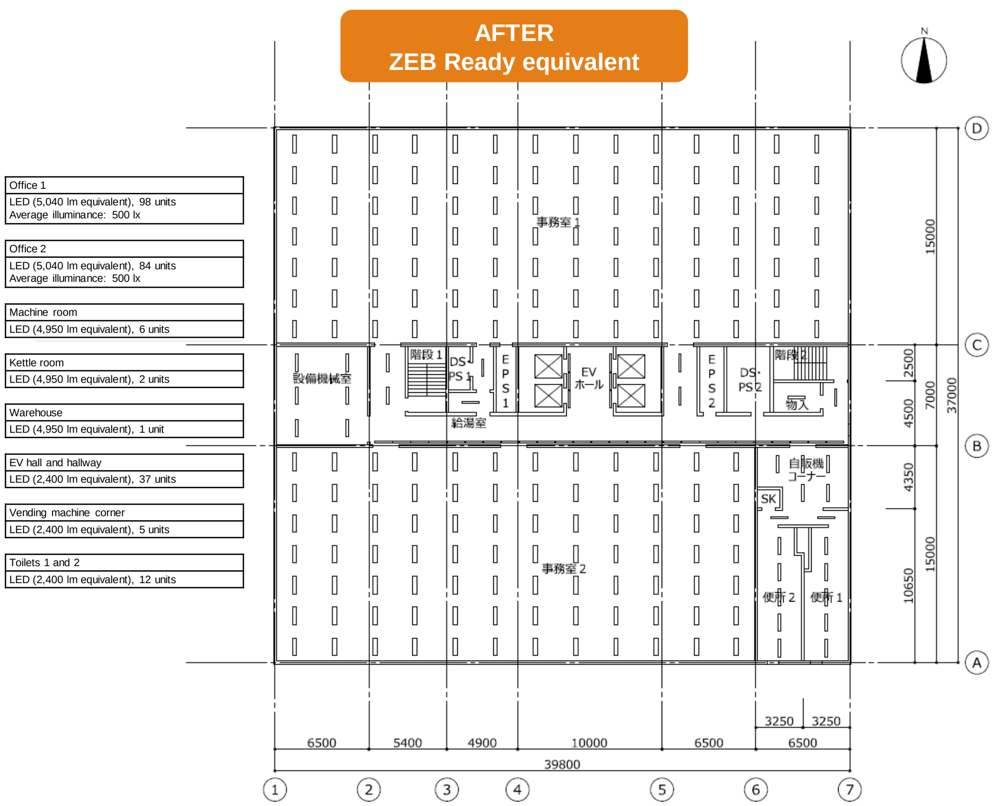




Lighting Plots

- The lighting plots of “Case A: 2016 standard equivalent” and “Case B: ZEB Ready” are as follows.





Outline of Energy Saving Effects (1/2)

- As a result of the case study in these Guidelines, it is suggested that the following items are of importance when designing an office building satisfying ZEB Ready.

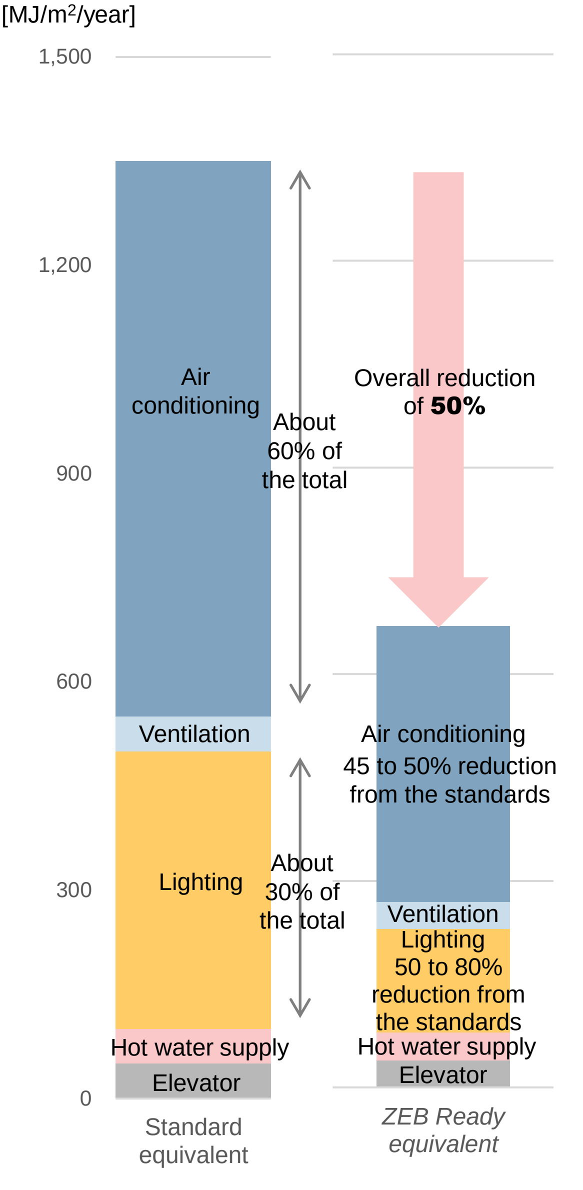
❶ In the primary energy consumption (excluding PCs and OA equipment) of a typical office building, air-conditioning system and lighting system account for 800 MJ/m²/year (about 60% of the total) and 400 MJ/m²/year (about 30% of the total) respectively. Thus, it is important to reduce the primary energy consumption due to air conditioning and lighting.

❷ Even a building based on a building plan adopting full height design which has been frequently used in recent office buildings has the possibility to achieve ZEB Ready by combining versatile advanced technologies and control methods within the scope to which evaluation with the energy consumption performance program is applicable.

❸ However, according to the following description in the "Summary of the Discussions in ZEB Roadmap Examination Committee (December 2015) (p. 7), it is preferable to effectively introduce passive technologies even though such technologies are difficult to be evaluated with the current energy consumption performance calculation program.

In the design stage of ZEB, it is important to adopt the design concept of using a hierarchy approach in a manner that combines the sophistication of a building envelope which has a long service life and is difficult to repair with the sophistication of building equipment while optimizing architectural methods (passive methods) such as heat insulation, insolation shielding, utilization of natural ventilation and daylight.

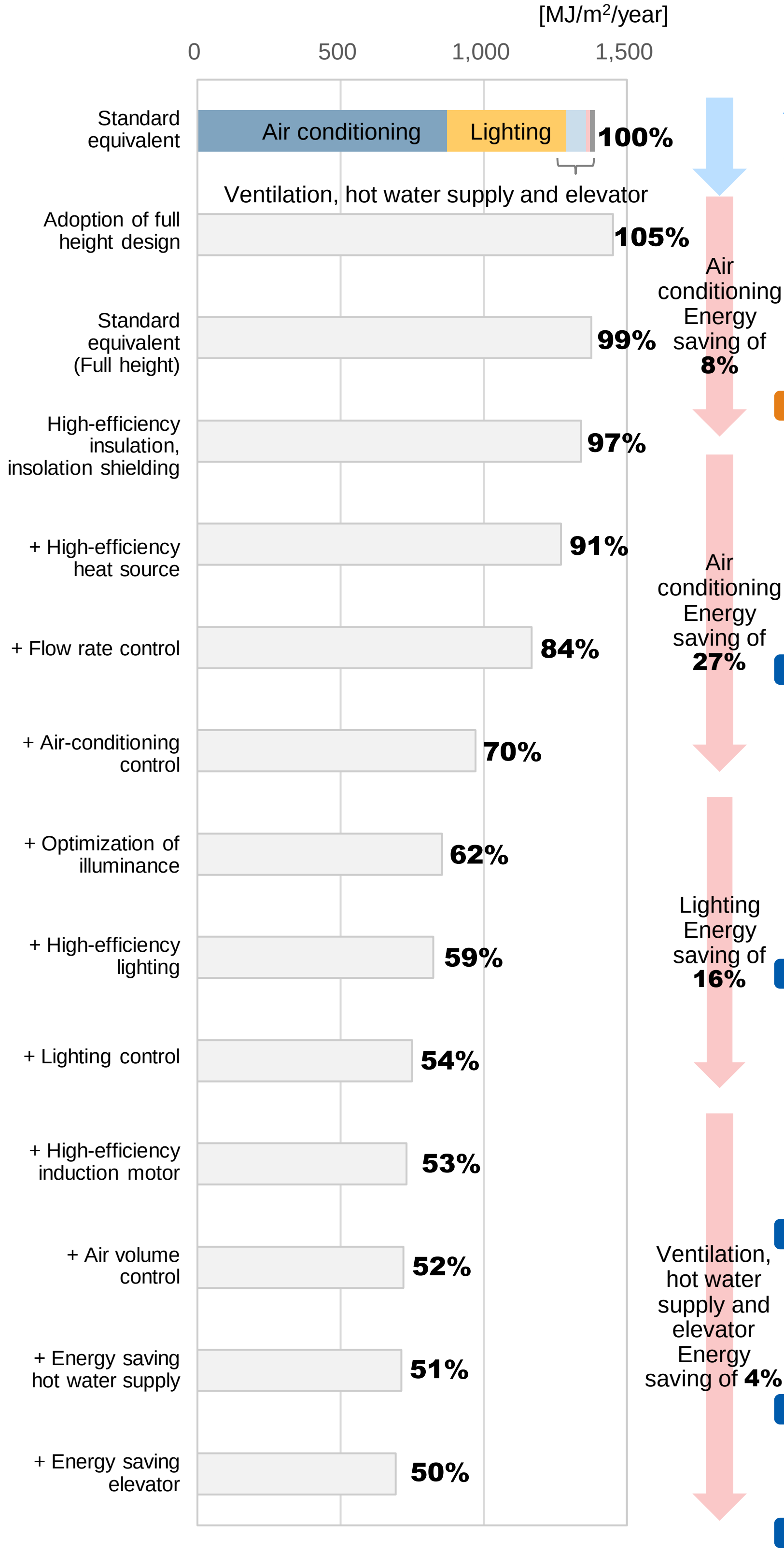
Breakdown of energy consumption in an office building (Target)



* The calculation sheet (Excel) of the case study model used in the energy consumption performance calculation program can be downloaded for free.

Outline of Energy Saving Effects (2/2)

The result of the case study of an office building satisfying ZEB Ready



Adoption of hull height design (Increase in the area ratio of an opening to an external wall)

Passive technology **Envelope insulation, Insolation shielding** Chapter 3.1 Chapter 3.2

- High-performance insulation material, high insulation window, canopy and louver

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Active technology **Air-conditioning system** Chapter 4.1

- High-efficiency heat source
- Large temperature difference water delivery, variable water volume control
- Total heat exchanger, variable air volume control, external air cut, external air cooling

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Active technology **Lighting system** Chapter 4.2

- Adoption of the illuminance of 500 lx (Office)
- LED lighting
- Motion detection control, time schedule control, initial illuminance correction, luminous detection control

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Active technology **Ventilation system** Chapter 4.3

- High-efficiency induction motor, invertor
- Temperature control (Machine room)

Active technology **Hot water supply system** Chapter 4.4

- Automatic hot water faucet

Active technology **Elevator system** Chapter 4.5

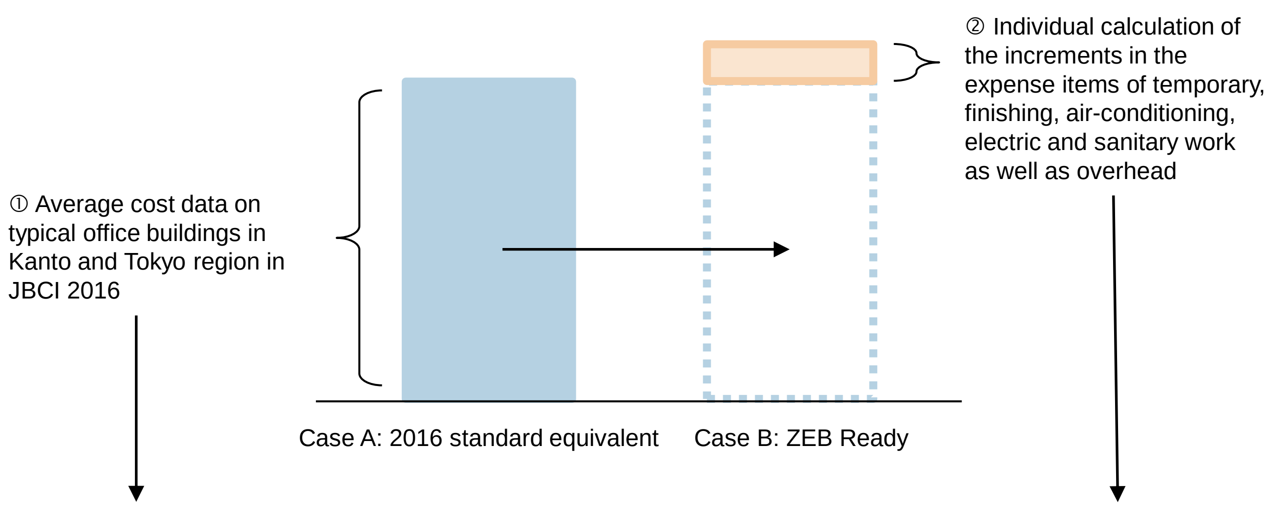
- VVVF (with power regeneration, gearless)

* For the details of the methods and results of the approximate construction cost estimation, please refer to “7.2 Reference Information of Model Building.”
* The approximate construction cost is the calculation result based on the data on the model building in these Guidelines. Therefore, please note that the approximate cost is subject to adjustment depending on price fluctuation due to the changes in economic situations and the changes in building specifications.

Outline of the Case Study in These Guidelines

Calculation Methods of Approximate Construction Costs

- What follows is the comparison of the approximate construction costs of “Case A: 2016 standard equivalent” and “Case B: ZEB Ready” estimated on the basis of the following cost estimation methods.
  - “Case A: 2016 standard equivalent”: Cost estimation was made using the average cost data (cost per unit floor area) on “typical office buildings in Kanto and Tokyo region” in Japan Building Cost Information 2016 (JBCI 2016) published by the Construction Research Institute.
  - “Case B: ZEB Ready”: Cost estimation was made in a manner that calculated the increments in the expense items of temporary, finishing, air-conditioning, electric and sanitary work as well as overhead for realizing the energy saving rate of 50% and added the increments to the estimated cost of “Case A: 2016 standard equivalent.”
- These approximate construction costs are the estimation results on the basis of the model building used in the case study of these Guidelines and, therefore, subject to adjustment depending on price fluctuation due to the changes in economic situations and the changes in building specifications. Also, please note that, when designing a building with higher performance than ZEB Ready (energy saving rate of 50%), there is a necessity of considering the introduction of those architectural methods (such as an atrium or void to utilize natural ventilation and daylight) which can produce high energy saving effects but cause initial costs to be increased.



① Average construction cost of typical office buildings in Kanto and Tokyo region

	Average (thousand yen/m^2)	Cost (million yen) *10,000 m^2	Composition ratio
Building finishing work (high-efficiency insulation, insolation shielding)	104.0	1,040	29.5%
Air conditioning work (air conditioning + ventilation)	26.3	263	7.5%
Electric work (lighting)	33.7	337	9.6%
Sanitary work (hot water supply)	19.0	190	5.4%
Elevator work	6.9	69	2.0%
Temporary work	22.2	222	6.3%
Earth work	11.1	111	3.2%
Foundation work	14.4	144	4.1%
Structural work	74.1	741	21.0%
Overhead	40.4	404	11.5%
Total	352.1 thousand yen/m^2	3,521	100.0%

② Bases of unit rates for calculating the increments in individual expense items

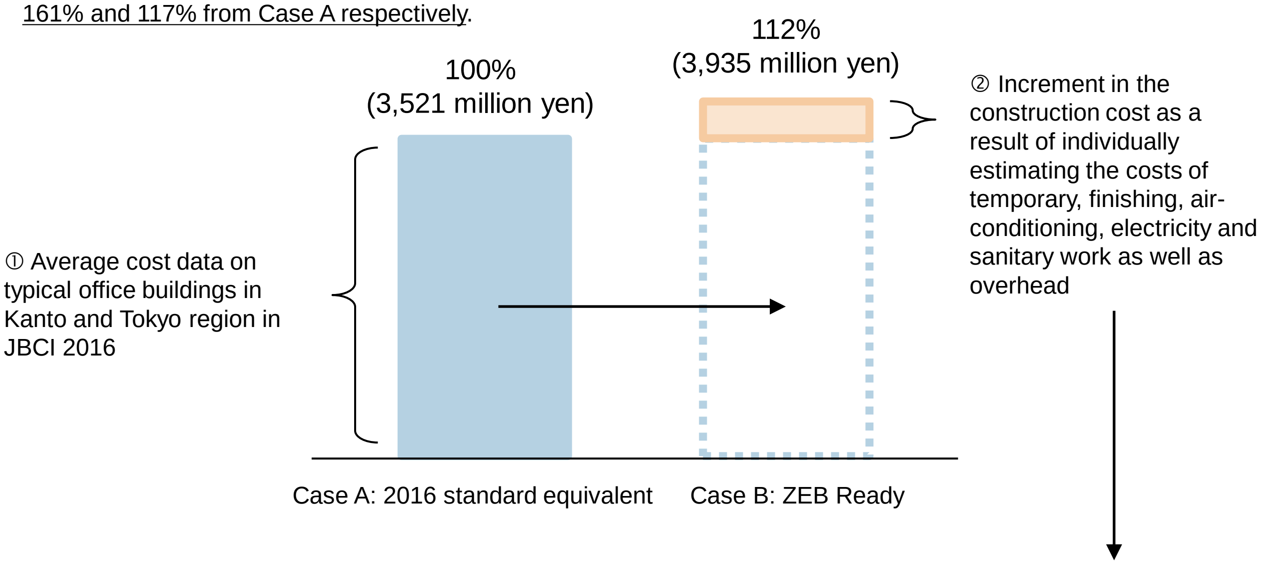
Item	Source of unit rate	Ratio of wholesale price to retail price
Double-glazed glass	Maker’s quoted price	18.2%
Horizontal canopy	Maker’s quoted price	70%
Extruded polystyrene foam insulation board	Catalog price	60%
Prefabricated double row scaffolding	Construction cost information in October 2016	100%
Absorption chiller heater	Maker’s quoted price	50%
Air conditioner	Maker’s quoted price	40%
Cooling tower	Maker’s estimation material	40%
Fan coil	Maker’s estimation material	40%
Heat source pump	Catalog price	45%
Air-cooled heat pump package	Catalog price	50%
Automatic control equipment	Maker’s approximate quoted price	40%
Labor for mechanical installation	Unit design and labor costs for public works in 2016	100%
Lighting fixture (Hf fluorescent lamp)	Maker’s quoted price	40%
Lighting fixture (LED fluorescent lamp)	Maker’s quoted price	50%
Lighting control equipment	Maker’s approximate quoted price	45%
Labor for electrical installation	Unit design and labor costs for public works in 2016	100%

* For the details of the methods and results of the approximate construction cost estimation, please refer to “7.2 Reference Information on the Model Building.”
* The approximate construction cost is the calculation result based on the data on the model building in these Guidelines. Therefore, please note that the approximate cost is subject to adjustment depending on price fluctuation due to the changes in economic situations and the changes in building specifications.

Calculation Results of Approximate Construction Costs

- The following is the result of comparing the approximate construction costs between “Case A: 2016 standard equivalent” and “Case B: ZEB Ready.”

- “Case B: ZEB Ready” has an increase in overall construction cost by 112% from “Case A: 2016 standard equivalent.” Looking at the increase rates of the approximate construction cost of Case B by individual equipment work, air-conditioning work (air conditioning + ventilation) and electric work (lighting) have the increases in construction costs of 161% and 117% from Case A respectively.



② Calculation result of the increments in the costs of individual equipment systems

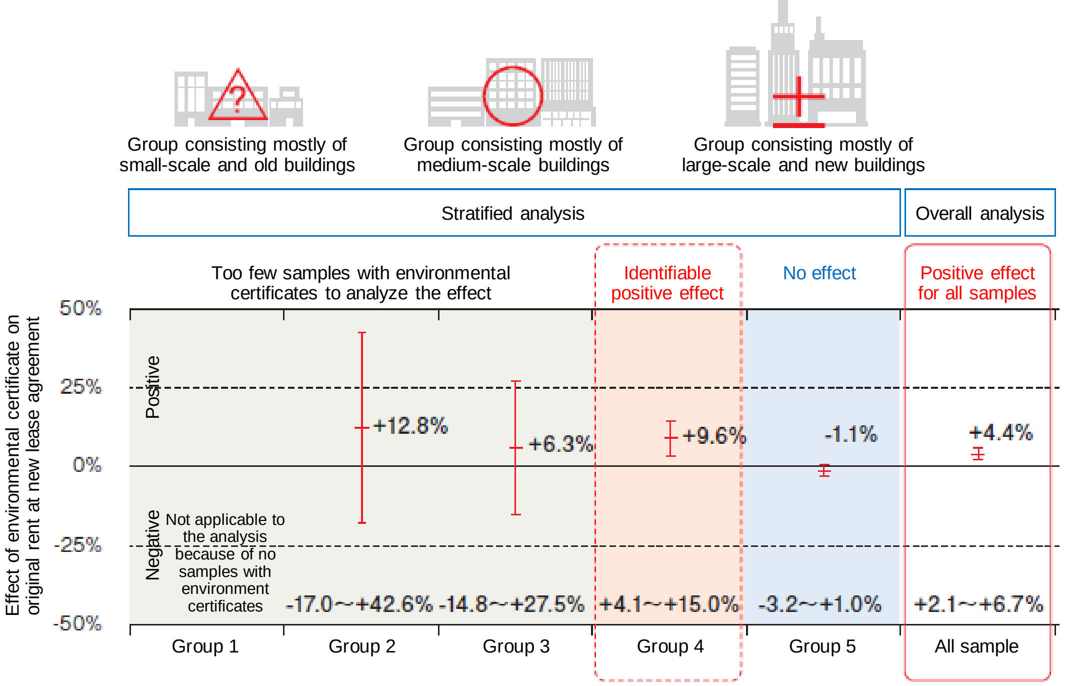
	Increment (million yen)	Approximate cost of Case B: ZEB Ready including increment (million yen)	Increase rate
Building finishing work (high-efficiency insulation, insolation shielding)	120	1,160	112%
Air conditioning work (air conditioning + ventilation)	160	423	161%
Electric work (lighting)	56	393	117%
Sanitary work (hot water supply)	1	191	100%
Elevator work	0	69	100%
Temporary work	24	246	111%
Earth work	0	111	100%
Foundation work	0	144	100%
Structural work	0	741	100%
Overhead	53	457	113%
Total	414	3,935	112%

Source: Estimation results by the ZEB Roadmap Follow-up Committee with the assistance of the Building Surveyor’s Institute of Japan

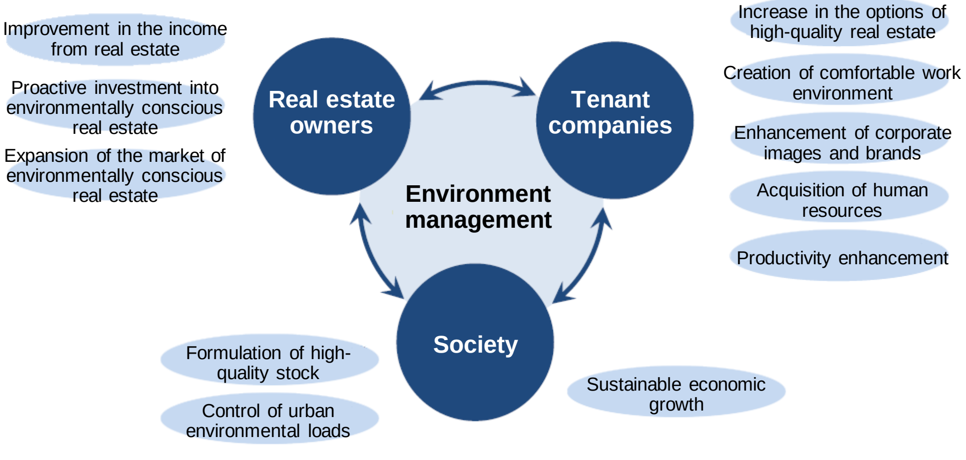
Column — Energy Saving Buildings and Real Estate Values

- According to an analytical research on the correlation between the acquisition of environmental certificates and original rents in the office buildings located in the 23 cities of Tokyo, as a result of the analysis taking into consideration scales, years of built, locations, years of lease agreements and other building performance and equipment, it has been identified that the acquisition of environmental certificates produces a positive effect of about 4.4% increase in the original rents of new lease agreements compared to the office buildings without environment certificates. Also, according to the result of stratification analyses of sample buildings in terms of the similarities in characteristics, the correlation is reported to be stronger in the group of medium scale office buildings than in the group of large-scale ones.

- Here, because the environmental certificates subject to the investigation above include CASBEE and LEED which certify comprehensive environmental performance of buildings including factors other than energy saving one, the factors other than energy saving performance may have caused the enhancement of the real estate value of these office buildings.



- Nonetheless, it has been clarified that environmental certificates can enhance the real estate value of buildings and the dissemination of environmental management including the acquisition of environmental certificates benefits real estate owners, tenant companies, designers, and society including real estate users.



Source: "Economic Analysis of Environmental Management," Xymax Real Estate Institute Corporation

Column Energy Saving and Intellectual Productivity of Offices

- Those office buildings achieving both energy saving and comfortable indoor environments are considered to contribute to the enhancement of intellectual productivity in office spaces. Thus, the office spaces required for realizing work styles focusing on intellectual productivity are those which enable each office worker to feel comfortable with indoor environments and maintain high productivity while saving energy consumption.

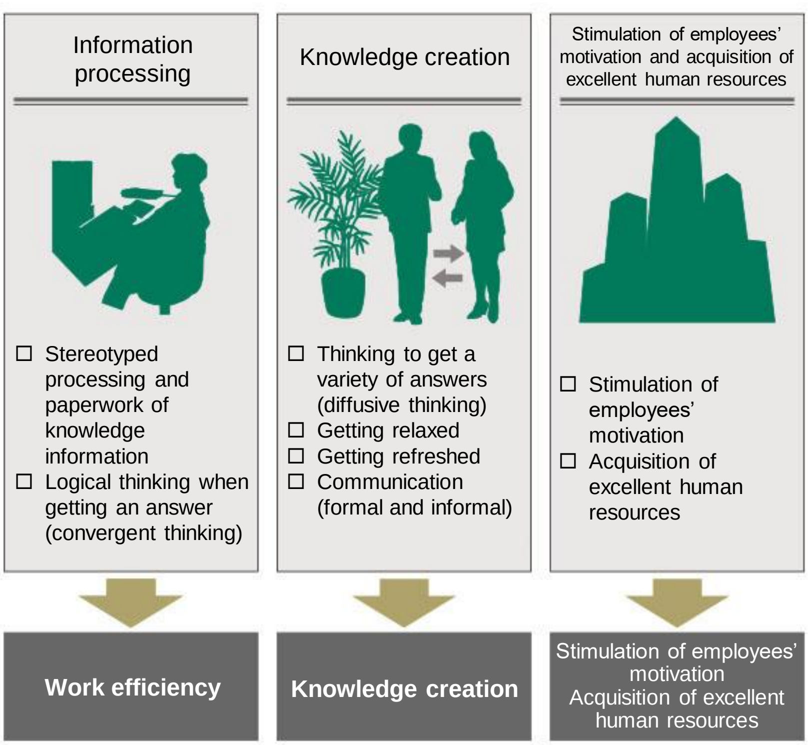
- In order to simultaneously achieve both the comfortable spaces maximizing productivity and energy saving, it is necessary to proactively promote energy saving measures such as the reduction in illuminance in private areas while controlling the warmer environments of indoor spaces so as to be as comfortable as possible.

Source: "Enhancement of Productivity of Offices through Comfortable Air Conditioning," NLI Research Institute

- In the Japanese office building industry, because the evaluation of real estate value has put too much emphasis on the distances from railway stations, the quality of office spaces contributing to the enhancement of intellectual productivity has not received much attention. However, there have been the cases of developing office buildings with high added value and intellectual productivity by plural developers and the tenants of these buildings have highly valued the quality of office spaces by saying the "office space contributes to improving the stability of employees." Thus, it can be said that the Japanese office building market has entered a phase of major change.

- One of the research activities of the Research Committee of Intellectual Productivity (chaired by Shuzo Murakami, then director of the Building Research Institute) obtained data on office buildings showing a positive correlation between the scores representing intellectual productivity and the estimated rents at the time of lease agreements. Accordingly, it is expected that the provision of office spaces contributing to the enhancement of intellectual productivity will be further utilized in the market of office building.

■ Enhancement of intellectual productivity through the improvement in building environmental performance



Source: "Office Space from the Perspective of Intellectual Productivity," autumn edition of *BZ Kukan*, 2015, CBRE

Column

Relation of Health, Comfort and Intellectual Productivity with the WELL Building Standard

Outline of the WELL Building Standard

- The importance of the building environment for the enhancement of health, comfort and intellectual productivity has also been recognized in the United States and a certification system called the WELL Being Standard was established by Phil Williams (Executive Director of Delos).
- The WELL Building Standard is a new certification system established in the United States in 2014 to evaluate office buildings for the purpose of enhancing health, comfort and intellectual productivity.
- The WELL Building Standard certifies office buildings in three stages: the silver certificate granted to those buildings satisfying 41 essential qualifications; the gold certificate granted to those buildings achieving 40% or more of additional requirements for comfort; and the platinum certificate granted to those buildings achieving 80% or more of additional requirements.

Evaluation criteria of the WELL Building Standard

- The WELL Building Standard evaluates buildings with the following 100 items in 7 fields.

Field	Score	Item
Air	29	Formaldehyde, total VOC (paint, adhesive, furniture, etc.), PM, smoking cessation, ventilation (ASHRAE 62.1), CO_2 concentration (800 ppm or less), filter, mold, construction, entrance, cleaning, insecticide, herbicide, pesticide, asbestos, PCB, moisture, airtightness
Water	8	Water quality, water intake
Nourishment	15	Ingestion of fruits and vegetables, additives, trans fatty acids, allergies, hand washing, preservation, responsible agriculture, content information, appropriate amount, vegetable garden, eating habits, meal space
Light	11	Light design, circadian, lighting and sunshine glare control, color temperature, reflection, natural light, window opening
Fitness	8	Stairs, incentives (gym memberships, races, bike sharing), pedestrian amenities, parks, various convenient facilities, bicycles, showers, lockers, exercise spaces, machines, standing desks
Comfort	12	Disabled access (ADA), ergonomics (PC, desk and chair heights), noise (inside and outside), thermal environment (ASHRAE 55), odor (negative pressure), echo sound, sound masking, echo prevention (ceiling and wall), soundproofing, individual air conditioning control, radiant air conditioning
Mind	17	WELL Guide, mental and physical books, questionnaires, biophilia, privacy, storage, nap (sleep support), business trip consideration, maternity leave, childcare leave, nursing, nursing time, physical condition sensors, charity participation, product information, LEED v4 MR (material and resources), JUST/GRI, ceiling heights, art works, innovative characteristics

Source: “LEED and WELL, Synergies through New Collaboration,” Woonerf Inc.

Chapter 3

Building Energy Saving Technologies (Passive Technologies)

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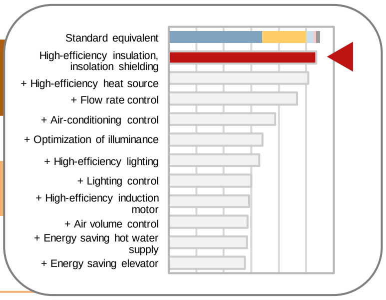


3.1 Envelope Insulation

Purposes of Introducing the Technology

To curb air-conditioning loads

- An envelope insulation plan is to curb heat transfer through boundaries (envelope) between indoor and outdoor spaces and envelope insulation enables a building to achieve comfortable warmer environment of indoor spaces with much less energy compared to other buildings without envelope insulation.
- A building without envelope insulation easily allows the insolation energy absorbed in it (acquired insolation heat) and internally generated heat to dissipate externally in a short amount of time. In contrast, a building with envelope insulation can effectively utilize such heat as energy source to increase room temperatures.
- Also, while envelope insulation is effective to prevent external heat from being transmitted into a building in summer, it may keep the acquired insolation heat and the internally generated heat inside the building. Therefore, it is necessary to introduce envelop insulation in combination with natural ventilation.

To maintain natural room temperatures

- The room temperatures of a building can be less likely to be affected by external temperatures as the level of envelope insulation is increased. Thus, envelope insulation enables unheated rooms to have temperatures higher than those of a building without envelope insulation because of the heat transmitted from neighboring heated rooms, the acquired insolation heat and the internally generated heat.

To bring the surface temperatures of walls, floors and windows close to a room temperature

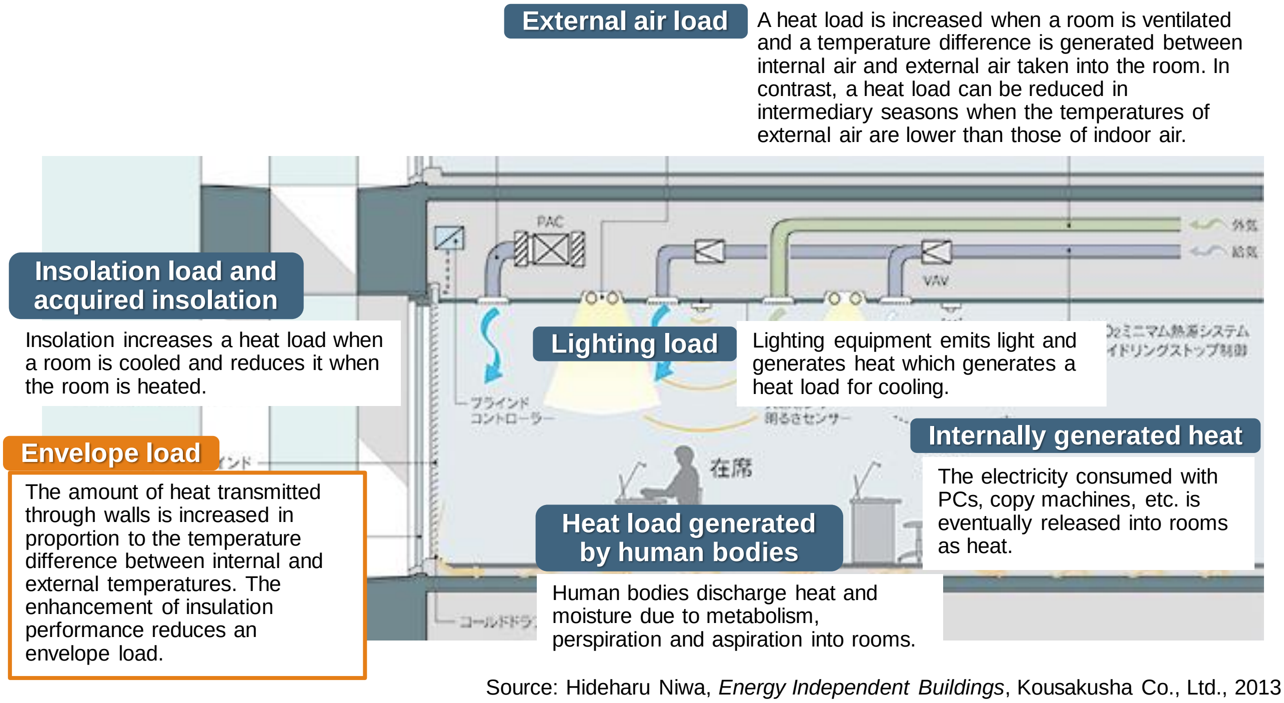
- Generally, a sensible temperature in a space is equivalent to the average of the surface temperatures of windows, walls, floors (average radiation temperature) and a room temperature. Thus, envelope insulation which brings the surface temperatures of a structure close to a room temperature can give a sense of warmth or coolness to office workers with the temperature difference between a sensible temperature and a room temperature reduced.
- Also, the vertical temperature differences and temperature variation in rooms can be reduced by increasing the surface temperatures of floors in a manner that enhances their insulation performance (installation of insulation materials and prevention of air leakage).

To alleviate the hotness of an uppermost floor by shielding solar radiation heat from a roof

- In summer, horizontal planes receive a large amount of solar radiation heat and, therefore, the surface temperatures of roof slabs easily reach 60 to 70°C. Thus, enhancing insulation of roof slab surfaces enables the hotness of an uppermost floor to be alleviated with the solar radiation heat on the roof slabs prevented from being transmitted to the uppermost floor.

Approach toward the Sophistication of Envelope Insulation Technologies

- Envelope insulation technologies can contribute to curbing heat loads of buildings.
- Heat loads mean heat quantities subject to treatments so as to keep room temperatures constant and are largely classified into: those like envelope load, insolation load and acquired insolation and external air load which vary from hour to hour depending on external weather conditions; and those like lighting load, heat generated by equipment and heat generated by human bodies which are affected by the use of rooms.



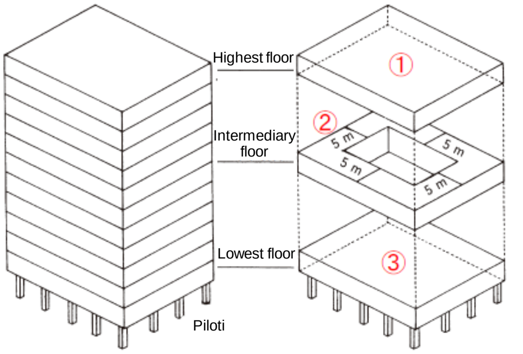
Source: Hideharu Niwa, *Energy Independent Buildings*, Kousakusha Co., Ltd., 2013

Target Level of Envelope Insulation Technologies

- When designing a building satisfying ZEB Ready (energy saving rate of 50%), the technologies to be introduced for enhancing the envelope insulation performance need to achieve **the control of the heat loads of an envelope by 10 to 40% with respect to the reference value of PAL* (for the actual examples of technologies used in the case study, please refer to a later chapter)**.

PAL* is a value obtained by dividing the annual heat load of indoor perimeter zones of respective floors by the floor area of the perimeter zone and expressed in the unit of [MJ/m²/year].

Perimeter zone is divided largely into the followings:
① a perimeter zone based on a roof and external walls;
② a perimeter zone based on external walls; and
③ a perimeter zone based on floors, and external walls exposed to external air.



Source: Japan Sustainable Building Consortium

Consideration for Insulation Area Classification (Point of Caution)

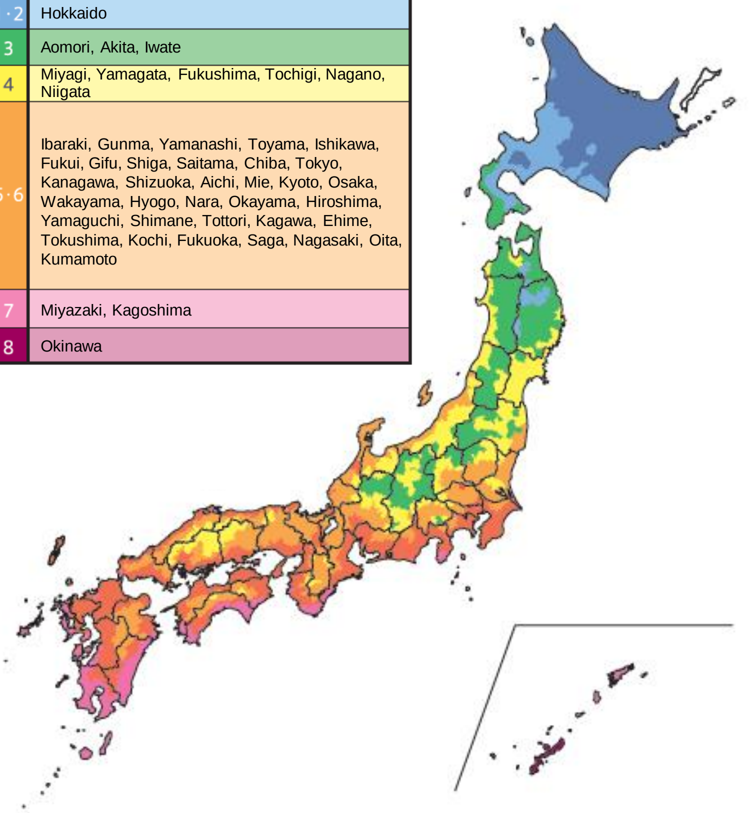
- The announcement of the “Standards of Judgment for Construction Clients, etc. and Owners of Specified Buildings on the Improvement of Energy Consumption Performance of Buildings” on the basis of the “Act on the Improvement of Energy Consumption Performance of Buildings (Building Energy Efficiency Act)” stipulates the insulation area classification grouping the country into eight area groups taking into consideration weather conditions, etc.

- Thus, when designing a building satisfying ZEB Ready, attention is required to the fact that envelope insulation needs to be introduced so as to reduce heat loads from the insulation performance requirements respectively set according to the insulation area classification.

* Area Groups 1 and 2 (Hokkaido) require higher insulation performance than the other area groups.

* Area Group 8 (Okinawa) is characterized by the fact that insolation shielding is more dominant than insulation performance in the control of heat loads.

Area group	Prefecture
1・2	Hokkaido
3	Aomori, Akita, Iwate
4	Miyagi, Yamagata, Fukushima, Tochigi, Nagano, Niigata
5・6	Ibaraki, Gunma, Yamanashi, Toyama, Ishikawa, Fukui, Gifu, Shiga, Saitama, Chiba, Tokyo, Kanagawa, Shizuoka, Aichi, Mie, Kyoto, Osaka, Wakayama, Hyogo, Nara, Okayama, Hiroshima, Yamaguchi, Shimane, Tottori, Kagawa, Ehime, Tokushima, Kochi, Fukuoka, Saga, Nagasaki, Oita, Kumamoto
7	Miyazaki, Kagoshima
8	Okinawa



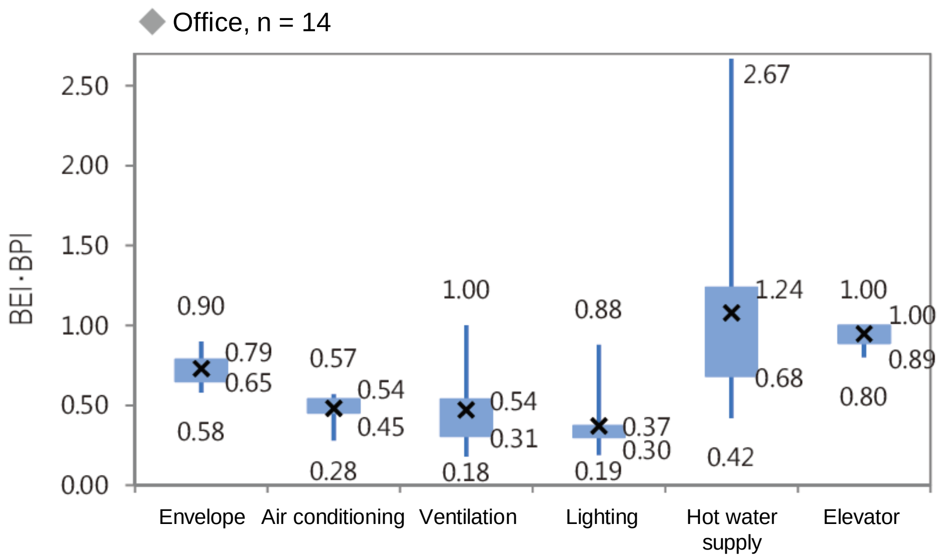
Source: Japan Sustainable Building Consortium

Column

Distribution of PAL* Reduction Rates in Buildings Applied to Subsidized Project (ZEB Verification Project)

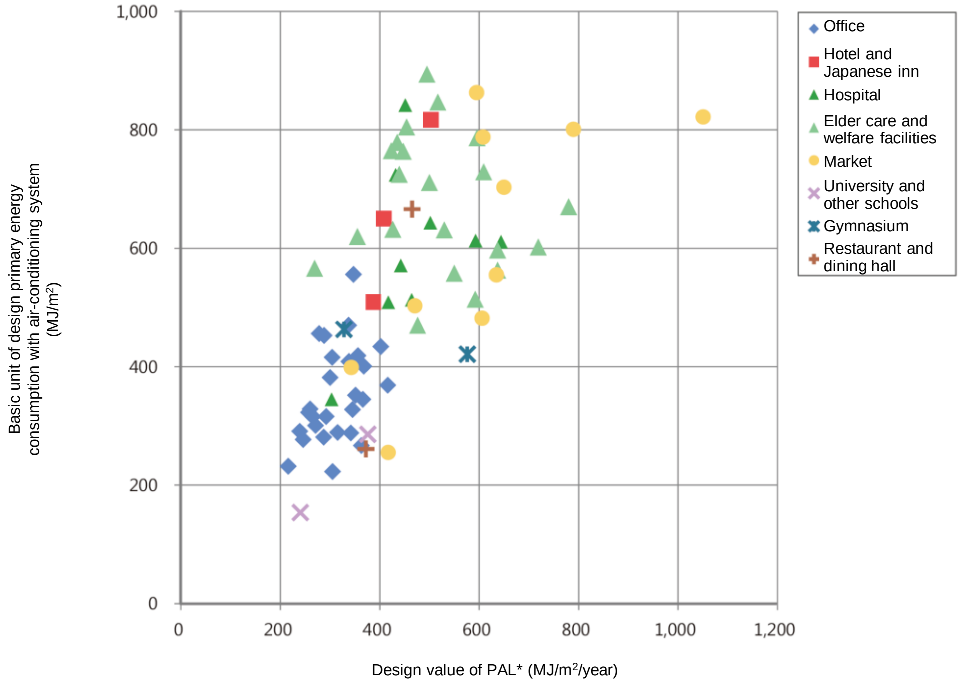
Distribution of PAL* Reduction Rates

- PAL* reduction rates (envelope BPI) of respective energy use in office buildings are distributed in the range of 0.65 (35% reduction) to 0.79 (21% reduction).



Relation between PAL* and the primary energy consumption with air-conditioning system

- According to the distribution of the buildings applied to the subsidized project (ZEB verification project), the basic unit of primary energy consumption with air-conditioning system shows a downward trend with the reduction in PAL* as a result of the sophistication of insulation performance of an envelope. This suggests the importance of combining passive and active technologies.



Source: "Debrief Meeting of 2017 ZEB Verification Project," Sustainable Open Innovation Initiative

Column

Enhancement of Comfort through the Control of Perimeter Heat Loads

The Effects of Reducing Heat Loads in Perimeter Zones

- In an office building, the spaces close to windows and external walls (perimeter zones) are subject to the increases in air-conditioning load due to the influence of insolation. It is expected that the introduction of a variety of technologies to reduce the heat loads in the perimeter zones can be an effective measure to reduce the air-conditioning load and thereby enhance the comfort and intellectual productivity of office workers.

- The effect of enhancing comfort and intellectual productivity is not subject to the evaluation in the energy consumption performance calculation program but such an effect is an important factor to express the effectiveness of the technologies contributing to reducing the heat loads in perimeter zones.

Technologies Contributing to Reducing Heat Loads in Perimeter Zones (Examples)

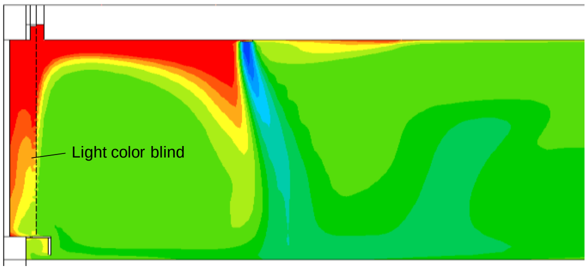
① High-efficient insulation glass such as double-glazed Low-E glass
- Window glass with high insulation performance is expected to reduce external loads by reducing heat loss due to external transmission and the internal transmission of insolation.
- Also, the comfort and intellectual productivity of office workers can be expected to be enhanced as a result of the improvement in the radiant heat environment of indoor spaces.

② Insolation shielding louver
- Insolation shielding louvers installed at upper or side sections of windows are expected to prevent heat gain due to insolation and thereby enhance the comfort of spaces near windows.

③ Simplified air flow
- Simplified air flow is a technology to reduce heat loads near windows by removing heat absorbed by blinds with push fans or pull fans and thereby enhance the comfort of perimeter zones. (The following is a calculation example of the effect of simplified air flow on the reduction in room temperatures.)

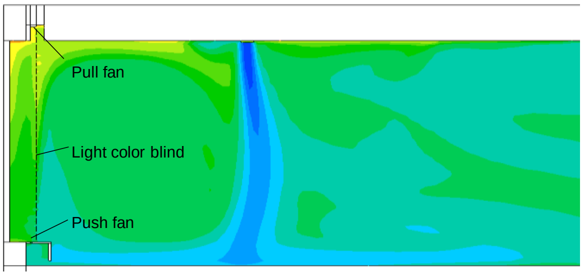
<Before: without simplified air flow>

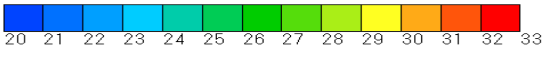
·Glass material: single glass
·Heat transmission rate: 5.9 W/m²K
·Heat gain: 0.86



<After: with simplified air flow>

·Glass material: double-glazed Low-E glass
·Heat transmission rate: 1.6 W/m²K
·Heat gain: 0.29





Calculation conditions
- Object time: 16:00 in summer
- External temperature: 34.6°C
- Heat transmission rate (internal wall): 2.0 W/m²K
- Heat transmission rate (floor): 2.0 W/m²K
- Heat transmission rate (external wall): 1.5 W/m²K
- Heat generation of OA equipment: 45 W/m²
- Heat generation of lighting system: 5 W/m²
- Density of office workers: 0.2 person/m²

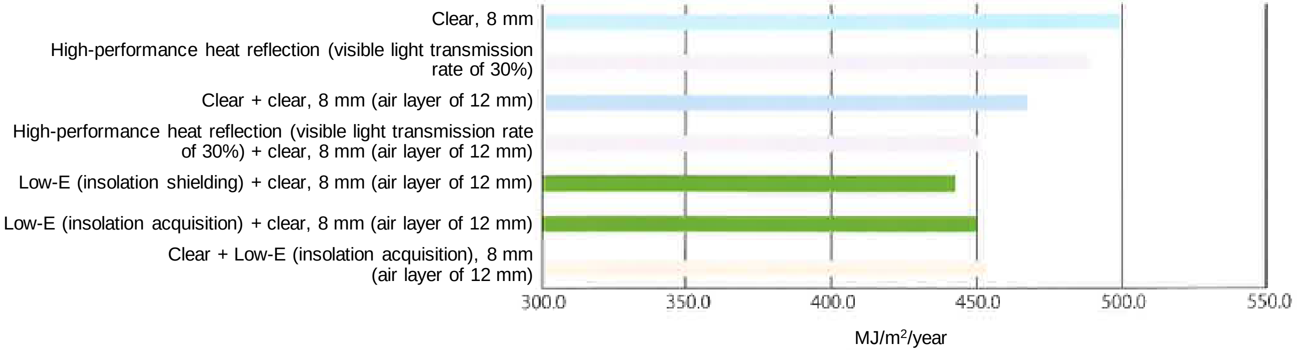
Source: Modification of the material by the ZEB Roadmap Examination Committee

Column: Importance of Insulation Performance Improvement according to Local Conditions

PAL* on a reference office floor of an office building (total floor area of 10,000 m²) (in Tokyo)

- The figure below shows the comparison of PAL* values on a reference office floor by the type of window glass. The types of window glass having smaller PAL* values are more suitable for saving energy. According to the comparison, it can be said that double-glazed Low-E glass has a higher energy saving effect than clear single glass and clear double-glazed glass and can reduce a heat load by 9 to 12% with respect to clear single glass.
- However, improvement in both insulation performance (heat transmission rate) and insolation acquisition performance (Insolation acquisition rate) is not always an energy saving solution in some area groups. Thus, in these groups, it is necessary to balance these performance improvement measures.

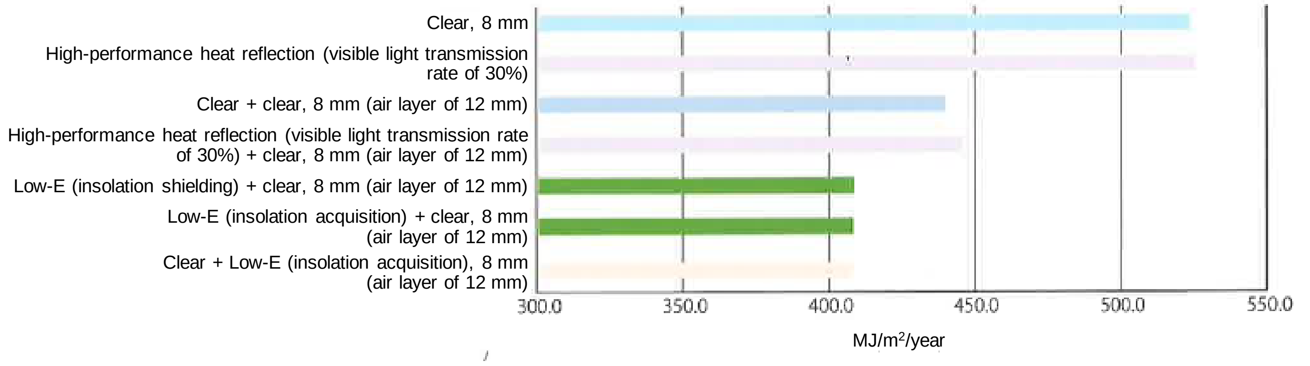
PAL* on a reference office floor in Tokyo (Group 6 in the insulation area classification)



PAL* on a reference office floor of an office building (total floor area of 10,000 m²) (in Sapporo)

- The figure below shows the comparison of the calculation results of PAL* values on a reference office floor by the type of window glass. The types of window glass having smaller PAL* values are more suitable for saving energy. According to the comparison, it can be said that double-glazed Low-E glass has a higher energy saving effect than clear single glass and clear double-glazed glass and can reduce a heat load by 22% with respect to clear single glass.
- Basically, windows having higher insulation performance tend to have smaller (superior) PAL* values in cold regions.

PAL* on a reference office floor in Sapporo (Group 2 in the insulation area classification)



Note 1: Although PAL* is defined as a value for an entire building, the expression of PAL* on a reference office floor used in the comparisons above represents a heat load per unit area of perimeter zone on a reference office floor.
Note 2: The heat performance values of glass to study PAL* of nonresidential buildings have been updated since the enforcement of the Guideline Standards based on the Building Energy Efficiency Act in April 2016.
Note 3: Because of Notes 1 and 2 above, the values in the comparison above do not correspond to the absolute values of PAL* of entire buildings when designing actual buildings.

Source: "High-performance Window Systems and 2013 Revision of the Energy Efficiency Standards, Buildings and Double-glazed Glass," the Flat Glass Manufacturers Association of Japan

Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program

- Technologies for reducing heat loads of an envelope need to be examined separately for ❶ structures (floor, wall and ceiling) and ❷ openings. High-performance insulation materials and high-performance heat shielding and insulation windows are considered to be the technologies corresponding to ❶ and ❷ respectively and contribute to realizing ZEB Ready.

- The targets of energy saving effect and approximate construction cost associated with the introduction of above technologies are as follows. The processes of calculating the energy saving effect using the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017) are explained on the following pages.

Example of technologies for ZEB Ready (those in orange cells are used in the case study)
○: Technology applicable to the evaluation with the program, △: Technology requiring attention when evaluated with the program, ×: Technology difficult to be evaluated with the program

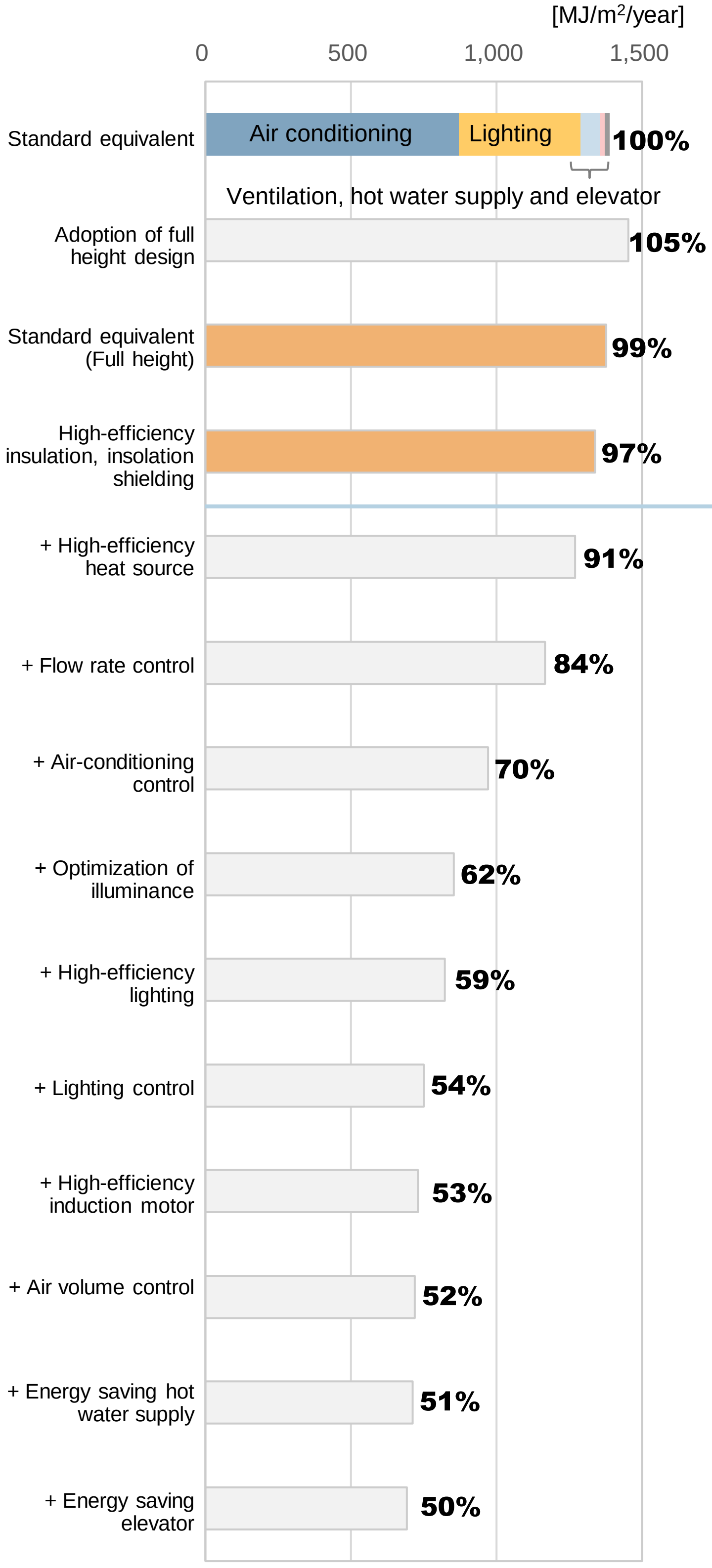
Envelope insulation and insolation shielding technologies (example)			Applicability of energy consumption performance calculation program	Energy saving effect (target)	Approximate cost increment (target)
❶ Structure	Out of scope	Rooftop greening	△ Only the insulation effect is considered in the calculation of PAL*		
❶ Structure	High insulation envelope and insolation shielding	High-performance insulation material	○	8% (Note)	About 120 million yen
❷ Opening	High insulation envelope and insolation shielding	High-performance heat shielding and insulation window	○	8% (Note)	About 120 million yen
❷ Opening	High insulation envelope and insolation shielding	Horizontal canopy and blind	○	8% (Note)	About 120 million yen

Note: Combined effect of high insulation envelope and insolation shielding

Source: Modification of the material by the ZEB Roadmap Examination Committee

Case Study Result of Office Building Realizing ZEB Ready

Note: The “energy saving effect” is a result of calculating combined effect of plural technologies and does not necessarily correspond to the accumulated total of energy saving effects of individual technologies.



Energy saving technology		Energy saving effect[Note]
Passive technology **Envelope insulation, Insolation shielding**	· High-performance insulation material · High insulation window · Canopy and louver	8%
Active technology **Air-conditioning system**	· High-efficiency heat source	6%
	· Large temperature difference water delivery · Variable water volume control	7%
	· Total heat exchanger · Variable air volume control · External air cut · External air cooling control	14%
Active technology **Lighting system**	· Adoption of the illuminance of 500 lx (Office)	8%
	· LED lighting	2%
	· Motion detection control · Time schedule control · Initial illuminance correction · Luminous detection control	5%
Active technology **Ventilation system**	· High-efficiency induction motor, invertor	1%
	· Temperature control (Machine room)	1%
Active technology **Hot water supply system**	· Automatic hot water faucet	Less than 1%
Active technology **Elevator system**	· VVVF (with power regeneration, gearless)	1%

1) Envelope Insulation Technologies (Example): High-performance insulation material

①: Name of external wall

- Arbitrary character strings can be input for the names of respective sections of external walls. In the case study, a roof, external walls and walls exposed to earth (ground wall) are input as “R1,” “W1” and “FG1” respectively.

②: Types of walls

- The character strings selected from the followings can be input for the types of walls.
  - External wall: walls and a roof composing the shell of a building and exposed to external air
  - Ground wall: walls exposed to earth

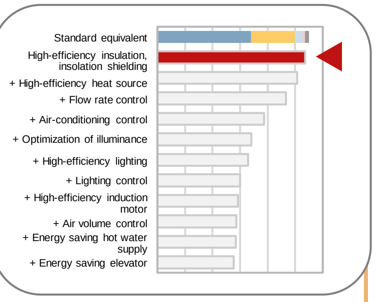
④: Material number, ⑤: Material name, ⑥: Thickness

- The types of constituent materials of walls can be selected from “Table 1-2-2: List of Building Materials and their Physical Properties (Source: Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2 Input Manual)” and corresponding numerical numbers and character strings can be input for material numbers and material names respectively.
- Numerical numbers can be input for the thicknesses of the materials input for ④ and ⑤.

Example of Entry into Form 2-2: (Air Conditioning) External Wall Composition

BEFORE 2016 standards equivalent (Full height)

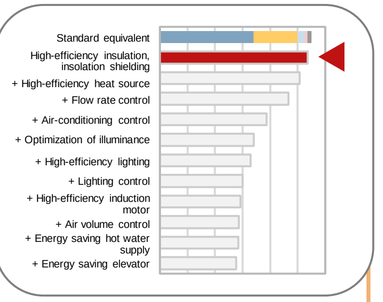
① Name of external wall	② Type of wall (Selection)	③ Heat transmission rate [W/m²K]	④ Material number (Selection)	⑤ Material name (Selection)	⑥ Thickness [mm]	⑦ Remarks
R1	External wall			Indoor side		
			70	Rock wool decorative acoustic board	12	
			62	Gypsum board	10	
			302	Unsealed air layer		
			41	Concrete	150	Normal concrete
			47	Cement mortar	15	
			102	FRP	5	
			47	Cement mortar	15	
			181	Extruded polystyrene foam insulation board, Type 1	50	
			41	Concrete	60	Normal concrete
				Outdoor side		
W1	External wall			Indoor side		
			62	Gypsum board	8	
			302	Unsealed air layer		
			181	Extruded polystyrene foam insulation board, Type 1	25	
			41	Concrete	150	Normal concrete
			47	Cement mortar	25	
			67	Tile	10	
				Outdoor side		
FG1	Ground wall			Indoor side		
			101	Vinyl floor material	3	
			47	Cement mortar	27	
			41	Concrete	150	Normal concrete
				Outdoor side		



AFTER (ZEB Ready equivalent)

Example of Entry into Form 2-2: (Air Conditioning) External Wall Composition

① Name of external wall	② Type of wall (Selection)	③ Heat transmission rate [W/m²K]	④ Material number (Selection)	⑤ Material name (Selection)	⑥ Thickness [mm]	⑦ Remarks
R1	External wall			Indoor side		
			70	Rock wool decorative acoustic board	12	
			62	Gypsum board	10	
			302	Unsealed air layer		
			41	Concrete	150	Normal concrete
			47	Cement mortar	15	
			102	FRP	5	
			47	Cement mortar	15	
			183	Extruded polystyrene foam insulation board, Type 3	100	
			41	Concrete	60	Normal concrete
				Outdoor side		
W1	External wall			Indoor side		
			62	Gypsum board	8	
			302	Unsealed air layer		
			183	Extruded polystyrene foam insulation board, Type 3	50	
			41	Concrete	150	Normal concrete
			47	Cement mortar	25	
			67	Tile	10	
				Outdoor side		
FG1	Ground wall			Indoor side		
			101	Vinyl floor material	3	
			47	Cement mortar	27	
			41	Concrete	150	Normal concrete
				Outdoor side		



2) Envelope Insulation Technologies (Example): High-performance heat shielding and insulation window

①: Name of opening

- Arbitrary character strings can be input for the names of windows (glass + fittings).
- In the case study, they are input as "G1."

④: Types of fittings, ⑤: Types of glass

- The specifications of windows can be selected from "Table 1-2-3: List of the Types of Glass and their Physical Properties (Source: Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2 Input Manual)" and corresponding character strings can be input for ④ (types of fittings) and ⑤ (types of glass).
- When using special types of glass not listed in "Table 1-2-3: List of the Types of Glass and their Physical Properties (Source: Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2 Input Manual)" and inputting special structures, only the cells for ② and ③ need to be filled and other cells for ④ to ⑦ can be left in blank (in this case, the bases of the values entered for ② and ③ need to be submitted additionally).

BEFORE
2016 standards equivalent (Full height)

Example of Entry into Form 2-3: (Air Conditioning) Window

① Name of opening	② Heat transmission rate of window [W/m²K]	③ Insolation acquisition rate of window [-]	Performance of window (glass + fitting)			
			④ Type of fitting (Selection)	Performance of glass		
				⑤ Type of glass (Selection)	⑥ Heat transmission rate [W/(m²K)] (Input)	⑦ Insolation acquisition rate [-] (Input)
G1			Aluminum	2LsA10		

AFTER
(ZEB Ready equivalent)

Example of Entry into Form 2-3: (Air Conditioning) Window

① Name of opening	② Heat transmission rate of window [W/m²K]	③ Insolation acquisition rate of window [-]	Performance of window (glass + fitting)			
			④ Type of fitting (Selection)	Performance of glass		
				⑤ Type of glass (Selection)	⑥ Heat transmission rate [W/(m²K)] (Input)	⑦ Insolation acquisition rate [-] (Input)
G1			Combined material of aluminum and resin	2LsG12		

Reference Information

Other Important Energy Saving Technologies (Example): Structure

* Out of scope of the case study

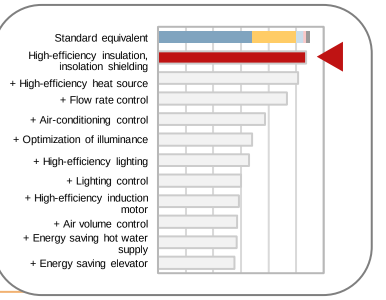
* Calculation is available with the energy consumption performance calculation program

Rooftop and external wall greening

Outline of technologies

- The introduction of rooftop greening produces the effects which contribute to reducing: the loads due to solar radiation heat transmitting into indoor spaces; the temperature of a roof surface and ambient temperature due to the transpiration effect of plants; and the irradiation of surrounding buildings with reflected light on a building concerned.
- Rooftop and external wall greening additionally produces large psychological effects, such as healing and landscape improvement effects, on the users of a building.
- Major rooftop greening technologies are as follows.
    - Conventional method (500 to 1,000 kg/m^2): Application of the method for ground greening including tall trees to roofs using amended soil based on natural soil.
    - Artificial lightweight soil method (100 to 500 kg/m^2): A method combining a drainage layer and an artificial soil layer with enhanced water retaining performance.
    - Thin layer greening method (30 to 100 kg/m^2): A greening method using a thin layer of artificial lightweight soil developed by a company specialized in waterproofing. A variety of unit type products of sedum and lawn grass with a water retaining function have been commercialized.

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government



3.2 Insolation Shielding

Purposes of Introducing the Technology

<u>**To reduce cooling load**</u>

- An insolation shielding plan is established to reduce a heat load. Insolation changes hour by hour according to weather conditions and produces a heat load when a building is cooled in summer and intermediary seasons. Thus, it is necessary to control insolation so as not to impair the comfort of the users of a building.
- Once heat is allowed to transmit into a building with high insulation and airtightness, it is difficult to release it outside the building. Particularly, if it happens in summer, a large amount of cooling energy needs to be consumed to cool the heat. Thus, insolation shielding is important to realize comfortable indoor temperature environment in summer.

<u>**To identify insolation heat transmission paths and to take countermeasures to block them**</u>

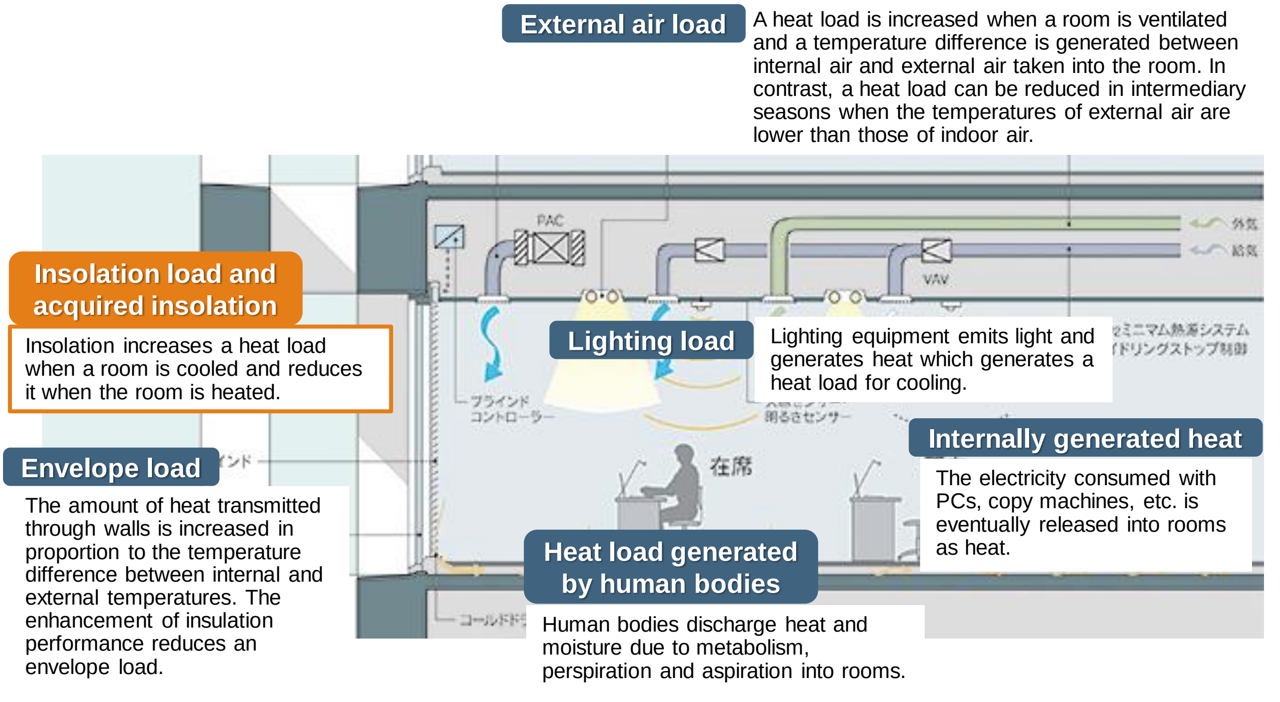
- A building accumulates insolation heat in manner that: ① allows insolation to pass through window glass and to be converted into heat when incident on inner walls and floors; and ② allows heat generated when insolation is incident on a roof and external walls to transmit into the building. Particularly, the heat taking the path of ① above accounts for more than 70% of total insolation heat transmitting into a building in summer. Because openings are more likely to acquire insolation than the other sections of a building, it is necessary to take countermeasure to block insolation heat transmission through the transparent portions of openings.

<u>**To balance and combine two contradictory purposes through comprehensive design**</u>

- It is necessary to determine suitable technologies taking into consideration the balance between contradictory purposes depending on time and situations, for example, between insolation shielding when cooling a building in summer and insolation acquisition when heating a building in winter and between the elimination of insolation heat and the preference for sunlight and views.
- Required performance to achieve contradictory purposes can be obtained by combining appropriate selection of the types of glass, blinds and louvers, the installation of canopies and the greening of a roof and external walls.

Approach toward the Sophistication of Insolation Shielding Technologies

- Insolation shielding technologies contribute to reducing a cooling load by shielding insolation heat transmitting from a roof and external walls to indoor spaces.
- The technologies applicable to the transparent portions of a building include the selection of high-performance glass effective for insolation shielding and the installation of blinds, louvers and canopies. For nontransparent portions of a building, insolation shielding performance can be enhanced by reinforcing insulation and insolation reflection performance with plants or materials with high sunlight reflection rates.

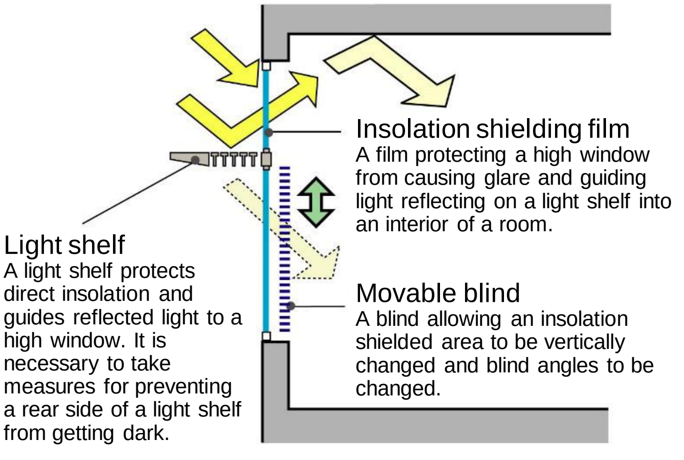


Source: Hideharu Niwa, *Energy Independent Buildings*, Kousakusha Co., Ltd., 2013

Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program

- The examples of technologies include the selection of high-performance glass effective for insolation shielding and the installation of insolation shielding members such as curtains and blinds as well as canopies. The insolation passing through windows causes the increase in an air-conditioning load, and local increases in temperature and glare near windows.

Example of insolation shielding and daylight utilization with light shelves



Insolation shielding with outer frames

Source: ZEB and Energy Saving, Kajima Corporation

Example of technologies for ZEB Ready (those in orange cells are used in the case study)

○: Technology applicable to the evaluation with the program, △: Technology requiring attention when evaluated with the program, ×: Technology difficult to be evaluated with the program

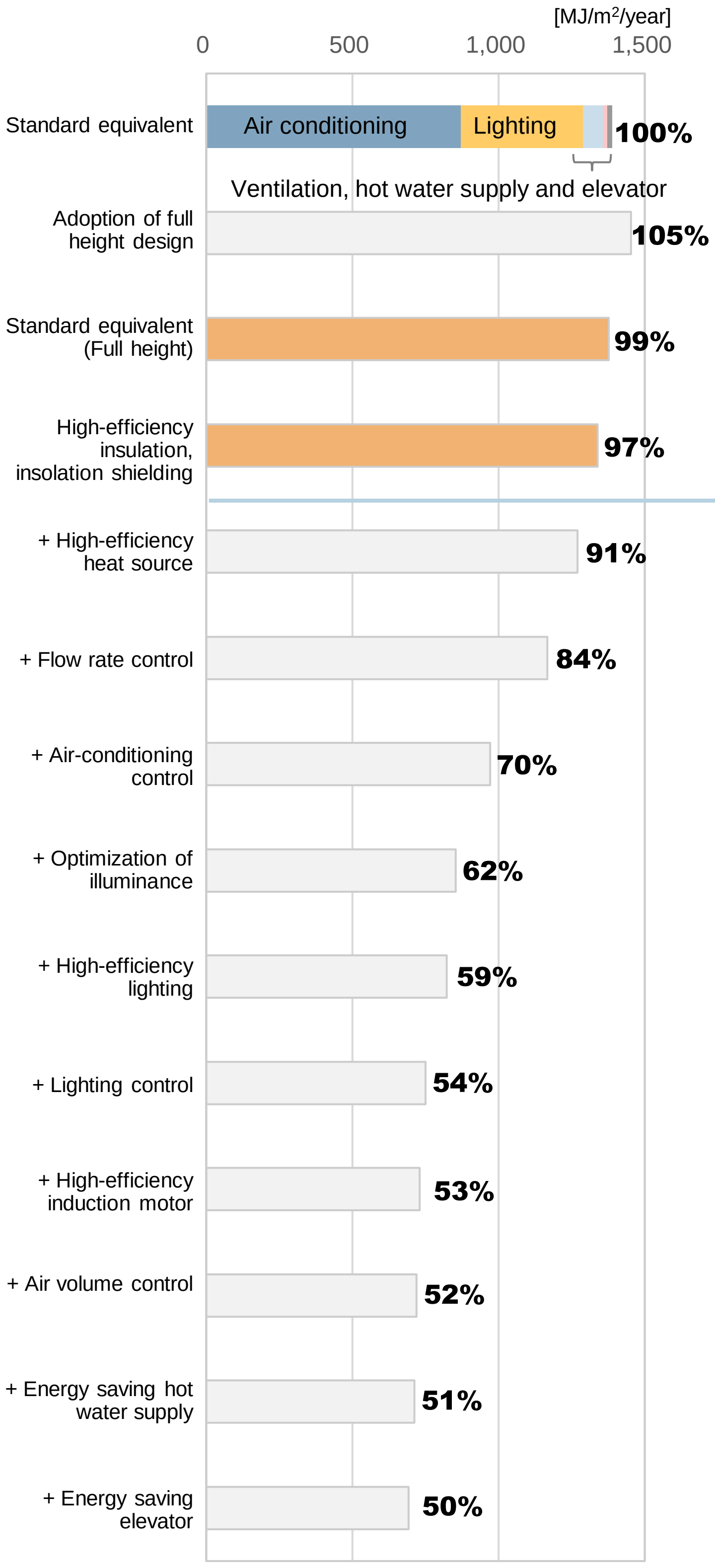
Envelope insulation and insolation shielding technologies (example)			Applicability of energy consumption performance calculation program	Energy saving effect (target)	Approximate cost increment (target)
❶ Structure	Out of scope	Rooftop greening	△ Only the insulation effect is considered in the calculation of PAL		
❶ Structure	High insulation envelope and insulation shielding	High-performance insulation material	○	8% (Note)	About 120 million yen
❷ Opening		High-performance heat shielding and insulation window	○		
		Horizontal canopy and blind	○		

Note: Combined effect of high insulation envelope and insolation shielding

Source: Modification of the material by the ZEB Roadmap Examination Committee

Case Study Result of Office Building Realizing ZEB Ready

Note: The "energy saving effect" is a result of calculating combined effect of plural technologies and does not necessarily correspond to the accumulated total of energy saving effects of individual technologies.



Energy saving technology		Energy saving effect[Note]
Passive technology **Envelope insulation, Insolation shielding**	· High-performance insulation material · High insulation window · Canopy and louver	8%
Active technology **Air-conditioning system**	· High-efficiency heat source	6%
	· Large temperature difference water delivery · Variable water volume control	7%
	· Total heat exchanger · Variable air volume control · External air cut · External air cooling control	14%
Active technology **Lighting system**	· Adoption of the illuminance of 500 lx (Office)	8%
	· LED lighting	2%
	· Motion detection control · Time schedule control · Initial illuminance correction · Luminous detection control	5%
Active technology **Ventilation system**	· High-efficiency induction motor, invertor	1%
	· Temperature control (Machine room)	1%
Active technology **Hot water supply system**	· Automatic hot water faucet	Less than 1%
Active technology **Elevator system**	· VVVF (with power regeneration, gearless)	1%

1) Insolation Shielding Technology (Example): Horizontal canopy and blind

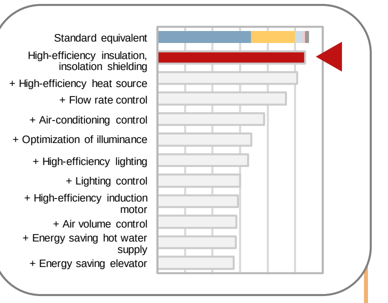
③: Insolation shielding effect coefficients for (cooling) and (heating)

- For a building provided with insolation shielding such as canopies, numerical values can be input for the insolation shielding effect coefficients separately for cooling and heating time in accordance with the shapes of a canopy. For a building without canopies, the cells can be left blank.
- The insolation shielding effect coefficients are basically calculated using the "insolation shielding effect calculation tool" published by the Building Research Institute.
    - "Insolation shielding effect coefficient calculation tool" http://www.kenken.go.jp/becc/index.html#5-1

Example of Entry into Form 2-4: (Air Conditioning) Envelope Specifications

BEFORE 2016 standards equivalent (Full height)

① Floor (Transcription)	① Name of air-conditioning zone (Transcription)	Envelope composition							
		② Azimuth direction (Selection)	③ Insolation shielding effect coefficient (cooling) [-]	③ Insolation shielding effect coefficient (heating) [-]	Wall: ④ Name of external wall (Transcription)	Wall: ⑤ Envelope area (including windows) [m^2]	Opening: ⑥ Name of opening (Transcription)	Opening: ⑦ Window area [m^2]	Opening: ⑧ With or without blind (Selection)
1F	Lobby	South			W1	50.00	G1	34.00	Without
		Shaded			FG1	114.12			
1F	EV hall	Shaded			FG1	16.32			
1F	Central control and security guard rooms	South			W1	38.80	G1	19.40	Without
		West			W1	12.50			
		Shaded			FG1	39.00			
1F	Changeroom 1	Shaded			FG1	14.63			
1F	Changeroom 2	Shaded			FG1	14.63			
1F	Resting room	Shaded			FG1	29.25			
1F	Office 1	North			W1	117.50	G1	58.75	Without
		West			W1	75.00	G1	37.50	Without
		Shaded			FG1	352.50			
1F	Office 2	South			W1	83.50	G1	41.75	Without
		West			W1	75.00	G1	37.50	Without
		Shaded			FG1	252.00			
2F	Office 1	West			W1	60.00	G1	37.50	Without
		North			W1	159.20	G1	99.50	Without
		East			W1	60.00	G1	37.50	Without
2F	Office 2	South			W1	159.20	G1	99.50	Without
		West			W1	60.00	G1	37.50	Without
3F	Office 1	West			W1	60.00	G1	37.50	Without
		North			W1	159.20	G1	99.50	Without
		East			W1	60.00	G1	37.50	Without
3F	Office 2	South			W1	159.20	G1	99.50	Without
		West			W1	60.00	G1	37.50	Without



Example of Entry into Form 2-4: (Air Conditioning) Envelope Specifications

AFTER (ZEB Ready equivalent)

① Floor (Transcription)	① Name of air-conditioning zone (Transcription)	Envelope composition							
		② Azimuth direction (Selection)	③ Insolation shielding effect coefficient (cooling) [-]	③ Insolation shielding effect coefficient (heating) [-]	Wall: ④ Name of external wall (Transcription)	Wall: ⑤ Envelope area (including windows) [m^2]	Opening: ⑥ Name of opening (Transcription)	Opening: ⑦ Window area [m^2]	Opening: ⑧ With or without blind (Selection)
1F	Lobby	South	0.890	0.969	W1	50.00	G1	34.00	With
		Shaded			FG1	114.12			
1F	EV hall	Shaded			FG1	16.32			
1F	Central control and security guard rooms	South	0.890	0.969	W1	38.80	G1	19.40	With
		West			W1	12.50			
		Shaded			FG1	39.00			
1F	Changeroom 1	Shaded			FG1	14.63			
1F	Changeroom 2	Shaded			FG1	14.63			
1F	Resting room	Shaded			FG1	29.25			
1F	Office 1	North	0.884	0.878	W1	117.50	G1	58.75	With
		West	0.923	0.931	W1	75.00	G1	37.50	With
		Shaded			FG1	352.50			
1F	Office 2	South	0.890	0.969	W1	83.50	G1	41.75	With
		West	0.923	0.931	W1	75.00	G1	37.50	With
		Shaded			FG1	252.00			
2F	Office 1	West	0.923	0.931	W1	60.00	G1	37.50	With
		North	0.884	0.878	W1	159.20	G1	99.50	With
		East	0.924	0.938	W1	60.00	G1	37.50	With
2F	Office 2	South	0.890	0.969	W1	159.20	G1	99.50	With
		West	0.923	0.931	W1	60.00	G1	37.50	With
3F	Office 1	West	0.923	0.931	W1	60.00	G1	37.50	With
		North	0.884	0.878	W1	159.20	G1	99.50	With
		East	0.924	0.938	W1	60.00	G1	37.50	With
3F	Office 2	South	0.890	0.969	W1	159.20	G1	99.50	With
		West	0.923	0.931	W1	60.00	G1	37.50	With

3.3 Utilization of Natural Ventilation

Purposes of Introducing the Technology

To reduce the cooling load during intermediary seasons by natural ventilation

- The utilization of natural ventilation is an idea to use external air to ventilate the interior of a building without using power. Introducing external air into a building using natural winds is an effective way to reduce a cooling load in summer nights and intermediary seasons when hygrothermal condition outdoors is more comfortable than that indoors.

To maintain comfortable indoor air environment while curbing air-conditioning energy

- Building ventilation is indispensable to maintain comfortable air environment by preventing the deterioration of air quality due to the fluctuation in indoor temperature and humidity, the accumulation of internal heat generation and body temperatures, the emissions of carbon dioxide, etc. Building ventilation is generally performed mechanically with air conditioners (air handling units) or ventilation systems but utilizing natural winds for building ventilation can curb energy consumption for air conditioning.

To understand the characteristics of winds for their effective utilization

- Temperature difference causes air to flow and pressure difference generates natural winds. In order to utilize natural winds, openings and ventilation passages need to be designed so as to efficiently introduce them into a building.

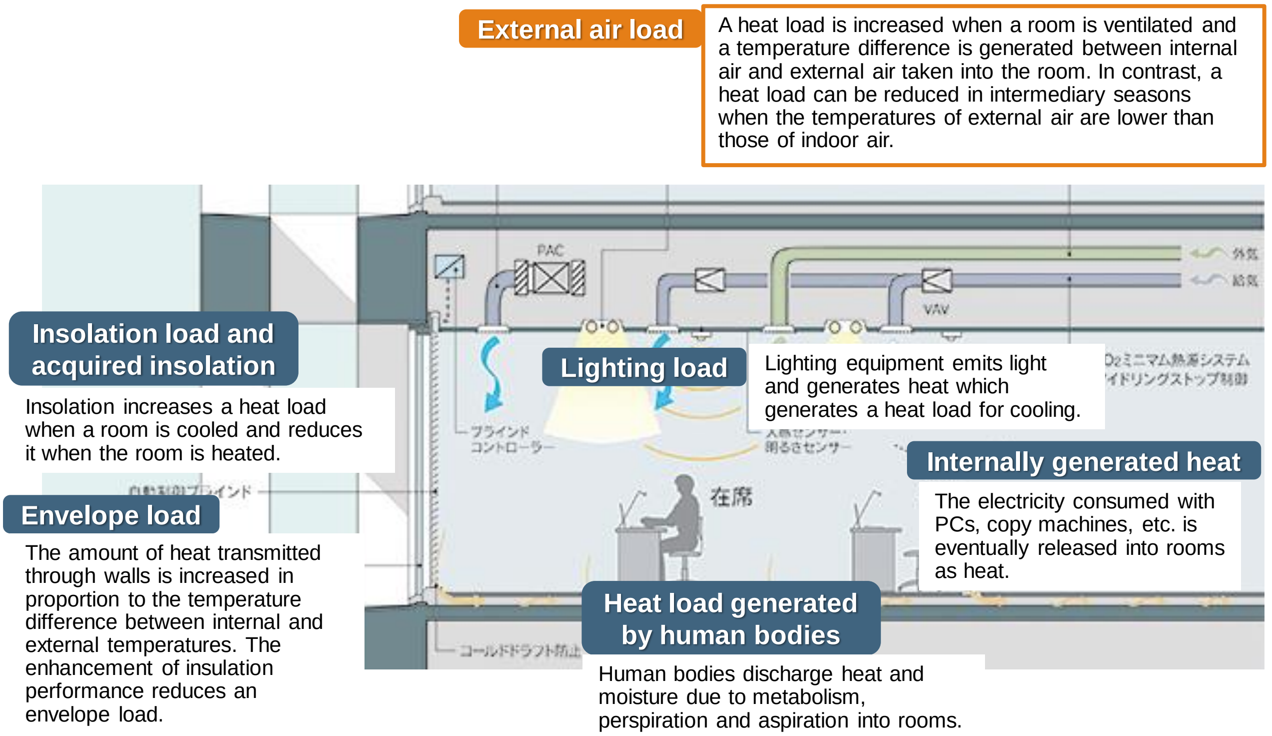
- The technologies to introduce natural winds into a building include: the installation of openings at two or more strategic locations to utilize the wind pressure difference between external walls or roof surfaces of a building; and the creation of ventilation passages with wing and bay windows on the wall along a prevailing wind direction or with skylight or dormer windows at locations on roof surfaces with negative wind pressure coefficients.

- Also, appropriate exterior plan such as arrangement of plants or water body on the windward side can reduce the temperature of air to be introduced into a building and thereby enhance the comfort of utilizing natural winds.

Approach toward the Sophistication of Natural Ventilation Utilization Technologies

- The natural ventilation utilization technologies contribute to reducing cooling and ventilation loads related to a building.

- In order to efficiently introducing natural winds into a building, it is important to design passages to allow natural winds to pass through with openings arranged at two or more strategic locations to utilize the wind pressure difference between external walls or roof surfaces.



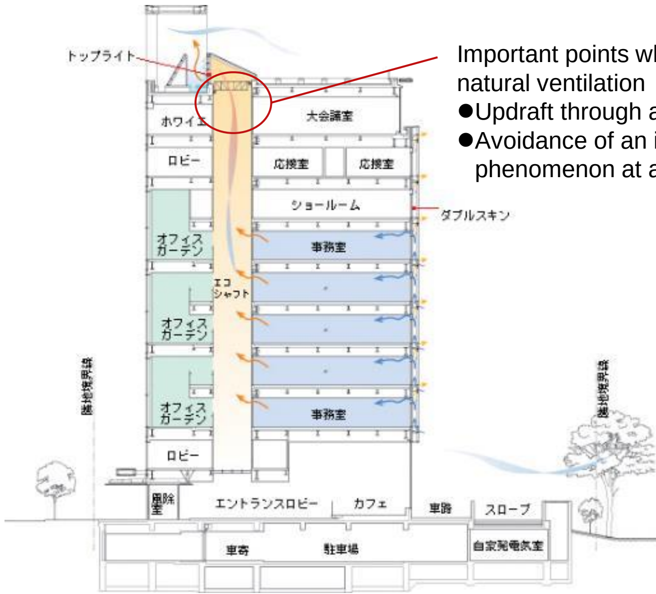
Source: Hideharu Niwa, *Energy Independent Buildings*, Kousakusha Co., Ltd., 2013

* Because the natural ventilation utilization technologies have already been evaluated in the energy saving effect of active air-conditioning system, the description of calculation examples, "Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program," is omitted.

Column

Natural Ventilation Utilization Technology (Example): Chimney Effect of Air Shaft

- There have been buildings provided with a ventilation system designed to use entire buildings as ventilation devices for proactively introducing natural winds into indoor spaces.
- Natural winds are taken into a building through transom windows on double skins, drifted through an ecological shaft (air shaft) by the chimney effect and discharged out of the building through a roof window.
- Movable windows located along ventilation passages are controlled by a computer in a manner that detects temperatures and humidity of external air and wind velocity with sensors and takes in necessary amount of external air into a building in accordance with the air-conditioning conditions inside the building.
- Together with daylight utilization technologies, natural ventilation utilization technologies as mentioned above are estimated to produce an energy saving effect accounting for about 20% of total air-conditioning load of a building.



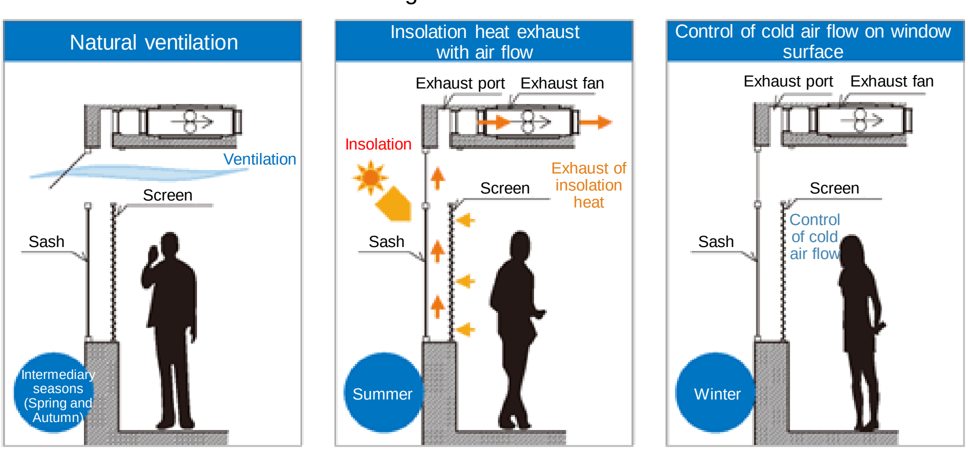
Source: "Environmental Conscious Buildings," Special Topic of *KAJIMA Digest* in January 2003 edition, Kajima Corporation

Column

Natural Ventilation Utilization Technology (Example): Combination of Natural Ventilation and Insolation Shielding

- The technology is to provide windows with an air flow window function and a natural ventilation function so as to enable natural ventilation to be introduced into a building through automatically controlled windows in intermediary seasons and thereby enable the building to save energy without impairing comfort. The automatically controlled windows comprise upper sashes which can be opened and indoor side screens which enable only their upper portions to be opened. In intermediary seasons when external hygrothermal conditions are favorable, the upper sashes are opened to introduce natural winds into a building. In summer, the indoor screens are used to exhaust hot air between the screens and window glass and thereby reduce the air-conditioning load.

Schematic drawings of seasonal control of window



Ventilation operation with a window opened

Source: "Development of Airy Office Window: Passive Air Flow Window, Researchers' Column Vol. 5," Daiwa House Industry

3.4 Daylight Utilization

Purposes of Introducing the Technology

To curb energy consumption for lighting

- Daylight utilization is to curb energy consumption for lighting by reducing the use of artificial lighting in a manner that secures illuminance of indoor spaces with daylight taken in through openings.
- In general office buildings, lighting system accounts for the second largest energy consumption next to air conditioning system. Thus, buildings can effectively save energy consumption if they can secure necessary illuminance indoors by utilizing daylight. Daylight utilization also enables buildings to enhance their energy self-dependence.

To optimize daylight utilization depending on the usage of rooms

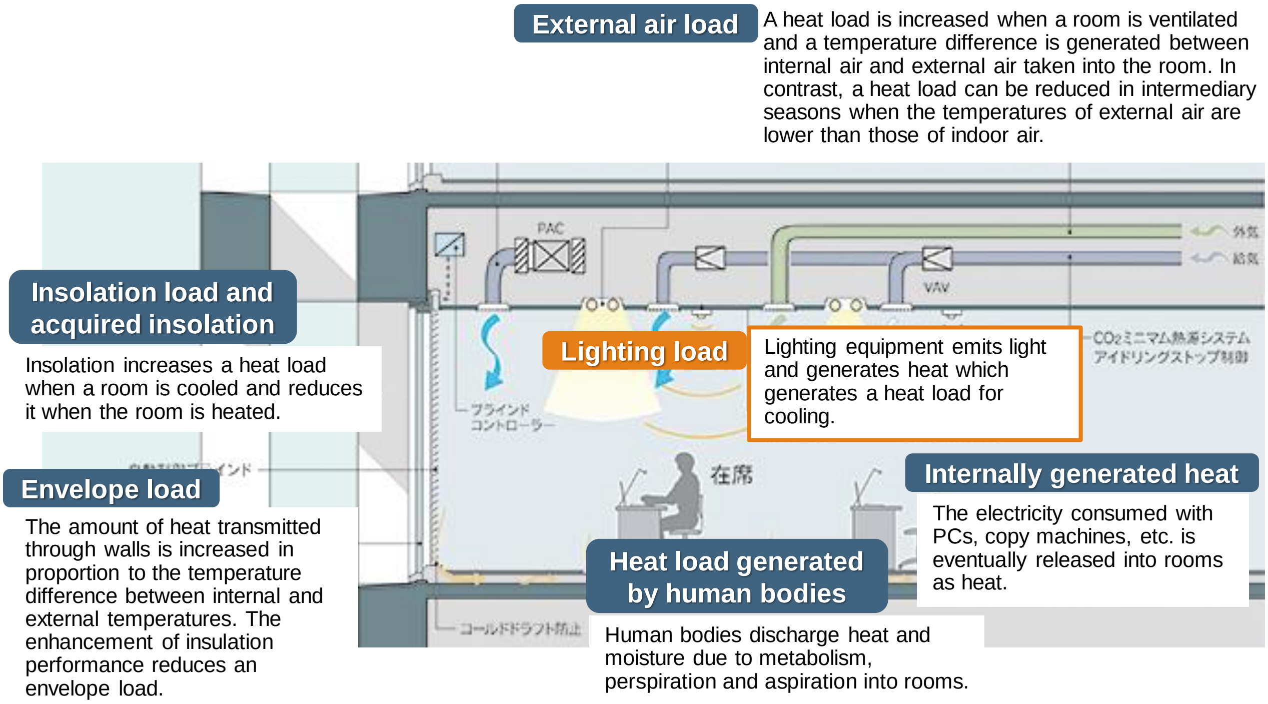
- Daylight is characterized by: ① temporal variation; ② intense illuminance more than necessary for indoor visual environment in some cases; and ③ exothermic nature.
- Thus, it is important to take daylighting measures appropriate for spatial property and usage of rooms taking into consideration the above characteristics. For those rooms such as offices and study rooms which require uniform illuminance, it is necessary to take in stable indirect insolation with little fluctuation while blocking direct insolation. In contrast, in the case of public areas for which insolation with a certain level of fluctuation is acceptable, comfortable spaces can be produced by taking in direct insolation with fluctuation having an effect of giving people a feeling of “nature.”
- Without daylighting appropriate for the spatial properties and usage of rooms, a building may end up an energy-intensive one with daylight mistakenly blocked by users or with cooling energy unexpectedly increased more than the lighting energy saved through daylight utilization.

To optimize surrounding environment

- Appropriate specifications for openings and rooms enable power consumption for lighting to be significantly reduced. However, the azimuth directions of openings and the existence of neighboring buildings and topographical constraints on the daylighting side may prevent effective utilization of daylight.

Approach toward the Sophistication of Daylight Utilization Technologies

- Daylight utilization technologies contribute to reducing a lighting load.
- The daylighting methods include: a direct method which secures the illuminance of indoor spaces of a building with daylight directly taken in through openings; and an indirect method which installs a light well and transoms to guide daylight into the inner side of indoor spaces and reflection boards behind eaves.



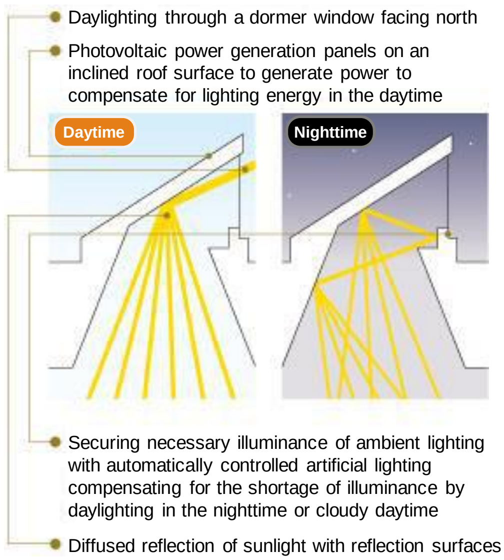
Source: Hideharu Niwa, *Energy Independent Buildings*, Kousakusha Co., Ltd., 2013

* Because the daylight utilization technologies have already been evaluated in the energy saving effect of active lighting system, the description of calculation examples, “Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program,” is omitted.

Column

Daylight Utilization Technology (Example): Roof Window and Dormer Window

- Openings at upper sections of a building are effective to take in a large amount of daylight. It is important to provide these openings with mechanisms to adjust the amount of daylighting because too much daylight causes the increase in a cooling load.
- Obayashi Corporation has introduced ambient and task lighting plans using daylighting into the main building of its Technical Research Institute as a measure to reduce lighting power consumption by about 30%. The measure has contributed to significantly saving power consumption by switching off ambient lighting in the daytime and minimizing power consumption with power saving type lighting fixtures when using artificial lighting in the nighttime and cloudy daytime. Even in a one-room type large working space with a ceiling height of 6 m, energy saving has been achieved while securing average illuminance of 300 lx and illuminance on a desk surface of 700 lx in the nighttime.



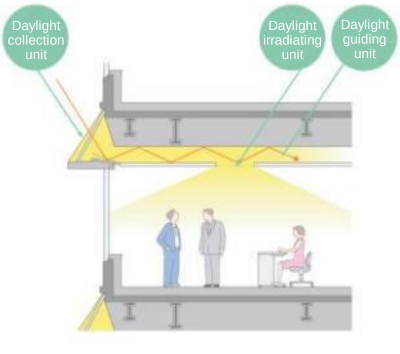
Source: “Main Building of Technical Research Institute of Obayashi Corporation, LIGHTING STYLE Vol. 6,” Panasonic

Column

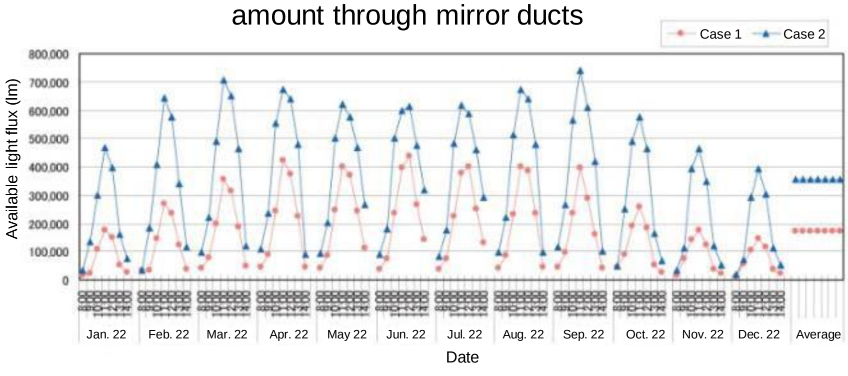
Daylight Utilization Technology (Example): Mirror Duct System

- The mirror duct system is a technology to efficiently collect external daylight and utilize it as illumination inside a building by distributing it to the places requiring illumination through ducts with high reflection mirrors on their inner faces. The system enables inner parts of a building or a windowless basement where external daylight is not available to be illuminated by daylight and can provide stable lighting through automatic dimming control which combines artificial lighting and daylighting so as to compensate the fluctuation of daylighting.
- The system enables a building to achieve not only the energy saving through the utilization of daylight but also a high-quality light environment producing comfortable and healthy indoor spaces.

Horizontal duct system



Example of the simulation of annual daylighting amount through mirror ducts

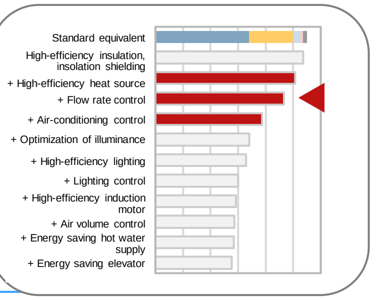


Source: “Incorporating Natural Light into Windowless Rooms by Introducing a Mirror Duct System” on the webpage of Nikken Sekkei

Chapter 4

System Energy Saving Technologies (Active Technologies)

PDF変換後に、
表紙･中扉の差し替えをお願いします



4.1 Air-conditioning Systems

Purposes of Introducing the Technology

To properly utilize air-conditioning energy

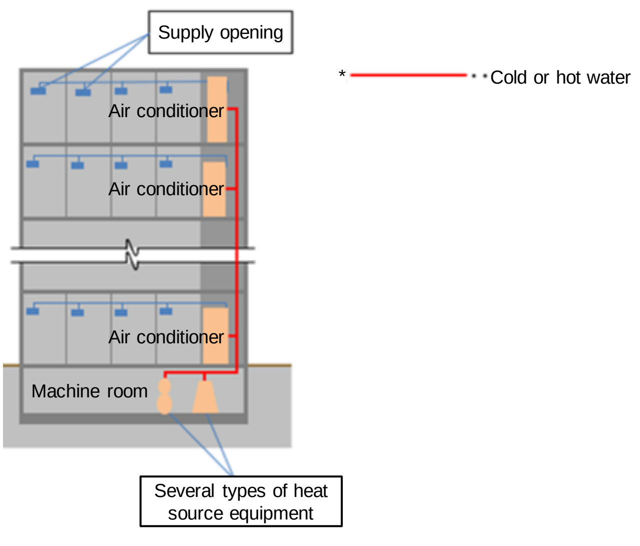
- Buildings require air-conditioning systems because there are many cases where only envelope insulation and insolation shielding are not enough to keep comfortable indoor environments of buildings. Considering that air-conditioning systems account for the largest proportion of total energy consumption in a general office building, the energy saving design of air-conditioning systems is of great importance.

- There are many types of air-conditioning systems used in office buildings. In terms of system configuration, they are largely classified into two categories: Category ❶ centralized heat source system; and Category ❷ dispersed individual heat source system. There is a wide variety of equipment available for these categories and new products have been continually developed.

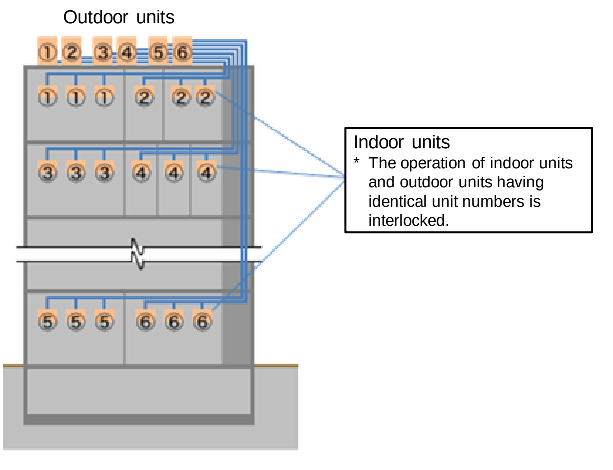
- The indoor warmer environments produced by air-conditioning systems and required energy consumption for the system vary depending on weather conditions, the insulation performance of a building envelope, the insolation shielding performance of openings, work situations of office workers, and usage of building equipment. Also, building operation with or without the utilization of natural ventilation and solar heat has influences on the reduction in air-conditioning energy.

- Systematic organization of the methods for designing energy saving air-conditioning systems is not easy. Still, it is important to select an appropriate category of the air-conditioning systems taking into consideration costs and the characteristics of available equipment and to design energy saving suitable for the selected category.

❶ Centralized heat source system



❷ Dispersed individual heat source system



Source: Special edition for building renewal technologies of Taisei Corporation "The third edition: Renewal for 'Energy Saving'—Office building air-conditioning systems evolving with the times," Taisei Corporation

- The system cools or heats a building in a manner that: generates cold or hot water with heat source equipment (including boiler, cooling machine, heat pumps, etc.); circulates the cooling or hot water with air conditioners; and uses the cooling or hot water to cool or heat air-conditioning air.
- The system enables the operation of an air conditioner or variable air volume control to be switched on or off depending on air-conditioning needs on each floor or zone.
- The system basically enables air conditioners in respective rooms to be individually switched on or off if these rooms are provided with VAV.

- The system enables indoor units in respective rooms to be individually switched on or off.
- The system enables respective rooms to be individually cooled or heated.

Approaches toward Enhancing the Efficiency of Air-conditioning Systems

Enhancement of the efficiency of heat source equipment and systems

- Heat source equipment varies its efficiency depending on the ratio of heat loads (partial load factors) to rated capacity. Generally, heat source equipment is characterized by the decline in efficiency with the reduction in the partial load factors. In contrast, because heat loads exist as partial loads in most of the time throughout the year, it is necessary to examine the selection of the category of heat source system, equipment configuration, the priorities or operation, etc. not only for a peak time zone of heat loads but also for other time zones taking into consideration the generation states of partial loads.
- The efficiency of heat source equipment and systems are generally measured in the unit of COP based on JIS. There has been remarkable improvement in the COP of cooling machines and heat pumps and there has also been progress in developing equipment capable of maintaining high efficiency even in partial load operation.
- A heat source system comprises heat source equipment such as a cooling machine and a heat pump and auxiliary equipment such as a pump and a cooling tower. Because the energy consumption of auxiliary equipment is mostly constant regardless of the magnitudes of loads, there have been cases where the energy saving efficiency of an entire heat source system cannot be improved, even though high-efficiency heat source equipment is selected, due to the energy consumption by a pump and a cooling tower. Thus, as a solution for this issue, a control method called rotation control which controls power consumption of a pump and a cooling tower depending on loads has started to be adopted in many buildings.

Enhancement of the efficiency of dispersed individual heat source system

- Many medium-to-small-scale office buildings have adopted the dispersed individual heat source systems. There has been remarkable improvement in the efficiency of packaged air conditioners (dispersed individual heat source systems) recently and there also has been the development of systems achieving significant improvement particularly in COP in partial load operation. In addition, there has been the development of a latent and sensible heat separation type air-conditioning system which can improve both indoor environments and COP. Such a system is applicable not only to the dispersed individual heat source system but also to the centralized heat source system.

Enhancement of the efficiency of delivery system

- The energy required for delivering water and air is proportional to their volumes and to the square of pump head (pressure losses). Also, the heat value to be delivered is proportional to temperature differences and volumes. Therefore, the following measures are considered to be effective in reducing energy required for delivering heat value:

    1. To minimize volumes (of air or water) in accordance with loads;
    2. To minimize volumes (of air or water) by securing delivery temperature differences between incoming air or water and outgoing air or water;
    3. To minimize pump head (pressure differences) required for delivering air or water; and
    4. To enhance the efficiency of delivery equipment (fans and pumps).

- The most typical measures taken are the variable air volume control (VAV) or variable water volume control (VWV) which use invertors to control air or water volumes in response to the fluctuation of heat loads with the temperature differences between inlets and outlets of fans and pumps kept at constant values.
- The measures to secure delivery temperature difference include a large temperature difference water delivery method which delivers water at temperatures lower than normal temperature (for cooling operation) and a low temperature water delivery method. For example, in an ideal situation, securing a delivery temperature difference of 14°C enables delivery energy to be reduced to 1/8 of that required for delivering the same heat value with the delivery temperature difference of 7°C. However, securing large delivery temperature differences requires to enlarge heat transfer areas with an air handling unit (AHU) or a fan coil unit (FCU) and, therefore, increases costs. Also, the diameters of delivery piping need to be equivalent to those used in the case of general delivery temperature differences.
- In order to minimize pressure losses, building equipment needs to be arranged so as to shorten delivery passages and lower vertical height differences taking into consideration the shape of a building. In some cases, allowing piping and ducts to have diameters in excess of generally required ones may be an effective measure to reduce pressure losses due to friction. These measures need to be sufficiently studied in early stage of design to confirm whether or not they are consistent with an architectural plan and cost increases due to these measures are acceptable.

Target Levels of Air-conditioning Systems

- A building satisfying ZEB Ready (energy saving rate of 50%) needs to be provided with an air-conditioning system which can achieve **the air-conditioning BEI of about 0.45 to 0.55 (reduction in the consumption of air-conditioning energy by 45 to 55%, refer to the following case study for actual calculation)**.

Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program

- The targets of energy saving effect and approximate construction cost of main air-conditioning systems are as follows. The processes of calculating the energy saving effect using the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017) are explained on the following pages.

Example of technologies for ZEB Ready (those in orange cells are used in the case study)

○: Technology applicable to the evaluation with the program, △: Technology requiring attention when evaluated with the program, ×: Technology difficult to be evaluated with the program

Energy saving of air-conditioning system (example)			Applicability of energy consumption performance calculation program	Energy saving effect (target)	Approximate cost increment (target)
❶ Dispersed individual	High-efficiency heat source	High-efficiency packaged air conditioner	○	6%	About 19 million yen
❷ Heat source		High-efficiency heat source equipment	○		
	High-efficiency heat source (out of scope of the case study)	Heat storage system	○		
		High-efficiency cogeneration system	○		
		Medium temperature cold water utilization system	○		
		Quantity control of heat source equipment	○		
		Remote control of preset outlet temperature of heat source equipment	×		
		Regional energy use	×		
❸ Cooling tower		High-efficiency cooling tower	△ Incorporated in the reduction in rated power consumption		
		Quantity and start-stop control of cooling tower fan	×		
		Inverter control of cooling tower fan	×		
		Free cooling system	×		
❹ Pump	Flow rate control	High-efficiency air-conditioning pump (high-efficiency induction motor)	△ Incorporated in the reduction in rated power consumption	7%	About 8 million yen
		Variable volume control of air-conditioning secondary pump	○		
		Large temperature difference water delivery system	○		
	Flow rate control (out of scope of case study)	Variable volume control of cooling water pump	×		
		Variable volume control of air-conditioning primary pump	×		
		Appropriate allocation of capacity to air-conditioning secondary pumps/small-capacity pumps	×		
		Sealing of water delivery passage	×		
		Piping friction reducing agent	×		

Source: Modification of the material by the ZEB Roadmap Examination Committee

Example of technologies for ZEB Ready (those in orange cells are used in the case study)

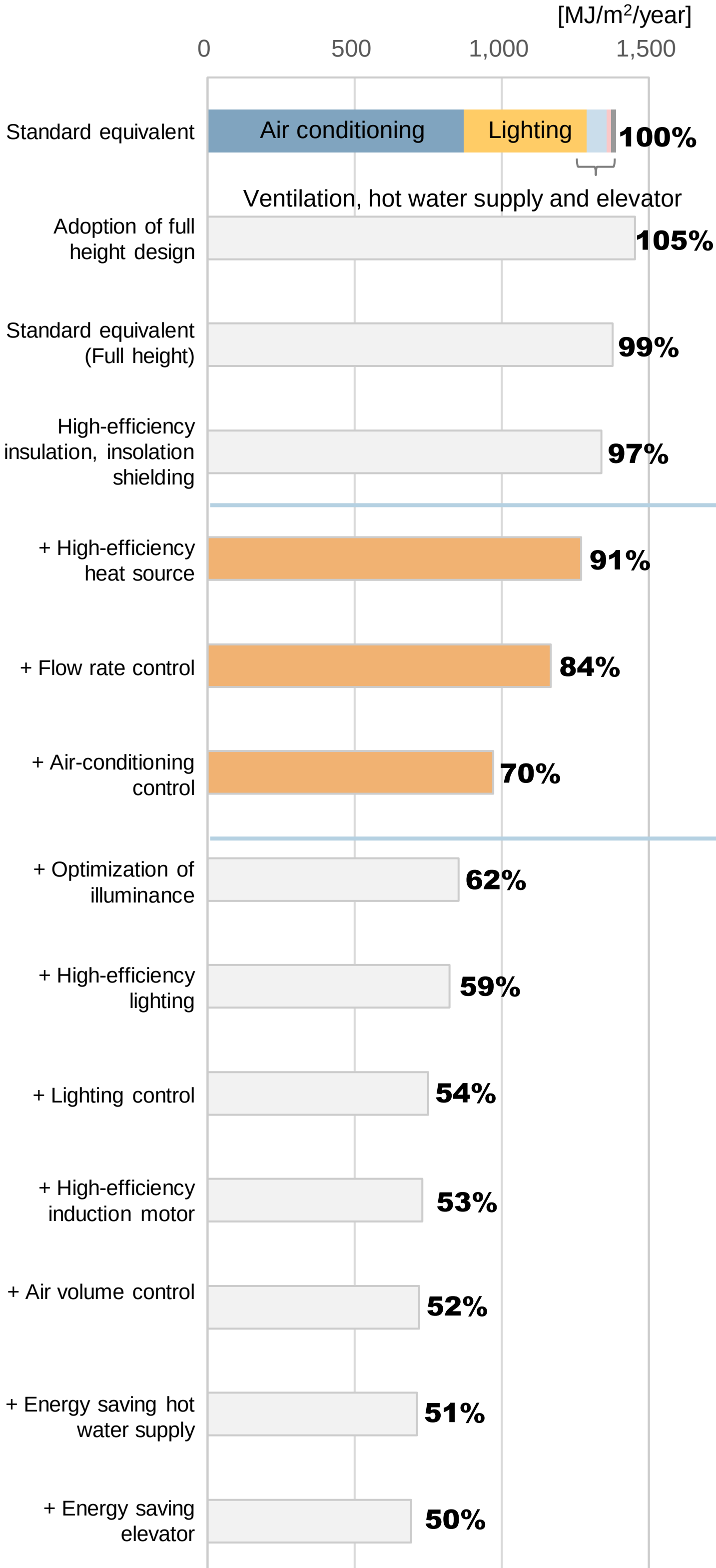
○: Technology applicable to the evaluation with the program, △: Technology requiring attention when evaluated with the program, ×: Technology difficult to be evaluated with the program

Energy saving of air-conditioning system (example)			Applicability of energy consumption performance calculation program	Energy saving effect (target)	Approximate cost increment (target)
❺ General air-conditioning	Air-conditioning control	High-efficiency air conditioner	△ Incorporated in the reduction in rated power consumption	14%	About 123 million yen
		Variable air volume control of air conditioner	○		
		Total heat exchanger	○		
		External air cooling system	○		
	Air-conditioning control (out of scope of the case study)	External air cut control during warming-up	○		
		Radiant cooling system	○		
		Latent and sensible heat separation type energy saving air-conditioning system	○		
		Large temperature difference air delivery type air conditioning system	△ Incorporated in the reduction in rated power consumption		
		External air volume control based on CO_2 concentration	×		
		Proportional control of fan coil unit	×		
		Floor air-conditioning system	×		
		Desiccant air-conditioning system	×		
		Hybrid air-conditioning system	×		

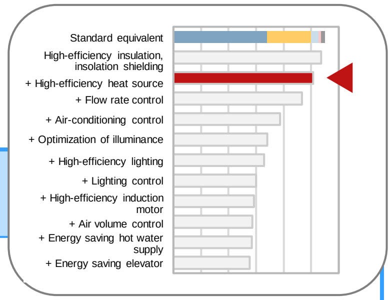
Source: Modification of the material by the ZEB Roadmap Examination Committee

Case Study Result of Office Building Realizing ZEB Ready

Note: "The energy saving effect" is a result of calculating combined effect of plural technologies and does not necessarily correspond to the accumulated total of energy saving effects of individual technologies.



	Energy saving technology	Energy saving effect[Note]
Passive technology **Envelope insulation, Insolation shielding**	· High-performance insulation material · High insulation window · Canopy and louver	8%
Active technology **Air-conditioning system**	· High-efficiency heat source	6%
	· Large temperature difference water delivery · Variable water volume control	7%
	· Total heat exchanger · Variable air volume control · External air cut · External air cooling control	14%
Active technology **Lighting system**	· Adoption of the illuminance of 500 lx (Office)	8%
	· LED lighting	2%
	· Motion detection control · Time schedule control · Initial illuminance correction · Luminance detection control	5%
Active technology **Ventilation system**	· High-efficiency induction motor, invertor	1%
	· Temperature control (Machine room)	1%
Active technology **Hot water supply system**	· Automatic hot water faucet	Less than 1%
Active technology **Elevator system**	· VVVF (with power regeneration, gearless)	1%



1) Energy Saving of Air-conditioning Systems (Example): High-efficiency Heat Source

<Corresponding to data entry into "Form 2-5: (Air Conditioning) Heat Source">

⑥: Type of heat source equipment

- The types of heat source equipment can be selected from "Table 1-2-7 List of the Types of Heat Source Equipment (Source: Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2 Input Manual)" and corresponding character strings can be input into the form.
- In the case study, "Absorption chiller (variable cooling water volume, city gas)" is selected and entered.

⑩: Rated cooling and heating capacity and ⑪: Rated energy consumption of heat source equipment

- Numerical values can be input for the rated cooling and heating capacity per equipment in the unit of kW/unit.
- The rated cooling and heating capacity shall be that measured under the standard rated conditions (cold and hot water temperature, cooling water temperature, flow rates, etc.) stipulated in JIS, etc.

- Also, a numerical value can be input for the rated energy consumption of corresponding heat source equipment.
- If "electricity" is the energy source of heat source equipment, the rated power consumption [kW/unit] shall be input and if "gas" or "oil" is the energy source, fuel consumption (primary energy equivalent) [kW/unit] shall be input.
- The rated energy consumption shall be that measured under the standard rated conditions (cold and hot water temperature, cooling water temperature, flow rates, etc.) stipulated in JIS, etc. Based on the assumption that the energy consumption of main heat source equipment varies depending on the conditions such as load factors and external air temperatures, the program calculates energy consumption values under respective conditions using characteristic curves of heat source equipment.
- In the case study, the following values are used.
  - • Absorption chiller (variable cooling water volume, city gas): Cooling COP of 1.30 and heating COP of 0.87

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 2-5: (Air Conditioning) Heat Source

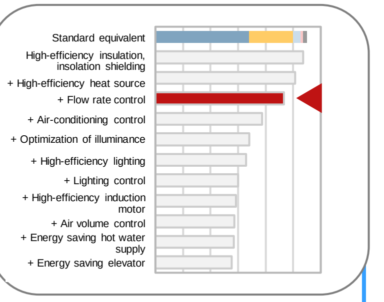
①	②	③	Heat storage system		⑥	Cold generation							Specifications of cooling tower			High temperature generation						
			④	⑤		⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑦	⑧	⑨	⑩	⑪	⑫	⑬
Name of heat source group	With or without simultaneous cooling and heating operation (Selection)	With or without quantity control (Selection)	Operation mode (Selection)	Heat storage capacity [MJ]	Type of heat source equipment (Selection)	Priority of operation (Selection)	Number of units [Unit]	Water delivery temperature [°C]	Rated cooling capacity [kW/unit]	Rated energy consumption of main equipment [kW/unit]	Rated power consumption of auxiliary equipment [kW/unit]	Rated power consumption of primary pump [kW/unit]	Rated cooling capacity [kW/unit]	Power consumption of cooling tower and fan [kW/unit]	Power consumption of cooling water pump [kW/unit]	Priority of operation (Selection)	Number of units [Unit]	Delivery water temperature [°C]	Rated heating capacity [kW/unit]	Rated energy consumption of main equipment [kW/unit]	Rated power consumption of auxiliary equipment [kW/unit]	Rated power consumption of primary pump [kW/unit]
AHP	With-out	With			Absorption chiller (city gas)	First	1	7	527	479	6.6	7.5	872	5.5	11	First	1	55	353	420	5.4	7.5
					Absorption chiller (city gas)	Second	1	7	527	479	6.6	7.5	872	5.5	11	Second	1	55	353	420	5.4	7.5
EHP1-1O	With-out	With-out			Packaged air conditioner (air cooled)	First	1		5.6	1.37						First	1		6.3	1.34		
EHP1-2O	With-out	With-out			Packaged air conditioner (air cooled)	First	1		3.6	0.805						First	1		4.0	0.81		
EHP1-3O	With-out	With-out			Packaged air conditioner (air cooled)	First	1		3.6	0.805						First	1		4.0	0.81		
EHP1-4O	With-out	With-out			Packaged air conditioner (air cooled)	First	1		3.6	0.805						First	1		4.0	0.81		

Example of Entry into Form 2-5: (Air Conditioning) Heat Source

AFTER
(ZEB Ready equivalent)

①	②	③	Heat storage system		⑥	Cold generation							Specifications of cooling tower			High temperature generation						
			④	⑤		⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑦	⑧	⑨	⑩	⑪	⑫	⑬
Name of heat source group	With or without simultaneous cooling and heating operation (Selection)	With or without quantity control (Selection)	Operation mode (Selection)	Heat storage capacity [MJ]	Type of heat source equipment (Selection)	Priority of operation (Selection)	Number of units [Unit]	Water delivery temperature [°C]	Rated cooling capacity [kW/unit]	Rated energy consumption of main equipment [kW/unit]	Rated power consumption of auxiliary equipment [kW/unit]	Rated power consumption of primary pump [kW/unit]	Rated cooling capacity [kW/unit]	Power consumption of cooling tower fan [kW/unit]	Power consumption of cooling water pump [kW/unit]	Priority of operation (Selection)	Number of units [Unit]	Delivery water temperature [°C]	Rated heating capacity [kW/unit]	Rated energy consumption of main equipment [kW/unit]	Rated power consumption of auxiliary equipment [kW/unit]	Rated power consumption of primary pump [kW/unit]
AHP	With-out	With			Absorption chiller (variable cooling water volume, city gas)	First	1	7	527	390	5.1	5.5	872	5.5	11	First	1	55	353	401	4.3	5.5
					Absorption chiller (variable cooling water volume, city gas)	Second	1	7	527	390	5.1	5.5	872	5.5	11	Second	1	55	353	401	4.3	5.5
EHP1-1O	With-out	With-out			Packaged air conditioner (air cooled)	First	1		5.6	1.37						First	1		6.3	1.34		
EHP1-2O	With-out	With-out			Packaged air conditioner (air cooled)	First	1		3.6	0.805						First	1		4.0	0.81		
EHP1-3O	With-out	With-out			Packaged air conditioner (air cooled)	First	1		3.6	0.805						First	1		4.0	0.81		
EHP1-4O	With-out	With-out			Packaged air conditioner (air cooled)	First	1		3.6	0.805						First	1		4.0	0.81		

2) Energy Saving of Air-conditioning Systems (Example): Flow Rate Control



<Corresponding to data entry into "Form 2-6: (Air Conditioning) Secondary Pump">

③: Temperature differences for cooling and heating operation

- Numerical values in the unit of °C can be input for the temperature differences between outgoing and incoming cold and hot water delivered to secondary air-conditioning systems for cooling and heating operation (design value of temperature difference between outgoing and incoming heat medium).
- In the case study, "7" °C is used assuming large temperature difference water delivery.

⑧: Flow rate control method

- The character strings selected from below can be input for the flow rate control methods of respective pumps.
  - Constant flow control: a method for delivering water at a constant flow rate
  - Rotation control: a method for delivering water with the number of rotations of a pump controlled by inverter, etc.
- In the case study, "rotation control" is used.

⑨: Minimum flow rate ratio under variable volume control

- A ratio of the minimum flow rate setting value to a rated flow rate can be input in the case "rotation control" is selected in ⑧: flow rate control method.
- In the case study, "60" is used assuming that the minimum flow rate of 60% or less of a rated flow rate.

Example of Entry into Form 2-6: (Air Conditioning) Secondary Pump

BEFORE
2016 standards equivalent
(Full height)

① Name of secondary pump group	② With or without quantity control (Selection)	③ Temperature difference for cooling operation [°C]	③ Temperature difference for heating operation [°C]	④ Priority of operation (Selection)	⑤ Number of units [Unit]	⑥ Rated flow rate [m³/h/unit]	⑦ Rated power consumption [kW/unit]	⑧ Flow rate control method (Selection)	⑨ Minimum flow rate ratio under variable volume control [%]	⑩ Remarks (Symbol in equipment list and system name)
PC2	Without	5	5	First	1	154.8	22	Constant flow		
				Second	1	154.8	22	Constant flow		
PH2	Without	5	5	First	1	154.8	22	Constant flow		
				Second	1	154.8	22	Constant flow		

Example of Entry into Form 2-6: (Air Conditioning) Secondary Pump

AFTER
(ZEB Ready equivalent)

① Name of secondary pump group	② With or without quantity control (Selection)	③ Temperature difference for cooling operation [°C]	③ Temperature difference for heating operation [°C]	④ Priority of operation (Selection)	⑤ Number of units [Unit]	⑥ Rated flow rate [m³/h/unit]	⑦ Rated power consumption [kW/unit]	⑧ Flow rate control method (Selection)	⑨ Minimum flow rate ratio under variable volume control [%]	⑩ Remarks (Symbol in equipment list and system name)
PC2	With	7	7	First	1	154.8	22	Rotation	60	
				Second	1	154.8	22	Rotation	60	
PH2	With	7	7	First	1	154.8	22	Rotation	60	
				Second	1	154.8	22	Rotation	60	

3) Energy Saving of Air-conditioning Systems (Example): Air-Conditioning Control (Variable Air Volume Control)

<Corresponding to data entry into "Form 2-7: (Air Conditioning) Air Conditioner">

⑪: Air volume control method

- Character strings selected from below can be input for the air volume control methods of air conditioners.
  - Constant air volume control: a method for delivering air at a constant flow rate
  - Rotation control: a method for delivering air with the number of rotations of a blower controlled by inverter, etc.

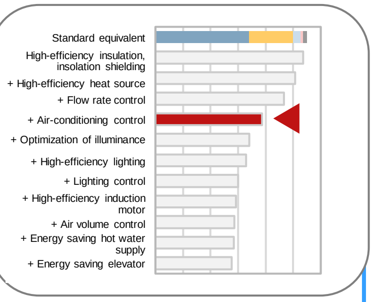
⑫: Minimum air volume ratio under variable volume control

- A ratio of the minimum air volume setting value to a rated air volume can be input in the case "rotation control" is selected in ⑪: air volume control method.
- In the case study, the minimum air volume is set at 50% of a rated air volume.

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 2-7: (Air Conditioning) Air Conditioner

①	②	③	④	⑤	⑥	Rated power consumption of blower				⑪	⑫	⑬	⑭	Total heat exchanger					Name of secondary pump group		Name of heat source group		㉔
						⑦	⑧	⑨	⑩					⑮	⑯	⑰	⑱	⑲	⑳	㉑	㉒	㉓	
Name of air conditioner group	Number of air conditioners	Type of air conditioner	Rated cooling capacity	Rated heating capacity	Design maximum external air volume	Air supply	Back-flow	External air	Exhaust	Air volume control method	Minimum air volume ratio under variable volume control	With or without external air cut control	With or without external air cooling control	With or without total heat exchanger	Design air volume of total heat exchanger	Total heat exchange efficiency	With or without automatic ventilation switching function	Power consumption of rotor	Cold temperature	High temperature	Cold temperature	High temperature	Remarks (Symbol in equipment list and system name)
	[Units]	(Selection)	[kW/unit]	[kW/unit]	[m³/h/unit]	[kW/unit]	[kW/unit]	[kW/unit]	[kW/unit]	(Selection)	[%]	(Selec-tion)	(Selec-tion)	(Selection)	[m³/h/unit]	[%]	(Selec-tion)	[kW/unit]	(Transcription)	(Transcription)	(Transcription)	(Transcription)	
EHP1-1	1	Indoor unit	5.60	6.30	1,290	0.05				Constant air volume											EHP1-1O	EHP1-1O	Central control room
	1	Total heat exchanger unit			200	0.17																	
EHP1-2	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume											EHP1-2O	EHP1-2O	Changing room 1
	1	Total heat exchanger unit			150	0.17																	
EHP1-3	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume											EHP1-3O	EHP1-3O	Changing room 2
	1	Total heat exchanger unit			150	0.17																	
EHP1-4	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume											EHP1-4O	EHP1-4O	Resting room
	1	Total heat exchanger unit			300	0.17																	
FCU1-1	1	FCU	6.79	6.77	1,020	0.08				Constant air volume									PC2	PH2	AHP	AHP	1F Lobby
FCU1-2	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	1F EV hall
FCU2	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	2F EV hall
FCU3	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	3F EV hall
FCU4	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	4F EV hall
FCU5	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	5F EV hall
FCU6	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	6F EV hall
FCU7	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	7F EV hall
HU-11	1	Air conditioner	52.00	29.00	6,100	2.20	0.75			Constant air volume									PC2	PH2	AHP	AHP	1F Office 1
HU-12	1	Air conditioner	41.00	21.00	5,100	2.20	0.75			Constant air volume									PC2	PH2	AHP	AHP	1F Office 2
HU-21	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	2F Office 1
HU-22	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	2F Office 2
HU-31	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	3F Office 1
HU-32	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	3F Office 2
HU-41	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	4F Office 1
HU-42	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	4F Office 2
HU-51	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	5F Office 1
HU-52	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	5F Office 2
HU-61	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	6F Office 1
HU-62	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	6F Office 2
HU-71	1	Air conditioner	95.00	47.00	11,600	5.50	1.50			Constant air volume									PC2	PH2	AHP	AHP	7F Office 1
HU-72	1	Air conditioner	82.00	39.00	10,100	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	7F Office 2



<Corresponding to data entry into "Form 2-7: (Air Conditioning) Air Conditioner">

⑬: With or without external air cut control

- The external air cut control (also called warming-up control) is to reduce external air loads by stopping the introduction of external air when starting up an air conditioner with no person in a room.
- Depending on whether or not the external air cut control is used, either "With" or "Without" needs to be input.

⑭: With or without external air cooling control

- The external air cooling control is to reduce heat quantity to be treated by a coil by introducing fresh external air more than necessary when the enthalpy of external air gets lower than that of indoor air while cooling operation.
- Depending on whether or not the external air cooling control is used, either "With" or "Without" needs to be input.

Example of Entry into Form 2-6: (Air Conditioning) Air Conditioner

AFTER (ZEB Ready equivalent)

① Name of air conditioner group	② Number of air conditioners [Units]	③ Type of air conditioner (Selection)	④ Rated cooling capacity [kW/unit]	⑤ Rated heating capacity [kW/unit]	⑥ Design maximum external air volume [m³/h/unit]	Rated power consumption of blower ⑦ Air supply [kW/unit]	⑧ Back-flow [kW/unit]	⑨ External air [kW/unit]	⑩ Exhaust [kW/unit]	⑪ Air volume control method (Selection)	⑫ Minimum air volume ratio under variable volume control [%]	⑬ With or without external air cut control (Selection)	⑭ With or without external air cooling control (Selection)	Total heat exchanger ⑮ With or without total heat exchanger (Selection)	⑯ Design air volume of total heat exchanger [m³/h/unit]	⑰ Total heat exchange efficiency [%]	⑱ With or without automatic ventilation switching function (Selection)	⑲ Power consumption of rotor [kW/unit]	Name of secondary pump group ⑳ Cold temperature (Transcription)	㉑ High temperature (Transcription)	Name of heat source group ㉒ Cold temperature (Transcription)	㉓ High temperature (Transcription)	㉔ Remarks (Symbol in equipment list and system name)
EHP1-1	1	Indoor unit	5.60	6.30	1,290	0.05				Constant flow		With	With								EHP1-1O	EHP1-1O	Central control room
	1	Total heat exchanger unit			200	0.17								With	200	60	With						
EHP1-2	1	Indoor unit	3.60	4.00	960	0.05				Constant flow		With	With								EHP1-2O	EHP1-2O	Changing room 1
	1	Total heat exchanger unit			150	0.17								With	150	60	With						
EHP1-3	1	Indoor unit	3.60	4.00	960	0.05				Constant flow		With	With								EHP1-3O	EHP1-3O	Changing room 2
	1	Total heat exchanger unit			150	0.17								With	150	60	With						
EHP1-4	1	Indoor unit	3.60	4.00	960	0.05				Constant flow		With	With								EHP1-4O	EHP1-4O	Resting room
	1	Total heat exchanger unit			300	0.17								With	300	60	With						
FCU1-1	1	FCU	6.79	6.77	1,020	0.08				Constant flow		With	With						PC2	PH2	AHP	AHP	1F Lobby
FCU1-2	1	FCU	2.70	2.62	360	0.04				Constant flow		With	With						PC2	PH2	AHP	AHP	1F EV hall
FCU2	1	FCU	2.70	2.62	360	0.04				Constant flow		With	With						PC2	PH2	AHP	AHP	2F EV hall
FCU3	1	FCU	2.70	2.62	360	0.04				Constant flow		With	With						PC2	PH2	AHP	AHP	3F EV hall
FCU4	1	FCU	2.70	2.62	360	0.04				Constant flow		With	With						PC2	PH2	AHP	AHP	4F EV hall
FCU5	1	FCU	2.70	2.62	360	0.04				Constant flow		With	With						PC2	PH2	AHP	AHP	5F EV hall
FCU6	1	FCU	2.70	2.62	360	0.04				Constant flow		With	With						PC2	PH2	AHP	AHP	6F EV hall
FCU7	1	FCU	2.70	2.62	360	0.04				Constant flow		With	With						PC2	PH2	AHP	AHP	7F EV hall
HU-11	1	Air conditioner	52.00	29.00	6,100	2.20	0.75			Rotation	50	With	With	With	1,800	60	With	0.2	PC2	PH2	AHP	AHP	1F Office 1
HU-12	1	Air conditioner	41.00	21.00	5,100	2.20	0.75			Rotation	50	With	With	With	1,300	60	With	0.2	PC2	PH2	AHP	AHP	1F Office 2
HU-21	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	2F Office 1
HU-22	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	2F Office 2
HU-31	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	3F Office 1
HU-32	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	3F Office 2
HU-41	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	4F Office 1
HU-42	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	4F Office 2
HU-51	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	5F Office 1
HU-52	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	5F Office 2
HU-61	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	6F Office 1
HU-62	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	6F Office 2
HU-71	1	Air conditioner	95.00	47.00	11,600	5.50	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	7F Office 1
HU-72	1	Air conditioner	82.00	39.00	10,100	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	7F Office 2

4) Energy Saving of Air-conditioning Systems (Example): Air-conditioning Control (External Air Cut and External Air Cooling Control)

<Corresponding to data entry into “Form 2-7: (Air Conditioning) Air Conditioner”>

⑮: With or without total heat exchanger

- Depending on whether or not a total heat exchanger is used, either “With” or “Without” needs to be input.

⑯: Design air volume of total heat exchanger

- A numerical value in the unit of m^3/h/unit can be input for the volume of air passing through a total heat exchanger with respect to each air conditioner.
- Introducing a total heat exchanger causes required fan static pressure to be increases and, therefore, the power consumption of AHU needs to be increased accordingly.

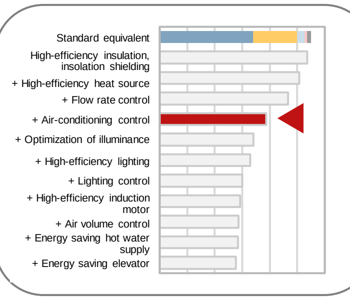
⑰: Total heat exchange efficiency

- A numerical value can be input for total heat exchanger efficiency of a total heat exchanger.
- In the case study, “60” is used assuming that a total heat exchanger has total heat exchange efficiency of 60%.

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 2-7: (Air Conditioning) Air Conditioner

① Name of air conditioner group	② Number of air conditioners [Units]	③ Type of air conditioner (Selection)	④ Rated cooling capacity [kW/unit]	⑤ Rated heating capacity [kW/unit]	⑥ Design maximum external air volume [m³/h/unit]	Rated power consumption of blower: ⑦ Air supply [kW/unit]	⑧ Back-flow [kW/unit]	⑨ External air [kW/unit]	⑩ Exhaust [kW/unit]	⑪ Air volume control method (Selection)	⑫ Minimum air volume ratio under variable volume control [%]	⑬ With or without external air cut control (Selection)	⑭ With or without external air cooling control (Selection)	Total heat exchanger: ⑮ With or without total heat exchanger (Selection)	⑯ Design air volume of total heat exchanger [m³/h/unit]	⑰ Total heat exchange efficiency [%]	⑱ With or without automatic ventilation switching function (Selection)	⑲ Power consumption of rotor [kW/unit]	Name of secondary pump group: ⑳ Cold temperature (Transcription)	㉑ High temperature (Transcription)	Name of heat source group: ㉒ Cold temperature (Transcription)	㉓ High temperature (Transcription)	㉔ Remarks (Symbol in equipment list and system name)
EHP1-1	1	Indoor unit	5.60	6.30	1,290	0.05				Constant air volume											EHP1-1O	EHP1-1O	Central control room
	1	Total heat exchanger unit			200	0.17																	
EHP1-2	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume											EHP1-2O	EHP1-2O	Changing room 1
	1	Total heat exchanger unit			150	0.17																	
EHP1-3	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume											EHP1-3O	EHP1-3O	Changing room 2
	1	Total heat exchanger unit			150	0.17																	
EHP1-4	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume											EHP1-4O	EHP1-4O	Resting room
	1	Total heat exchanger unit			300	0.17																	
FCU1-1	1	FCU	6.79	6.77	1,020	0.08				Constant air volume									PC2	PH2	AHP	AHP	1F Lobby
FCU1-2	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	1F EV hall
FCU2	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	2F EV hall
FCU3	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	3F EV hall
FCU4	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	4F EV hall
FCU5	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	5F EV hall
FCU6	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	6F EV hall
FCU7	1	FCU	2.70	2.62	360	0.04				Constant air volume									PC2	PH2	AHP	AHP	7F EV hall
HU-11	1	Air conditioner	52.00	29.00	6,100	2.20	0.75			Constant air volume									PC2	PH2	AHP	AHP	1F Office 1
HU-12	1	Air conditioner	41.00	21.00	5,100	2.20	0.75			Constant air volume									PC2	PH2	AHP	AHP	1F Office 2
HU-21	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	2F Office 1
HU-22	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	2F Office 2
HU-31	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	3F Office 1
HU-32	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	3F Office 2
HU-41	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	4F Office 1
HU-42	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	4F Office 2
HU-51	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	5F Office 1
HU-52	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	5F Office 2
HU-61	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	6F Office 1
HU-62	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	6F Office 2
HU-71	1	Air conditioner	95.00	47.00	11,600	5.50	1.50			Constant air volume									PC2	PH2	AHP	AHP	7F Office 1
HU-72	1	Air conditioner	82.00	39.00	10,100	3.70	1.50			Constant air volume									PC2	PH2	AHP	AHP	7F Office 2



Example of Entry into Form 2-7 (Air Conditioning): Air Conditioner

AFTER (ZEB Ready equivalent)

①	②	③	④	⑤	⑥	Rated power consumption of blower				⑪	⑫	⑬	⑭	Total heat exchanger					Name of secondary pump group		Name of heat source group		㉔
						⑦	⑧	⑨	⑩					⑮	⑯	⑰	⑱	⑲	⑳	㉑	㉒	㉓	
Name of air conditioner group	Number of air conditioners	Type of air conditioner	Rated cooling capacity	Rated heating capacity	Design maximum external air volume	Air supply	Back-flow	External air	Exhaust	Air volume control method	Minimum air volume ratio under variable volume control	With or without external air cut control	With or without external air cooling control	With or without total heat exchanger	Design air volume of total heat exchanger	Total heat exchange efficiency	With or without automatic ventilation switching function	Power consumption of rotor	Cold temperature	High temperature	Cold temperature	High temperature	Remarks (Symbol in equipment list and system name)
	[Units]	(Selection)	[kW/unit]	[kW/unit]	[m³/h/unit]	[kW/unit]	[kW/unit]	[kW/unit]	[kW/unit]	(Selection)	[%]	(Selection)	(Selection)	(Selection)	[m³/h/unit]	[%]	(Selection)	[kW/unit]	(Transcription)	(Transcription)	(Transcription)	(Transcription)	
EHP1-1	1	Indoor unit	5.60	6.30	1,290	0.05				Constant air volume		With	With								EHP1-1O	EHP1-1O	Central control room
	1	Total heat exchanger unit			200	0.17								With	200	60	With						
EHP1-2	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume		With	With								EHP1-2O	EHP1-2O	Changing room 1
	1	Total heat exchanger unit			150	0.17								With	150	60	With						
EHP1-3	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume		With	With								EHP1-3O	EHP1-3O	Changing room 2
	1	Total heat exchanger unit			150	0.17								With	150	60	With						
EHP1-4	1	Indoor unit	3.60	4.00	960	0.05				Constant air volume		With	With								EHP1-4O	EHP1-4O	Resting room
	1	Total heat exchanger unit			300	0.17								With	300	60	With						
FCU1-1	1	FCU	6.79	6.77	1,020	0.08				Constant air volume		With	With						PC2	PH2	AHP	AHP	1F Lobby
FCU1-2	1	FCU	2.70	2.62	360	0.04				Constant air volume		With	With						PC2	PH2	AHP	AHP	1F EV hall
FCU2	1	FCU	2.70	2.62	360	0.04				Constant air volume		With	With						PC2	PH2	AHP	AHP	2F EV hall
FCU3	1	FCU	2.70	2.62	360	0.04				Constant air volume		With	With						PC2	PH2	AHP	AHP	3F EV hall
FCU4	1	FCU	2.70	2.62	360	0.04				Constant air volume		With	With						PC2	PH2	AHP	AHP	4F EV hall
FCU5	1	FCU	2.70	2.62	360	0.04				Constant air volume		With	With						PC2	PH2	AHP	AHP	5F EV hall
FCU6	1	FCU	2.70	2.62	360	0.04				Constant air volume		With	With						PC2	PH2	AHP	AHP	6F EV hall
FCU7	1	FCU	2.70	2.62	360	0.04				Constant air volume		With	With						PC2	PH2	AHP	AHP	7F EV hall
HU-11	1	Air conditioner	52.00	29.00	6,100	2.20	0.75			Rotation	50	With	With	With	1,800	60	With	0.2	PC2	PH2	AHP	AHP	1F Office 1
HU-12	1	Air conditioner	41.00	21.00	5,100	2.20	0.75			Rotation	50	With	With	With	1,300	60	With	0.2	PC2	PH2	AHP	AHP	1F Office 2
HU-21	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	2F Office 1
HU-22	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	2F Office 2
HU-31	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	3F Office 1
HU-32	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	3F Office 2
HU-41	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	4F Office 1
HU-42	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	4F Office 2
HU-51	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	5F Office 1
HU-52	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	5F Office 2
HU-61	1	Air conditioner	87.00	43.00	10,000	3.70	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	6F Office 1
HU-62	1	Air conditioner	75.00	36.00	8,800	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	6F Office 2
HU-71	1	Air conditioner	95.00	47.00	11,600	5.50	1.50			Rotation	50	With	With	With	3,000	60	With	0.2	PC2	PH2	AHP	AHP	7F Office 1
HU-72	1	Air conditioner	82.00	39.00	10,100	3.70	1.50			Rotation	50	With	With	With	2,500	60	With	0.2	PC2	PH2	AHP	AHP	7F Office 2

Reference Information

Other Important Energy Saving Technologies (Example): Heat Source (1/4)

* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

Optimizing Control of Preset Outlet Temperatures of Heat Source Equipment

Outline of technology

- The capacity of air conditioners and heat source equipment is designed in consideration of safety factors and future increments in loads. However, there may be cases where such design is based on low load factors and low efficiency operation (larger energy consumption) except at peak times of cooling and heating operation.
- Thus, considering seasonal changes in air-conditioning demands and the fluctuation of use states of buildings (cooling and heating loads), optimizing control of preset outlet temperatures of cold and hot water enables heat source equipment to be operated with high efficiency, thereby contributing to the reduction in primary energy consumption.

Energy saving effects

<Heat pump chiller>

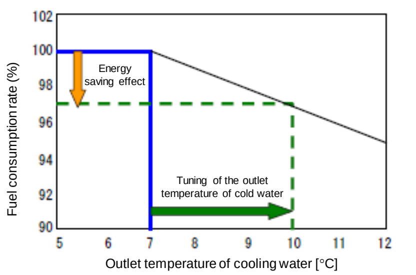
- Cooling operation: Setting a high outlet temperature of cold water enables compressive drive force per refrigerating capacity to be saved in a manner that reduces pressure head of a coolant with its evaporation temperature increased.
- Heating operation: Setting a low outlet temperature of hot water enables compressive drive force to be saved with pressure head reduced.

<Turbo refrigerator>

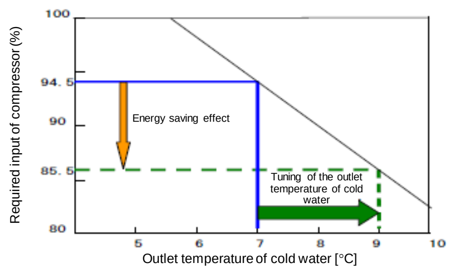
- General turbo refrigerators are water-cooled types exclusively used for cooling operation. Thus, setting a high outlet temperature of cold water enables compressive drive force to be saved as is the case with heat pump chiller.

< Hot-and-chilled-water generator >

- Cooling operation: Setting a high outlet temperature of cold water enables fuel consumption rates to be reduced when an operation load is low. Particularly, a high outlet temperature with a small difference from external temperature can significantly save fuel consumption with heat losses due to absorption and dew condensation reduced.
- Heating operation: Setting a low outlet temperature of hot water enables heat loss due to radiation from piping systems to be reduced.



Outlet temperature and fuel consumption efficiency of hot-and-chilled-water generator



Outlet temperature and fuel consumption efficiency of turbo refrigerator

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Reference Information

Other Important Energy Saving Technologies (Example): Heat Source (2/4)

*** Out of scope of the case study**

*** Calculation is not available with the energy consumption performance calculation program**

Regional Energy Use

Outline of technology

- On the one hand, consolidating and integrally controlling high-efficiency equipment can enhance energy saving effects but on the other hand they can be factors increasing energy consumption due to the increases in heat loss in piping and delivery power when delivering cold and hot water. Thus, in order to save primary energy consumption, it is necessary to comprehensively design and control heat source equipment so as to make an overall energy saving effect larger than an overall energy increasing effect.
- Primary energy consumption can also be saved by effectively utilizing untapped energy, such as exhaust heat of waste incineration plants or factories, to which individual business enterprises are not accessible.

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Classification	Scale	Agreement, etc.	Supplier	Supply method	Others
① Heat supply project type (Energy supply by a large energy plant (Note 1) to a wide consuming area)	Large	Energy supply regulation based on the Heat Supply Business Act	Heat supply operator based on the Act	Mandatory energy supply based on the Heat Supply Business Act (with energy supply conditions according to the regulation) Electric power supply has been implemented in some cases.	The procedure required for the permission of road occupancy corresponds to that of mandatory occupancy.
② Consolidated plant type (Energy supply by consolidated energy plants to small-scale special consuming area)	Medium to small	Agreement between suppliers and consumers	Energy suppliers based on agreement	Mandatory energy supply based on agreement (Less cases than ①. Supply conditions according to agreement)	Road occupancy is legally permissible and there are actual cases of road occupancy.
③ Inter-building energy sharing type (Collaborative energy supply and reception or shared energy consumption among neighboring buildings)	Small	Mutual agreement among building owners	Plural building owners	Mutually agreed method	Road occupancy is legally permissible (Note 2).

Note 1: Heat source equipment such as heat pump, cogeneration and boiler.
Note 2: Currently, there are very few cases of road occupancy.

Heat supply project type

Consolidated plant type

Inter-building energy sharing type

Source: "Investigation report on the regional energy use," the Regional Energy Use Promotion Committee

Regional Energy Use (continued)

Energy saving effects

① Effect due to the consolidation of scale

- The regional energy use enables: high-efficiency equipment to be adopted through the effects of consolidating regional energy loads; and partial loads to be efficiently dealt with through appropriate allocation of equipment. Also, regional energy use facilitates the sophistication of operation and maintenance through sensitive operation control and appropriate maintenance. Regarding the energy loss effect due to the increases in the heat loss and delivery power associated with cold and hot water delivery, appropriate formulation and operation of a regional energy use system can make overall energy saving effect larger than overall energy loss effect.
- What follows is an example of the estimated energy saving effects of regional energy use by effect factor obtained by comparing the energy saving and loss effects of respective factors between an energy system of an individual building and general regional energy use.

Example of the estimated energy saving effects of regional energy use

Factor	Effect (Note) (Energy saving rate compared to individual energy system): Increase in energy consumption	Energy saving
○Consolidation effect • Equalization of energy demands • Appropriate allocation of equipment • Introduction of high-efficiency equipment		16%
○Operation and maintenance • Sensitive operation control • Appropriate maintenance		9%
○Increase in heat loss from piping • Heat loss due to the extension of piping	▲10%	
○Increase in delivery power • Increase in power demand due to the extension of piping • Cooling water (hot water) pumps	▲3%	
Total		12%

Source: The Japan Heat Supply Business Association

(Note) Estimation result in the commissioned investigative research conducted by the Japan Heat Supply Business Association in 2004 following "(2002 Investigation Commissioned by the Ministry of Economy, Industry and Trade) Report on the Basic Investigation to Promote the Introduction of New Energy in 2002 (Investigation for the Development of Infrastructure to Introduce Untapped Energy Use), March 2003"

Energy saving effects

② Effects due to untapped energy utilization

- When untapped energy such as urban exhaust heat and temperature difference energy generated by heat pumps is available nearby, the introduction of regional energy use comprising heat recovery plants with centrally controlled heat pumps or a regional piping network with heat storage facilities enables those individual buildings, which cannot utilize untapped energy due to the problems with mismatch between demand and supply, investment capability and compatibility with the public nature of untapped energy, to overcome these problems and access such untapped energy. Untapped energy is abundant in urban areas and will enable large energy saving effects to be achieved once proactively utilized through regional energy use and largely contribute to saving the consumption of exhaustible resources.

Source: "Investigation report on the regional energy use," the Regional Energy Use Promotion Committee

Other Important Energy Saving Technologies (Example): Heat Source (4/4)

* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

Ground Source Heat Pumps

Utilization of earth thermal energy as temperature difference between above ground and underground

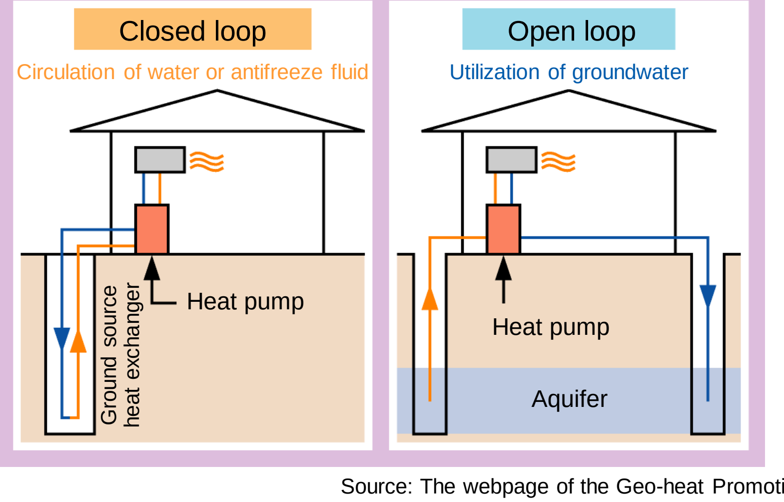
- Earth thermal energy is defined as “energy utilizing such thermal property of underground that daily and seasonal temperature differences are small.” In Japan having four distinct seasons, temperature differences between summer and winter reach close to 30°C above ground; however, the temperature at a depth of 10 m from ground surface is almost constant throughout the year. The underground temperature at that depth is almost equal to the annual average temperature above ground for example about 20°C in the south parts of Shikoku and Kyushu, about 10°C in Hokkaido and about 17°C in Tokyo and Osaka. Thus, underground which is warm in winter and cool in summer produces temperature differences from above ground of 10°C and 15°C in winter and summer respectively. Focusing on the temperature differences, ground source heat pumps are designed to utilize earth thermal energy.

Mechanism of ground source heat pumps

- Ground source heat pumps are the systems used for cooling and heating houses and buildings and supplying hot water to them, supplying hot water to pools and hot bath facilities, melting snow on roads, and cooling and heating agricultural greenhouses. They are classified into “closed loop type” and “open loop type.”

① Closed loop type
- The closed loop type has a mechanism to circulate fluid through a ground heat exchanger to take earth heat from the ground. The fluid transfers earth heat to a heat pump which converts the transferred earth heat into the heat in an intended temperature range for effective cooling, heating and hot water supply operation. The fluid is normally antifreeze fluid or water and there has been development of a method using coolants as the fluid.
- Because the closed loop type requires almost no maintenance, it has wide scope of application including houses, buildings, pools and snow melting.

② Open loop type (groundwater heat use heat pump system, groundwater use heat pump system)
- The open loop type has a mechanism to pump up groundwater and takes heat of pumped groundwater with a heat pump on the ground. There are several methods for treating the groundwater undergoing heat exchange through a heat pump. These methods include: one which returns the groundwater to original aquifer; one which returns the groundwater to a different aquifer; and one which discharges the groundwater into a surface flow.
- The open loop type is economically superior to the close loop type in terms of available heat quantity per borehole but requires maintenance for possible clogging inside boreholes. The open loop type has been frequently used in large-scale facilities but is difficult to be applied to areas subject to the limitation in groundwater use.



Source: The webpage of the Geo-heat Promotion Association of Japan

Reference Information

Other Important Energy Saving Technologies (Example): Cooling Tower

* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

Quantity and Start-stop Control of Cooling Tower Fans

Outline of Technologies

- The quantity control or start-stop control of cooling tower fans, etc. (including water spray pumps in the case of sealed type cooling towers), for adjusting cooling water temperatures to set values on the basis of that detected by temperature sensors installed at the side of cooling water outlets on cooling towers, enables cooling towers to be efficiently operated according to loads, thereby contributing to the reduction in primary energy consumption.
- In the cases where the output of motors of individual cooling tower fans is less than 11 kW each, only the quantity control or start-stop control is not sufficient to perform sensitive control according to loads. In such cases, the primary energy consumption reduction effects can be enhanced by using pole change control or invertor control in addition to the quantity or start-stop control.

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Invertor Control of Cooling Tower Fan

Outline of technology

- The invertor control of a cooling tower fan enables primary energy consumption to be reduced through optimal operation of the fan particularly in low load times.

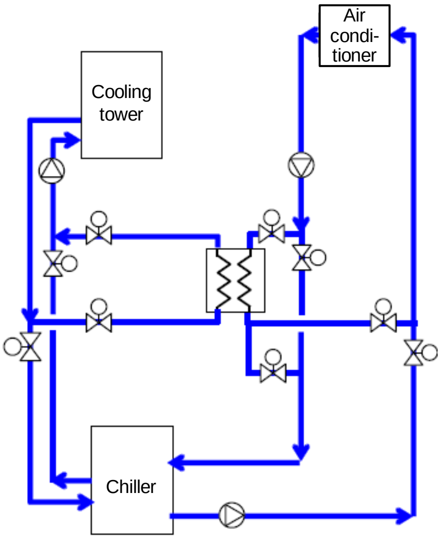
Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Free Cooling System

Outline of technology

- The system is to save heat source energy by producing cold water not with a chiller but with a cooling tower in winter by using chilled external air, thereby reducing primary energy consumption.
- Preliminarily cooling water through a free cooling system before sending it to an inlet of a chiller can increase the operation hours of the free cooling system throughout the year, thereby contributing the reduction in primary energy consumption.
- In Tokyo metropolitan area, it is difficult to produce cold water at a temperature equal to or lower than 8°C because the temperatures of external air do not drop much. Thus, it is necessary to use the free cooling system for preliminarily cooling of a chiller or to use cold water with its operation temperature increased to around 15°C.

Example of free cooling system



Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Reference Information

Other Important Energy Saving Technologies (Example): Pump (1/2)

* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

Variable Volume Control of Cooling Water Pump

Outline of technology

- When a chiller is subject to partial load operation, the variable volume control with an inverter by detecting the outlet temperature of cooling water enables water delivery energy to be reduced, thereby contributing to the reduction in primary energy consumption.
- It is necessary to examine the possibility of introducing the variable volume control of a cooling water pump because there may be a case where constant flow control with the temperature of cooling water reduced is superior to variable volume control in terms of energy efficiency depending on the types of heat source equipment.

Source: Modification of the “Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016,” Bureau of Environment, Tokyo Metropolitan Government

Variable Volume Control of Air-conditioning Primary Pump

Outline of technology

- Heat source equipment compatible with variable volume control enables a flow rate to be reduced to 50 to 70% of rated one. Therefore, the quantity control of air-conditioning primary pumps or the variable volume control of an air-conditioning primary pump with an inverter enables delivery energy to be reduced, thereby contributing to the reduction in primary energy consumption.
- It is necessary to secure the minimum flow rates of heat source equipment when using the quantity control of air-conditioning primary pumps or the variable volume control of an air-conditioning primary pump with an inverter.

Source: Modification of the “Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016,” Bureau of Environment, Tokyo Metropolitan Government

Appropriate Allocation of Capacity to Air-conditioning Secondary Pumps and Small-capacity Pumps

Outline of technologies

- Air-conditioning secondary pumps vary flow rates according to heat loads. Thus, the load-follow quantity control based on either load flow rates or load heat quantity enables air-conditioning secondary pumps to be efficiently operated according to loads, thereby contributing to the reduction in primary energy consumption.
- Actual heat loads of air-conditioning secondary pumps are 10% or less of their heat capacity most of the operating time. Thus, introducing air-conditioning secondary pumps with capacity appropriate for the actual loads enables delivery energy to be reduced.
- When loads are low, only one pump is operated. Thus, the valuable volume control according to load flow rates with an inverter enables delivery energy to be reduced.
- If each pump is provided with an inverter, parallel operation of plural inverter pumps can lower frequency to output minimum pressure, thereby achieving larger reduction in primary energy consumption than the case of combined operation of rated pumps and inverter pumps.

Source: Modification of the “Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016,” Bureau of Environment, Tokyo Metropolitan Government

Other Important Energy Saving Technologies (Example): Pump (2/2)

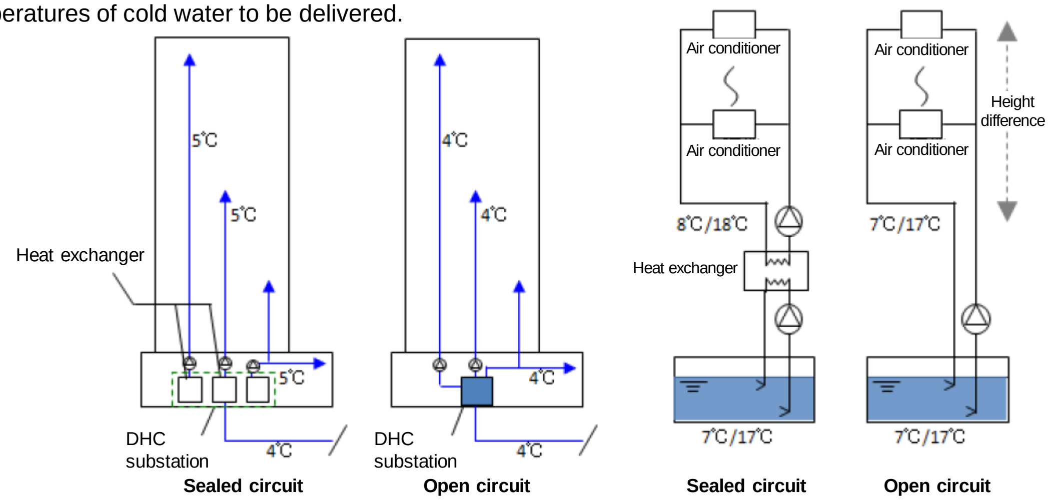
* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

Sealing of Water Delivery Passage

Outline of technology

- Applying sealed circuits to cold and hot water piping systems enables pump head to be determined only by the head loss of piping regardless of the actual pump head depending on building heights, thereby contributing to the reduction in primary energy consumption. Regarding the heat storage systems, because they comprise open circuits, it is important to applied sealed circuits to the secondary side of the heat storage tank (the side of air conditioners) in a manner that isolates the secondary circuits from primary ones and interlinks the two circuits through heat exchangers.
- In the case of superhigh-rise buildings and high-rise buildings connected to district heating and cooling through a breed-in system which does not isolate the district heating and cooling from the secondary circuits of individual buildings with heat exchangers, these buildings need energy for booster pumps which pump water up to the actual pump head depending on building heights, thereby requiring large water delivery power even when delivering small volume of water. Using indirect connection of the secondary circuits of individual buildings to district heating and cooling through heat exchangers enables the deliver power to be reduced in exchange of the increase in the temperatures of cold water to be delivered.



Sealed and open circuits designed for DHC

Sealed and open circuits designed for heat storage system

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Piping Friction Reducing Agent

Outline of technology

- The piping friction reducing agent is composed mostly of a surface-activating agent and can reduce water delivery energy through the reduction in friction resistance of piping. Combined with the inverter control of cooling water pumps, the piping friction reducing agent contributes to reducing primary energy consumption.
- Because the piping friction reducing agent has heat transfer property similar to water, it can be directly used for existing absorption chiller heaters and air conditioners without requiring their remodeling.
- The piping friction reducing agent is particularly effective when applied to cooling water piping in large-scale buildings.

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Reference Information

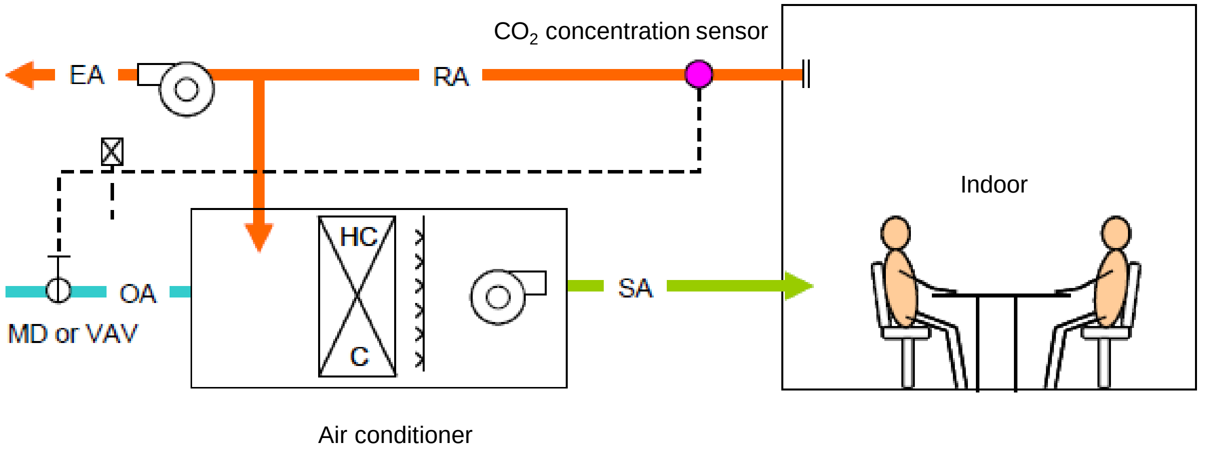
Other Important Energy Saving Technologies (Example): General Air Conditioning (1/3)

* Out of scope of the case study
* Calculation is not available with the energy consumption performance calculation program

External Air Volume Control based on CO_2 Concentration

Outline of technology

- The external air volume control based on CO_2 concentration enables an external air load to be reduced in a manner that controls the volume of external air to be introduced into a room appropriate for the number of persons in the room by detecting CO_2 concentration, thereby contributing to the reduction in primary energy consumption.
- The external air volume control based on CO_2 concentration is particularly effective when applied to facilities accommodating a large number of users with large fluctuation in the number of users by hour.
- In many cases, the actual number of users is smaller than designed one and, therefore, introducing the external air volume control based on CO_2 concentration is expected to produce an energy saving effect in these cases.
- Depending on surrounding environments and locations, there may be a case where the CO_2 concentration of external air is higher than that of indoor air. Thus, it is necessary to confirm the appropriateness of external air volume to be introduced.

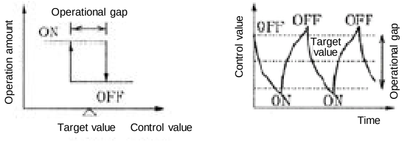
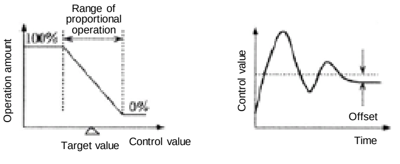


Source: Modification of the “Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016,” Bureau of Environment, Tokyo Metropolitan Government

Proportional Control of Fan Coil Unit

Outline of technology

- The proportional control of the flow rates of cold and hot water depending on air-conditioning loads can reduce the flow rates of cold and hot water when the load is low and thereby contributing to the reduction in primary energy consumption.
- The proportional control of fan coil unit is classified into: a method to control a control valve so as to adjust indoor temperatures to set values on the basis of the indoor temperatures detected through the indoor temperature sensors (built into remote controllers or installed at suction ports of fan coil units); and a method to control a control valve so as to adjust the temperatures of air returning to a fan coil unit to set values.
- In the proportional control, there may be a case where an actual control value in equilibrium is different from a preset control value (offset). Thus, it is necessary to manually correct the preset control value at fixed intervals.
- Also, in the case of the proportional control based on the temperatures of air returning to a fan coil unit, energy saving cannot be achieved some times with the temperatures of air returning to a fan coil unit during cooling operation constantly higher than set temperatures due to heat generated by lighting fixtures. Thus, it is necessary to pay careful attention to set temperatures.

No control	Interlock	On-off control	Proportional control
Cold and hot water is delivered through the operation of a heat source.	When cooling or heating operation is stopped with start-up states of fans undetected through a distribution board, cold water or hot water valves are fully closed.	Not appropriate for air conditioners subject to sensitive control. 	Stable control even with fluctuation in loads 

Small — Energy saving effect → Large

Control methods of valves on fan coil unit

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

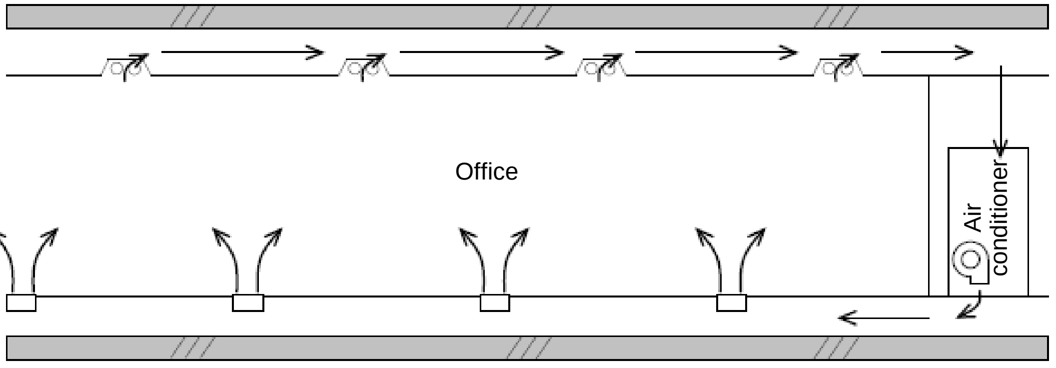
Other Important Energy Saving Technologies (Example): General Air Conditioning (3/3)

* Out of scope of the case study
* Calculation is not available with the energy consumption performance calculation program

Floor Air-conditioning System

Outline of technology

- The floor air-conditioning system is to supply air-conditioning air through an underfloor space or an underfloor duct and supply openings on a floor surface for the purpose of the efficient elimination of internal heat and the enhancement of comfortability in indoor spaces. Through the efficient air conditioning using temperature differences between upper and lower spaces in rooms, the floor air-conditioning system contributes to the reduction in primary energy consumption.
- Because the system can reduce the quantity of ducts, it can also reduce energy required for delivering air.
- Since the system has a risk of conducting heat to structures, it is necessary to securely insulate air passages. Also, in the case of SRC structures through dry construction with PC panels, it is necessary to pay attention to a leakage of air-conditioning air due to poor airtightness and the distances between supply openings and an air conditioner.

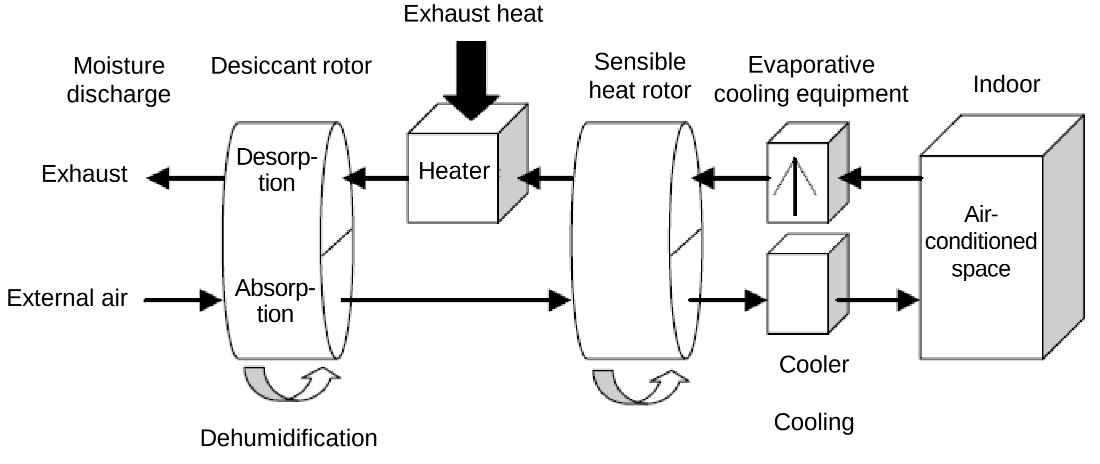


Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

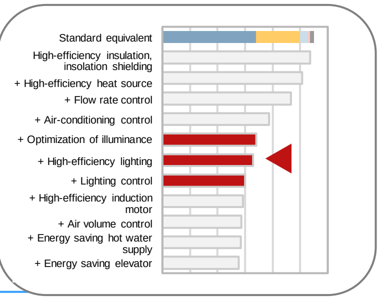
Desiccant Air-conditioning System

Outline of technology

- The desiccant air-conditioning system can save energy because it does not require reheating energy to prevent supercooling as is not the case with a cooling and dehumidification system using a cooling coil and enables exhaust heat to be utilized as a heat source for regenerating desiccants, thereby contributing to the reduction in primary energy consumption.
- Also, because the system is capable of controlling temperatures and humidity separately as well as performing high-temperature-low-humidity cooling and low temperature-high-humidity heating, it can reduce the loads of heat source equipment, thereby contributing to the reduction in primary energy consumption.



Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government



4.2 Lighting Systems

Purposes of Introducing the Technology

To appropriately control lighting energy

- In order to save lighting energy consumption, it is necessary to reduce artificial lighting energy while compensating for the lack of illuminance of daylight and providing light environments appropriate for nighttime work in respective spaces.

- A lighting system plan is expected to produce higher energy saving effects if it enables lighting systems to be appropriately controlled through the combined use of conventional technologies with daylight utilization technologies such as daylighting and daylight guiding.

- The approaches toward enhancing the efficiency of lighting systems are threefold: ❶ optimization of illuminance; ❷ high-efficiency lighting (the enhancement of efficiency of lighting fixtures themselves); and ❸ lighting control (the enhancement of efficiency through control).

Approaches toward Enhancing the Efficiency of Lighting Systems

❶ Optimization of illuminance

- The illuminance of typical offices has been set at 750 lx; however, the popularization of PCs in recent years has changed working styles in offices and commonly required offices to provide light environments different from those for conventional working styles based on print media. Thus, optimizing set illuminance contributes to the reduction in lighting energy consumption.

❷ High-efficiency lighting (the enhancement of efficiency of lighting fixtures)

- The enhancement of the efficiency of light sources for lighting have progressed in the order of incandescent lights, fluorescent lights (FL type), high-efficiency fluorescent lights (Hf type) and LEDs. In terms of an index “lm/W” which is a ratio of the amount of light emitted from a light source (light flux in the unit of lm (lumen)) to the power consumed by the light source (in the unit of W) and commonly used to express the efficiency of light sources, LEDs have high index values representing their efficiency to produce many times more light fluxes with same power compared to other light sources, thereby contributing to the reduction in power consumption.

❸ Lighting control

- The major lighting control methods include: on-off control according to time schedules; automatic dimming control with light sensors; automatic dimming and on-off control with motion sensors; and the combinations of above control methods.

- The automatic dimming control with light sensors is to automatically dim artificial lighting so as to adjust the illuminance on the surfaces of desks or floors to set illuminance (target illuminance) and an indispensable method to realize energy saving through daylight utilization.

- Arbitrary values can be set for the target illuminance in a manner, for example, that enables the target illuminance of ambient lighting to be set at 300 lx while task lighting is used. Also, control units can be arbitrarily set. Controlling lighting systems with finely tuned ranges enables lighting to be tailored to personal preferences, thereby contributing to the enhancement of the satisfaction of workers.

- When performing lighting control, it is necessary to pay attention to the consistency of the space units of lighting control with the space units of room use and the directions of guiding daylight.

Target Levels of Lighting Systems

- When realizing a building satisfying ZEB Ready (energy saving rate of 50%), it is necessary to introduce lighting systems with **lighting BEI of 0.20 to 0.50 (reduction in lighting energy consumption of 50 to 80% with respect to a reference value: for the example of the case study, refer to the followings)**.

- As previously mentioned, the target levels of lighting systems can be achieved through ❶ optimization of illuminance; ❷ high-efficiency lighting (the enhancement of efficiency of lighting fixtures themselves); and ❸ lighting control (the enhancement of efficiency through control).

Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program

- The targets of energy saving effect and approximate construction cost of main lighting systems are as follows. The processes of calculating the energy saving effect using the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017) are explained on the following pages.

Example of technologies for ZEB Ready (those in orange cells are used in the case study)

○: Technology applicable to the evaluation with the program, △: Technology requiring attention when evaluated with the program, ×: Technology difficult to be evaluated with the program

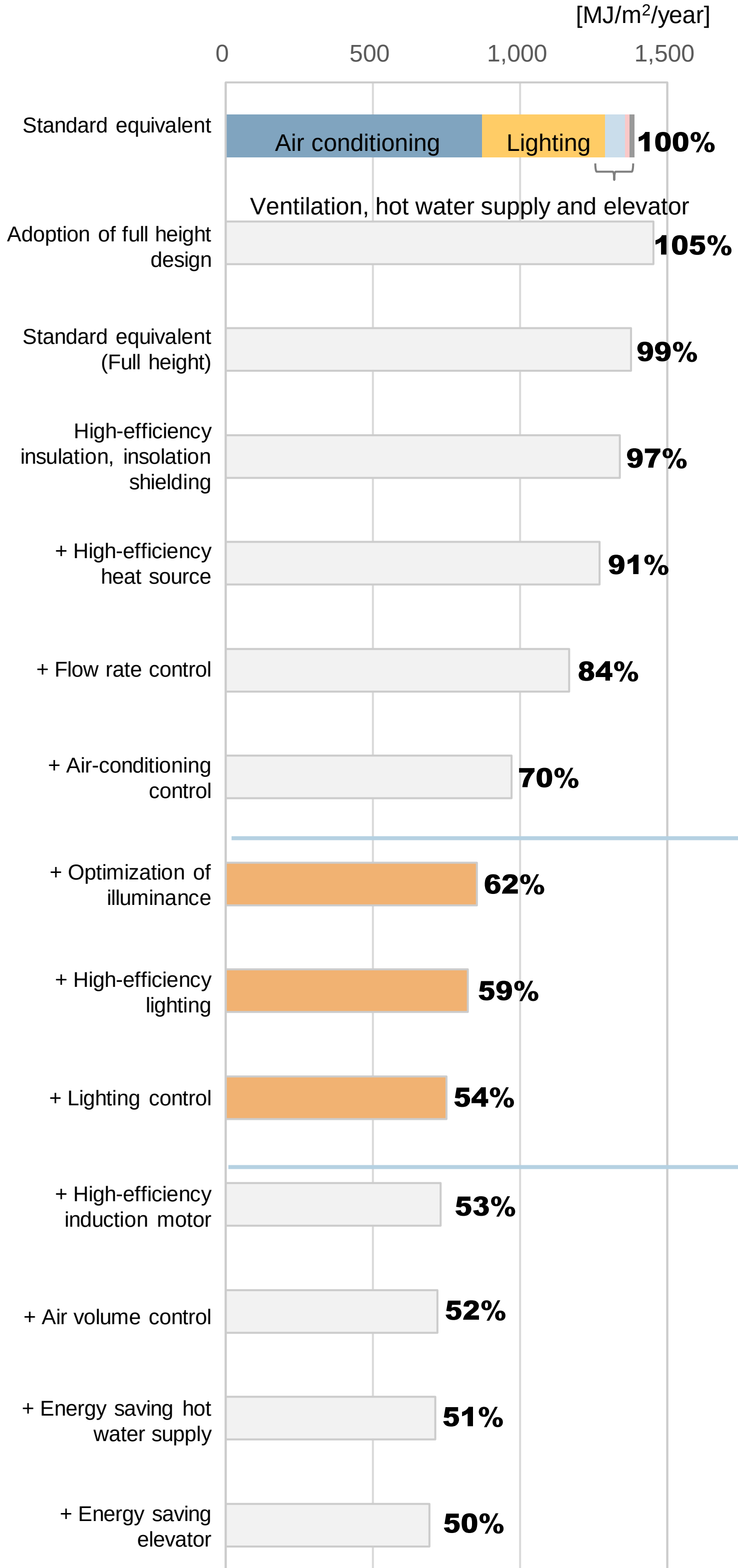
Energy saving of lighting system (example)			Applicability of energy consumption performance calculation program	Energy saving effect (target)	Approximate cost increment (target)
❶ Optimization of illuminance		Adoption of the illuminance of 500 lx	△ Incorporated in the reduction in rated power consumption	8%	About 47 million yen (Note)
❷ High-efficiency lighting		High-efficiency lighting fixture	○	2%	
❸ Lighting control	Lighting control	Motion detection control	○	5%	About 9 million yen
		Daylight utilization lighting control	○		
		Time schedule control	○		
		Initial illuminance control	○		
	Lighting control (out of scope of the case study)	Automatic on-off control based on luminance detection	○		
		Task-ambient lighting system	△ Incorporated in the reduction in rated power consumption		
		Zoning control	×		
		Fragmentation of lighting control unit	×		

Note: The estimation of the cost increment due to the "optimization of illuminance" is combined with the estimation of cost decrement due to the reduction in the number of lighting fixtures as a result of introducing "high-efficiency lighting."

Source: Modification of the material by the ZEB Road Map Examination Committee

Case Study Result of Office Building Realizing ZEB Ready

Note: "The energy saving effect" is a result of calculating combined effect of plural technologies and does not necessarily correspond to the accumulated total of energy saving effects of individual technologies.



	Energy saving technology	Energy saving effect[Note]
Passive technology **Envelope insulation, Insolation shielding**	· High-performance insulation material · High insulation window · Canopy and louver	8%
Active technology **Air-conditioning system**	· High-efficiency heat source	6%
	· Large temperature difference water delivery · Variable water volume control	7%
	· Total heat exchanger · Variable air volume control · External air cut · External air cooling control	14%
Active technology **Lighting system**	· Adoption of the illuminance of 500 lx (Office)	8%
	· LED lighting	2%
	· Motion detection control · Time schedule control · Initial illuminance correction · Luminance detection control	5%
Active technology **Ventilation system**	· High-efficiency induction motor, invertor	1%
	· Temperature control (Machine room)	1%
Active technology **Hot water supply system**	· Automatic hot water faucet	Less than 1%
Active technology **Elevator system**	· VVVF (with power regeneration, gearless)	1%

1) High-efficiency Lighting (Introduction of LEDs)

<Corresponding to data entry into “Form 4: (Lighting) Lighting”>

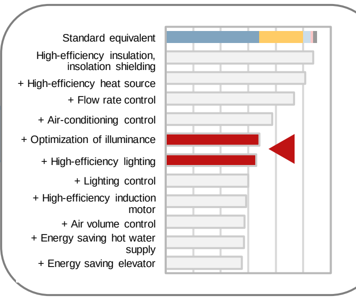
⑥: Rated power consumption

- Numerical values in the unit of W/unit can be input for the power consumption of each lighting fixture (including a stabilizer). Such numerical values can be those corresponding to intended lighting fixtures listed in the “Guide No. 114: Reference Values for Power Consumption of Lighting Fixtures to Calculate Lighting Energy Consumption Coefficients” by the Japan Lighting Manufacturers Association.
- In the case study, the rated power consumption is input assuming the use of LEDs.

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 4: (Lighting) Lighting

①	①	①	①	①	①	①	Room index ②	③	④	Specifications of lighting fixture ⑤	⑥	⑦	With or without control ⑧	⑨	⑩	⑪
Floor	Room name	Use of building	Use of room	Room area	Floor height	Ceiling height	Width of room	Depth of room	Room index	Name of fixture	Rated power consump-tion	Number of units	Motion detection control	Luminance detection control	Time schedule control	Initial illuminance correction function
				[m²]	[m]	[m]	[m]	[m]	[-]	(Symbol in lighting fixture list, etc.)	[W/unit]	[Unit]				
(Tran-scription)	(Transcription)	(Transcription)	(Transcription)	(Transcrip-tion)	(Transcrip-tion)	(Transcrip-tion)							(Selection)	(Selection)	(Selection)	(Selection)
1F	Windbreak room	Office, etc.	Hallway	21.12	5	2.6	3.3	6.4			35	4	Without	Without	Without	Without
1F	Lobby	Office, etc.	Lobby	114.12	5	3.5	10	11.412			87	24	Without	Without	Without	Without
1F	EV hall	Office, etc.	Hallway	16.32	5	3.5	3.4	4.8			35	4	Without	Without	Without	Without
1F	Central control room and guard room	Office, etc.	Central control room	39	5	2.6	6	6.5			48	10	Without	Without	Without	Without
1F	Changeroom 1	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25			48	3	Without	Without	Without	Without
1F	Changeroom 2	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25			48	3	Without	Without	Without	Without
1F	Resting room	Office, etc.	Changeroom or warehouse	29.25	5	2.4	3.25	9			48	5	Without	Without	Without	Without
1F	Vending machine corner	Office, etc.	Hallway	25.87	5	2.6	6.5	3.98			35	5	Without	Without	Without	Without
1F	Toilet 1	Office, etc.	Toilet	33.28	5	2.4	3.25	10.24			35	10	Without	Without	Without	Without
1F	Toilet 2	Office, etc.	Toilet	33.7675	5	2.4	3.25	10.39			35	10	Without	Without	Without	Without
1F	DS・PS1	Office, etc.	Machine room	5.76	5	5	3.2	1.8			48	1	Without	Without	Without	Without
1F	DS・PS2	Office, etc.	Machine room	14.4	5	5	3	4.8			48	2	Without	Without	Without	Without
1F	ES1	Office, etc.	Machine room	8.64	5	5	1.8	4.8			48	1	Without	Without	Without	Without
1F	ES2	Office, etc.	Machine room	9.6	5	5	2	4.8			48	1	Without	Without	Without	Without
1F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	5	5	2.3	3.3			48	2	Without	Without	Without	Without
1F	Kettle room	Office, etc.	Kettle room, etc.	5.28	5	2.4	1.6	3.3			48	1	Without	Without	Without	Without
1F	Machine room 1	Office, etc.	Machine room	164.312	5	5	15.2	10.81			48	16	Without	Without	Without	Without
1F	Machine room 2	Office, etc.	Machine room	45.5	5	5	7	6.5			48	5	Without	Without	Without	Without
1F	Electric rom	Office, etc.	Electric rom	50	5	5	5	10			48	5	Without	Without	Without	Without
1F	Office 1	Office, etc.	Office	352.5	5	2.6	23.5	15			95	61	Without	Without	Without	Without
1F	Office 2	Office, etc.	Office	252	5	2.6	16.8	15			95	44	Without	Without	Without	Without
1F	Hallway	Office, etc.	Hallway	149.25	5	2.4	2.2	67.84			35	28	Without	Without	Without	Without
1F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
1F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without
2F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8			35	4	Without	Without	Without	Without
2F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98			35	5	Without	Without	Without	Without
2F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24			35	10	Without	Without	Without	Without
2F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39			35	10	Without	Without	Without	Without
2F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8			48	1	Without	Without	Without	Without
2F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8			48	2	Without	Without	Without	Without
2F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8			48	1	Without	Without	Without	Without
2F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8			48	1	Without	Without	Without	Without
2F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3			48	2	Without	Without	Without	Without
2F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3			48	1	Without	Without	Without	Without
2F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5			48	5	Without	Without	Without	Without
2F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15			95	103	Without	Without	Without	Without
2F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15			95	86	Without	Without	Without	Without
2F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1			35	22	Without	Without	Without	Without
2F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
2F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without
3F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8			35	4	Without	Without	Without	Without
3F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98			35	5	Without	Without	Without	Without
3F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24			35	10	Without	Without	Without	Without
3F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39			35	10	Without	Without	Without	Without
3F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8			48	1	Without	Without	Without	Without
3F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8			48	2	Without	Without	Without	Without
3F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8			48	1	Without	Without	Without	Without
3F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8			48	1	Without	Without	Without	Without
3F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3			48	2	Without	Without	Without	Without
3F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3			48	1	Without	Without	Without	Without
3F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5			48	5	Without	Without	Without	Without
3F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15			95	103	Without	Without	Without	Without
3F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15			95	86	Without	Without	Without	Without
3F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1			35	22	Without	Without	Without	Without
3F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
3F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without



Example of Entry into Form 4: (Lighting) Lighting

AFTER
(ZEB Ready equivalent)

①	①	①	①	①	①	①	Room index			Specifications of lighting fixture			With or without control			
Floor (Tran-scription)	Room name (Transcription)	Use of building (Transcription)	Use of room (Transcription)	Room area [m²] (Transcrip-tion)	Floor height [m] (Transcrip-tion)	Ceiling height [m] (Transcrip-tion)	② Width of room [m]	③ Depth of room [m]	④ Room index [-]	⑤ Name of fixture (Symbol in lighting fixture list, etc.)	⑥ Rated power consump-tion [W/unit]	⑦ Number of units [Unit]	⑧ Motion detection control (Selection)	⑨ Luminance detection control (Selection)	⑩ Time schedule control (Selection)	⑪ Initial illuminance correction function (Selection)
1F	Windbreak room	Office, etc.	Hallway	21.12	5	2.6	3.3	6.4		LED	19.2	4	Without	On-off control	On-off control	Without
1F	Lobby	Office, etc.	Lobby	114.12	5	3.5	10	11.412		LED	19.2	24	Without	On-off control	On-off control	Without
1F	EV hall	Office, etc.	Hallway	16.32	5	3.5	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
1F	Central control room and guard room	Office, etc.	Central control room	39	5	2.6	6	6.5		LED	31	10	Without	Without	Without	Without
1F	Changeroom 1	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25		LED	31	3	On-off control	Without	Without	Without
1F	Changeroom 2	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25		LED	31	3	On-off control	Without	Without	Without
1F	Resting room	Office, etc.	Changeroom or warehouse	29.25	5	2.4	3.25	9		LED	31	5	On-off control	Without	Without	Without
1F	Vending machine corner	Office, etc.	Hallway	25.87	5	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
1F	Toilet 1	Office, etc.	Toilet	33.28	5	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
1F	Toilet 2	Office, etc.	Toilet	33.7675	5	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
1F	DS・PS1	Office, etc.	Machine room	5.76	5	5	3.2	1.8		LED	31	1	Without	Without	Without	Without
1F	DS・PS2	Office, etc.	Machine room	14.4	5	5	3	4.8		LED	31	2	Without	Without	Without	Without
1F	ES1	Office, etc.	Machine room	8.64	5	5	1.8	4.8		LED	31	1	Without	Without	Without	Without
1F	ES2	Office, etc.	Machine room	9.6	5	5	2	4.8		LED	31	1	Without	Without	Without	Without
1F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	5	5	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
1F	Kettle room	Office, etc.	Kettle room, etc.	5.28	5	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
1F	Machine room 1	Office, etc.	Machine room	164.312	5	5	15.2	10.81		LED	31	16	Without	Without	Without	Without
1F	Machine room 2	Office, etc.	Machine room	45.5	5	5	7	6.5		LED	31	5	Without	Without	Without	Without
1F	Electric room	Office, etc.	Electric rom	50	5	5	5	10		LED	31	5	Without	Without	Without	Without
1F	Office 1	Office, etc.	Office	352.5	5	2.6	23.5	15		LED	47	80	Without	On-off control	On-off control	Sensor control (LED)
1F	Office 2	Office, etc.	Office	252	5	2.6	16.8	15		LED	47	57	Without	On-off control	On-off control	Sensor control (LED)
1F	Hallway	Office, etc.	Hallway	149.25	5	2.4	2.2	67.84		LED	12.5	28	Without	On-off control	On-off control	Without
1F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
1F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without
2F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
2F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
2F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
2F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
2F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8		LED	31	1	Without	Without	Without	Without
2F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8		LED	31	2	Without	Without	Without	Without
2F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8		LED	31	1	Without	Without	Without	Without
2F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8		LED	31	1	Without	Without	Without	Without
2F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
2F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
2F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5		LED	31	5	Without	Without	Without	Without
2F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15		LED	47	135	Without	On-off control	On-off control	Sensor control (LED)
2F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15		LED	47	113	Without	On-off control	On-off control	Sensor control (LED)
2F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1		LED	19.2	22	Without	On-off control	On-off control	Without
2F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
2F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without
3F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
3F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
3F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
3F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
3F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8		LED	31	1	Without	Without	Without	Without
3F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8		LED	31	2	Without	Without	Without	Without
3F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8		LED	31	1	Without	Without	Without	Without
3F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8		LED	31	1	Without	Without	Without	Without
3F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
3F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
3F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5		LED	31	5	Without	Without	Without	Without
3F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15		LED	47	135	Without	On-off control	On-off control	Sensor control (LED)
3F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15		LED	47	113	Without	On-off control	On-off control	Sensor control (LED)
3F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1		LED	19.2	22	Without	On-off control	On-off control	Without
3F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
3F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without

2) Lighting Control (Motion Detection Control and Luminance Detection Control)

<Corresponding to data entry into "Form 4: (Lighting) Lighting">

⑧: With or without control (Motion detection control)

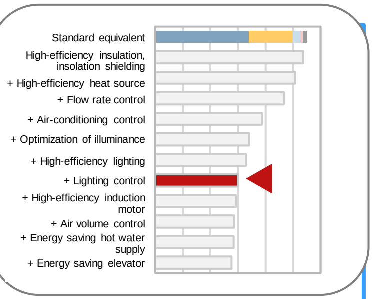
- In the case of lighting control through motion detection, character strings selected from the following choices can be input for the names of specific control methods.
  - Lower limit dimming control method: A method for automatically dimming or switching on and off lighting fixtures on the basis of signals from continuous dimming type motion sensors.
  - On-off control method: A method for automatically switching on and off lighting fixtures: by cutting in and off circuit current with heat ray type automatic switches; on the basis of control signals from on-off type motion sensors; or on the basis of control signals of motion sensors mounted on lighting fixtures.
  - Extinction control method: A method for automatically reducing luminance on the basis of control signals from independent step dimming type motion sensors; or step dimming type motion sensors mounted on lighting fixtures.

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 4: (Lighting) Lighting

①	①	①	①	①	①	①	Room index			Specifications of lighting fixture			With or without control			
							②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪
Floor	Room name	Use of building	Use of room	Room area	Floor height	Ceiling height	Width of room	Depth of room	Room index	Name of fixture	Rated power consump-tion	Number of units	Motion detection control	Luminance detection control	Time schedule control	Initial illuminance correction function
				[m²]	[m]	[m]	[m]	[m]	[-]	(Symbol in lighting fixture list, etc.)	[W/unit]	[Unit]				
(Tran-scription)	(Transcription)	(Transcription)	(Transcription)	(Transcrip-tion)	(Transcrip-tion)	(Transcrip-tion)							(Selection)	(Selection)	(Selection)	(Selection)
1F	Windbreak room	Office, etc.	Hallway	21.12	5	2.6	3.3	6.4			35	4	Without	Without	Without	Without
1F	Lobby	Office, etc.	Lobby	114.12	5	3.5	10	11.412			87	24	Without	Without	Without	Without
1F	EV hall	Office, etc.	Hallway	16.32	5	3.5	3.4	4.8			35	4	Without	Without	Without	Without
1F	Central control room and guard room	Office, etc.	Central control room	39	5	2.6	6	6.5			48	10	Without	Without	Without	Without
1F	Changeroom 1	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25			48	3	Without	Without	Without	Without
1F	Changeroom 2	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25			48	3	Without	Without	Without	Without
1F	Resting room	Office, etc.	Changeroom or warehouse	29.25	5	2.4	3.25	9			48	5	Without	Without	Without	Without
1F	Vending machine corner	Office, etc.	Hallway	25.87	5	2.6	6.5	3.98			35	5	Without	Without	Without	Without
1F	Toilet 1	Office, etc.	Toilet	33.28	5	2.4	3.25	10.24			35	10	Without	Without	Without	Without
1F	Toilet 2	Office, etc.	Toilet	33.7675	5	2.4	3.25	10.39			35	10	Without	Without	Without	Without
1F	DS・PS1	Office, etc.	Machine room	5.76	5	5	3.2	1.8			48	1	Without	Without	Without	Without
1F	DS・PS2	Office, etc.	Machine room	14.4	5	5	3	4.8			48	2	Without	Without	Without	Without
1F	ES1	Office, etc.	Machine room	8.64	5	5	1.8	4.8			48	1	Without	Without	Without	Without
1F	ES2	Office, etc.	Machine room	9.6	5	5	2	4.8			48	1	Without	Without	Without	Without
1F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	5	5	2.3	3.3			48	2	Without	Without	Without	Without
1F	Kettle room	Office, etc.	Kettle room, etc.	5.28	5	2.4	1.6	3.3			48	1	Without	Without	Without	Without
1F	Machine room 1	Office, etc.	Machine room	164.312	5	5	15.2	10.81			48	16	Without	Without	Without	Without
1F	Machine room 2	Office, etc.	Machine room	45.5	5	5	7	6.5			48	5	Without	Without	Without	Without
1F	Electric room	Office, etc.	Electric rom	50	5	5	5	10			48	5	Without	Without	Without	Without
1F	Office 1	Office, etc.	Office	352.5	5	2.6	23.5	15			95	61	Without	Without	Without	Without
1F	Office 2	Office, etc.	Office	252	5	2.6	16.8	15			95	44	Without	Without	Without	Without
1F	Hallway	Office, etc.	Hallway	149.25	5	2.4	2.2	67.84			35	28	Without	Without	Without	Without
1F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
1F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without
2F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8			35	4	Without	Without	Without	Without
2F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98			35	5	Without	Without	Without	Without
2F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24			35	10	Without	Without	Without	Without
2F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39			35	10	Without	Without	Without	Without
2F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8			48	1	Without	Without	Without	Without
2F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8			48	2	Without	Without	Without	Without
2F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8			48	1	Without	Without	Without	Without
2F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8			48	1	Without	Without	Without	Without
2F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3			48	2	Without	Without	Without	Without
2F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3			48	1	Without	Without	Without	Without
2F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5			48	5	Without	Without	Without	Without
2F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15			95	103	Without	Without	Without	Without
2F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15			95	86	Without	Without	Without	Without
2F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1			35	22	Without	Without	Without	Without
2F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
2F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without
3F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8			35	4	Without	Without	Without	Without
3F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98			35	5	Without	Without	Without	Without
3F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24			35	10	Without	Without	Without	Without
3F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39			35	10	Without	Without	Without	Without
3F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8			48	1	Without	Without	Without	Without
3F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8			48	2	Without	Without	Without	Without
3F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8			48	1	Without	Without	Without	Without
3F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8			48	1	Without	Without	Without	Without
3F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3			48	2	Without	Without	Without	Without
3F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3			48	1	Without	Without	Without	Without
3F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5			48	5	Without	Without	Without	Without
3F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15			95	103	Without	Without	Without	Without
3F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15			95	86	Without	Without	Without	Without
3F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1			35	22	Without	Without	Without	Without
3F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
3F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without

<Corresponding to data entry into "Form 4: (Lighting) Lighting">



⑨: With or without control (Luminance detection control)

- In the case of lighting control through luminance detection, character strings selected from the following choices can be input for the names of specific control methods.
  - Dimming control method: A method for automatically dimming lighting fixtures on the basis of control signals from continuous dimming type luminance sensors.
  - Dimming control method (combined with automatically controlled blind): A method for automatically dimming lighting fixtures and operating blinds on the basis of control signals from continuous dimming type luminance sensors.
  - On-off control method: A method corresponds to any of the followings:
    - · Switching on and off lighting fixtures on the basis of control signals from continuous dimming type luminance sensors;
    - · Switching on and off lighting fixtures on the basis of luminance detection of automatic on-off equipment; or
    - · Switching on and off lighting fixtures on the basis of luminance detection of heat ray type automatic switches.
  - Without: Other than those above

AFTER (ZEB Ready equivalent)

Example of Entry into Form 4: (Lighting) Lighting

① Floor (Transcription)	① Room name (Transcription)	① Use of building (Transcription)	① Use of room (Transcription)	① Room area [m²] (Transcription)	① Floor height [m] (Transcription)	① Ceiling height [m] (Transcription)	Room index ② Width of room [m]	③ Depth of room [m]	④ Room index [-]	Specifications of lighting fixture ⑤ Name of fixture (Symbol in lighting fixture list, etc.)	⑥ Rated power consumption [W/unit]	⑦ Number of units [Unit]	With or without control ⑧ Motion detection control (Selection)	⑨ Luminance detection control (Selection)	⑩ Time schedule control (Selection)	⑪ Initial illuminance correction function (Selection)
1F	Windbreak room	Office, etc.	Hallway	21.12	5	2.6	3.3	6.4		LED	19.2	4	Without	On-off control	On-off control	Without
1F	Lobby	Office, etc.	Lobby	114.12	5	3.5	10	11.412		LED	19.2	24	Without	On-off control	On-off control	Without
1F	EV hall	Office, etc.	Hallway	16.32	5	3.5	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
1F	Central control room and guard room	Office, etc.	Central control room	39	5	2.6	6	6.5		LED	31	10	Without	Without	Without	Without
1F	Changeroom 1	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25		LED	31	3	On-off control	Without	Without	Without
1F	Changeroom 2	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25		LED	31	3	On-off control	Without	Without	Without
1F	Resting room	Office, etc.	Changeroom or warehouse	29.25	5	2.4	3.25	9		LED	31	5	On-off control	Without	Without	Without
1F	Vending machine corner	Office, etc.	Hallway	25.87	5	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
1F	Toilet 1	Office, etc.	Toilet	33.28	5	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
1F	Toilet 2	Office, etc.	Toilet	33.7675	5	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
1F	DS・PS1	Office, etc.	Machine room	5.76	5	5	3.2	1.8		LED	31	1	Without	Without	Without	Without
1F	DS・PS2	Office, etc.	Machine room	14.4	5	5	3	4.8		LED	31	2	Without	Without	Without	Without
1F	ES1	Office, etc.	Machine room	8.64	5	5	1.8	4.8		LED	31	1	Without	Without	Without	Without
1F	ES2	Office, etc.	Machine room	9.6	5	5	2	4.8		LED	31	1	Without	Without	Without	Without
1F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	5	5	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
1F	Kettle room	Office, etc.	Kettle room, etc.	5.28	5	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
1F	Machine room 1	Office, etc.	Machine room	164.312	5	5	15.2	10.81		LED	31	16	Without	Without	Without	Without
1F	Machine room 2	Office, etc.	Machine room	45.5	5	5	7	6.5		LED	31	5	Without	Without	Without	Without
1F	Electric room	Office, etc.	Electric rom	50	5	5	5	10		LED	31	5	Without	Without	Without	Without
1F	Office 1	Office, etc.	Office	352.5	5	2.6	23.5	15		LED	47	80	Without	On-off control	On-off control	Sensor control (LED)
1F	Office 2	Office, etc.	Office	252	5	2.6	16.8	15		LED	47	57	Without	On-off control	On-off control	Sensor control (LED)
1F	Hallway	Office, etc.	Hallway	149.25	5	2.4	2.2	67.84		LED	12.5	28	Without	On-off control	On-off control	Without
1F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
1F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without
2F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
2F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
2F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
2F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
2F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8		LED	31	1	Without	Without	Without	Without
2F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8		LED	31	2	Without	Without	Without	Without
2F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8		LED	31	1	Without	Without	Without	Without
2F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8		LED	31	1	Without	Without	Without	Without
2F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
2F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
2F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5		LED	31	5	Without	Without	Without	Without
2F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15		LED	47	135	Without	On-off control	On-off control	Sensor control (LED)
2F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15		LED	47	113	Without	On-off control	On-off control	Sensor control (LED)
2F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1		LED	19.2	22	Without	On-off control	On-off control	Without
2F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
2F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without
3F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
3F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
3F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
3F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
3F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8		LED	31	1	Without	Without	Without	Without
3F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8		LED	31	2	Without	Without	Without	Without
3F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8		LED	31	1	Without	Without	Without	Without
3F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8		LED	31	1	Without	Without	Without	Without
3F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
3F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
3F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5		LED	31	5	Without	Without	Without	Without
3F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15		LED	47	135	Without	On-off control	On-off control	Sensor control (LED)
3F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15		LED	47	113	Without	On-off control	On-off control	Sensor control (LED)
3F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1		LED	19.2	22	Without	On-off control	On-off control	Without
3F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
3F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without

3) Lighting Control (Time Schedule Control and Initial Illuminance Correction)

<Corresponding to data entry into “Form 4: (Lighting) Lighting”>

⑩: With or without control (Time schedule control)

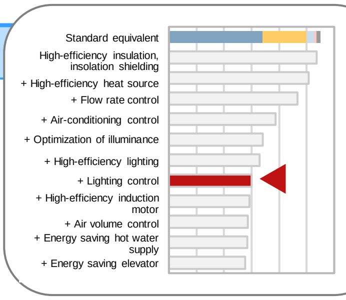
- In the case of lighting control through time schedule, character strings selected from the following choices can be input for the names of specific control methods.

  - Extinction control method: A method for reducing luminance of lighting fixtures according to preset time schedules.
  - On-off control method: A method for switching on and off lighting fixtures according to preset time schedules.
  - Without: Other than those above

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 4: (Lighting) Lighting

①	①	①	①	①	①	①	Room index ②	Room index ③	Room index ④	Specifications of lighting fixture ⑤	Specifications of lighting fixture ⑥	Specifications of lighting fixture ⑦	With or without control ⑧	With or without control ⑨	With or without control ⑩	With or without control ⑪
Floor (Tran-scription)	Room name (Transcription)	Use of building (Transcription)	Use of room (Transcription)	Room area [m²] (Transcrip-tion)	Floor height [m] (Transcri-ption)	Ceiling height [m] (Transcri-ption)	Width of room [m]	Depth of room [m]	Room index [-]	Name of fixture (Symbol in lighting fixture list, etc.)	Rated power consump-tion [W/unit]	Number of units [Unit]	Motion detection control (Selection)	Luminance detection control (Selection)	Time schedule control (Selection)	Initial illuminance correction function (Selection)
1F	Windbreak room	Office, etc.	Hallway	21.12	5	2.6	3.3	6.4			35	4	Without	Without	Without	Without
1F	Lobby	Office, etc.	Lobby	114.12	5	3.5	10	11.412			87	24	Without	Without	Without	Without
1F	EV hall	Office, etc.	Hallway	16.32	5	3.5	3.4	4.8			35	4	Without	Without	Without	Without
1F	Central control room and guard room	Office, etc.	Central control room	39	5	2.6	6	6.5			48	10	Without	Without	Without	Without
1F	Changeroom 1	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25			48	3	Without	Without	Without	Without
1F	Changeroom 2	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25			48	3	Without	Without	Without	Without
1F	Resting room	Office, etc.	Changeroom or warehouse	29.25	5	2.4	3.25	9			48	5	Without	Without	Without	Without
1F	Vending machine corner	Office, etc.	Hallway	25.87	5	2.6	6.5	3.98			35	5	Without	Without	Without	Without
1F	Toilet 1	Office, etc.	Toilet	33.28	5	2.4	3.25	10.24			35	10	Without	Without	Without	Without
1F	Toilet 2	Office, etc.	Toilet	33.7675	5	2.4	3.25	10.39			35	10	Without	Without	Without	Without
1F	DS・PS1	Office, etc.	Machine room	5.76	5	5	3.2	1.8			48	1	Without	Without	Without	Without
1F	DS・PS2	Office, etc.	Machine room	14.4	5	5	3	4.8			48	2	Without	Without	Without	Without
1F	ES1	Office, etc.	Machine room	8.64	5	5	1.8	4.8			48	1	Without	Without	Without	Without
1F	ES2	Office, etc.	Machine room	9.6	5	5	2	4.8			48	1	Without	Without	Without	Without
1F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	5	5	2.3	3.3			48	2	Without	Without	Without	Without
1F	Kettle room	Office, etc.	Kettle room, etc.	5.28	5	2.4	1.6	3.3			48	1	Without	Without	Without	Without
1F	Machine room 1	Office, etc.	Machine room	164.312	5	5	15.2	10.81			48	16	Without	Without	Without	Without
1F	Machine room 2	Office, etc.	Machine room	45.5	5	5	7	6.5			48	5	Without	Without	Without	Without
1F	Electric room	Office, etc.	Electric rom	50	5	5	5	10			48	5	Without	Without	Without	Without
1F	Office 1	Office, etc.	Office	352.5	5	2.6	23.5	15			95	61	Without	Without	Without	Without
1F	Office 2	Office, etc.	Office	252	5	2.6	16.8	15			95	44	Without	Without	Without	Without
1F	Hallway	Office, etc.	Hallway	149.25	5	2.4	2.2	67.84			35	28	Without	Without	Without	Without
1F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
1F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without
2F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8			35	4	Without	Without	Without	Without
2F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98			35	5	Without	Without	Without	Without
2F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24			35	10	Without	Without	Without	Without
2F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39			35	10	Without	Without	Without	Without
2F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8			48	1	Without	Without	Without	Without
2F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8			48	2	Without	Without	Without	Without
2F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8			48	1	Without	Without	Without	Without
2F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8			48	1	Without	Without	Without	Without
2F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3			48	2	Without	Without	Without	Without
2F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3			48	1	Without	Without	Without	Without
2F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5			48	5	Without	Without	Without	Without
2F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15			95	103	Without	Without	Without	Without
2F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15			95	86	Without	Without	Without	Without
2F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1			35	22	Without	Without	Without	Without
2F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
2F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without
3F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8			35	4	Without	Without	Without	Without
3F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98			35	5	Without	Without	Without	Without
3F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24			35	10	Without	Without	Without	Without
3F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39			35	10	Without	Without	Without	Without
3F	DS・PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8			48	1	Without	Without	Without	Without
3F	DS・PS2	Office, etc.	Machine room	14.4	4	4	3	4.8			48	2	Without	Without	Without	Without
3F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8			48	1	Without	Without	Without	Without
3F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8			48	1	Without	Without	Without	Without
3F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3			48	2	Without	Without	Without	Without
3F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3			48	1	Without	Without	Without	Without
3F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5			48	5	Without	Without	Without	Without
3F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15			95	103	Without	Without	Without	Without
3F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15			95	86	Without	Without	Without	Without
3F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1			35	22	Without	Without	Without	Without
3F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3			35	1	Without	Without	Without	Without
3F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5			35	3	Without	Without	Without	Without



<Corresponding to data entry into "Form 4: (Lighting) Lighting">

⑪: With or without control (Initial illuminance correction function)

- In the case of lighting control through initial illuminance correction, character strings selected from the following choices can be input for the names of specific control methods. The initial illuminance correction is a function to switch on lighting fixtures with light flux obtained by multiplying rated light flux by maintenance factors and to keep almost constant light flux during operation.
  - Timer control method (LED): A method to keep light flux of LED lighting fixtures constant with internal timers.
  - Timer control method (fluorescent light): A method to keep light flux of fluorescent lighting fixtures constant with internal timers.
  - Sensor control method (LED): A method to keep light flux of LED lighting fixtures constant with luminance sensors.
  - Sensor control method (fluorescent light): A method to keep light flux of fluorescent lighting fixtures constant with luminance sensors.
  - Without: Other than those above.

AFTER (ZEB Ready equivalent)

Example of Entry into Form 4: (Lighting) Lighting

① Floor (Transcription)	① Room name (Transcription)	① Use of building (Transcription)	① Use of room (Transcription)	① Room area [m²] (Transcription)	① Floor height [m] (Transcription)	① Ceiling height [m] (Transcription)	Room index: ② Width of room [m]	Room index: ③ Depth of room [m]	Room index: ④ Room index [-]	Specifications of lighting fixture: ⑤ Name of fixture (Symbol in lighting fixture list, etc.)	Specifications of lighting fixture: ⑥ Rated power consumption [W/unit]	Specifications of lighting fixture: ⑦ Number of units [Unit]	With or without control: ⑧ Motion detection control (Selection)	With or without control: ⑨ Luminance detection control (Selection)	With or without control: ⑩ Time schedule control (Selection)	With or without control: ⑪ Initial illuminance correction function (Selection)
1F	Windbreak room	Office, etc.	Hallway	21.12	5	2.6	3.3	6.4		LED	19.2	4	Without	On-off control	On-off control	Without
1F	Lobby	Office, etc.	Lobby	114.12	5	3.5	10	11.412		LED	19.2	24	Without	On-off control	On-off control	Without
1F	EV hall	Office, etc.	Hallway	16.32	5	3.5	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
1F	Central control room and guard room	Office, etc.	Central control room	39	5	2.6	6	6.5		LED	31	10	Without	Without	Without	Without
1F	Changeroom 1	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25		LED	31	3	On-off control	Without	Without	Without
1F	Changeroom 2	Office, etc.	Changeroom or warehouse	14.625	5	2.4	4.5	3.25		LED	31	3	On-off control	Without	Without	Without
1F	Resting room	Office, etc.	Changeroom or warehouse	29.25	5	2.4	3.25	9		LED	31	5	On-off control	Without	Without	Without
1F	Vending machine corner	Office, etc.	Hallway	25.87	5	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
1F	Toilet 1	Office, etc.	Toilet	33.28	5	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
1F	Toilet 2	Office, etc.	Toilet	33.7675	5	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
1F	DS･PS1	Office, etc.	Machine room	5.76	5	5	3.2	1.8		LED	31	1	Without	Without	Without	Without
1F	DS･PS2	Office, etc.	Machine room	14.4	5	5	3	4.8		LED	31	2	Without	Without	Without	Without
1F	ES1	Office, etc.	Machine room	8.64	5	5	1.8	4.8		LED	31	1	Without	Without	Without	Without
1F	ES2	Office, etc.	Machine room	9.6	5	5	2	4.8		LED	31	1	Without	Without	Without	Without
1F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	5	5	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
1F	Kettle room	Office, etc.	Kettle room, etc.	5.28	5	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
1F	Machine room 1	Office, etc.	Machine room	164.312	5	5	15.2	10.81		LED	31	16	Without	Without	Without	Without
1F	Machine room 2	Office, etc.	Machine room	45.5	5	5	7	6.5		LED	31	5	Without	Without	Without	Without
1F	Electric room	Office, etc.	Electric rom	50	5	5	5	10		LED	31	5	Without	Without	Without	Without
1F	Office 1	Office, etc.	Office	352.5	5	2.6	23.5	15		LED	47	80	Without	On-off control	On-off control	Sensor control (LED)
1F	Office 2	Office, etc.	Office	252	5	2.6	16.8	15		LED	47	57	Without	On-off control	On-off control	Sensor control (LED)
1F	Hallway	Office, etc.	Hallway	149.25	5	2.4	2.2	67.84		LED	12.5	28	Without	On-off control	On-off control	Without
1F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
1F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without
2F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
2F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
2F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
2F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
2F	DS･PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8		LED	31	1	Without	Without	Without	Without
2F	DS･PS2	Office, etc.	Machine room	14.4	4	4	3	4.8		LED	31	2	Without	Without	Without	Without
2F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8		LED	31	1	Without	Without	Without	Without
2F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8		LED	31	1	Without	Without	Without	Without
2F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
2F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
2F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5		LED	31	5	Without	Without	Without	Without
2F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15		LED	47	135	Without	On-off control	On-off control	Sensor control (LED)
2F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15		LED	47	113	Without	On-off control	On-off control	Sensor control (LED)
2F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1		LED	19.2	22	Without	On-off control	On-off control	Without
2F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
2F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without
3F	EV hall	Office, etc.	Hallway	16.32	5	2.6	3.4	4.8		LED	19.2	4	Without	On-off control	On-off control	Without
3F	Vending machine corner	Office, etc.	Hallway	25.87	4	2.6	6.5	3.98		LED	12.5	5	Without	On-off control	On-off control	Without
3F	Toilet 1	Office, etc.	Toilet	33.28	4	2.4	3.25	10.24		LED	7.4	10	On-off control	Without	Without	Without
3F	Toilet 2	Office, etc.	Toilet	33.7675	4	2.4	3.25	10.39		LED	7.4	10	On-off control	Without	Without	Without
3F	DS･PS1	Office, etc.	Machine room	5.76	4	4	3.2	1.8		LED	31	1	Without	Without	Without	Without
3F	DS･PS2	Office, etc.	Machine room	14.4	4	4	3	4.8		LED	31	2	Without	Without	Without	Without
3F	ES1	Office, etc.	Machine room	8.64	4	4	1.8	4.8		LED	31	1	Without	Without	Without	Without
3F	ES2	Office, etc.	Machine room	9.6	4	4	2	4.8		LED	31	1	Without	Without	Without	Without
3F	Warehouse	Office, etc.	Changeroom or warehouse	7.59	4	4	2.3	3.3		LED	31	2	On-off control	Without	Without	Without
3F	Kettle room	Office, etc.	Kettle room, etc.	5.28	4	2.4	1.6	3.3		LED	31	1	On-off control	Without	Without	Without
3F	Machine room	Office, etc.	Machine room	45.5	4	4	7	6.5		LED	31	5	Without	Without	Without	Without
3F	Office 1	Office, etc.	Office	597	4	2.6	39.8	15		LED	47	135	Without	On-off control	On-off control	Sensor control (LED)
3F	Office 2	Office, etc.	Office	499.5	4	2.6	33.3	15		LED	47	113	Without	On-off control	On-off control	Sensor control (LED)
3F	Hallway	Office, etc.	Hallway	117.74	4	2.4	2.5	47.1		LED	19.2	22	Without	On-off control	On-off control	Without
3F	Hallway (beside kettle room)	Office, etc.	Hallway	3.6	5	2.4	1.2	3		LED	31	1	Without	On-off control	On-off control	Without
3F	Stair case	Office, etc.	Hallway	12.5	5	2.4	2.5	5		LED	31	3	Without	On-off control	On-off control	Without

Reference Information

Other Important Energy Saving Technologies (Example): Lighting Control

*** Out of scope of the case study**

*** Calculation is not available with the energy consumption performance calculation program**

Zoning Control

Outline of technology

- Fragmentation of lighting on-off areas can reduce lighting energy in a manner that enables lighting and dimming to be performed only in required areas, thereby contributing to the reduction in primary energy consumption.
- Reducing time to light hallways and parking spaces with illuminance requirements relaxed depending on time zones enables lighting energy to be reduced, thereby contributing to the reduction in primary energy consumption.

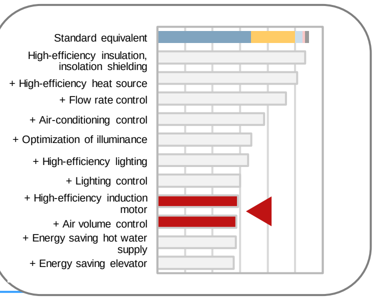
Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Fragmentation of Lighting Control Unit

Outline of technology

- Fragmentation of lighting control areas can reduce lighting energy in a manner that enables lighting to be performed only in required areas through lighting control using luminance or motion sensors, thereby contributing to the reduction in primary energy consumption.

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government



4.3 Ventilation Systems

Approaches toward Enhancing the Efficiency of Ventilation Systems

To appropriately control ventilation energy

- Ventilation energy can be saved through appropriate control of ventilation systems according to use purposes of indoor spaces instead of continuously operating them. It is preferable to operate ventilation systems in consistency with air-conditioning systems taking into consideration proper distribution of air circulation volume in an entire building.

- Ventilation of habitable rooms and common spaces: It is necessary to take architectural measures to stop or reduce the operation of ventilation systems focusing on the structures of buildings such as windows and vaulted ceilings designed for enhancing natural ventilation.

- Ventilation of kitchens: Detailed control linked to the use of kitchen instruments (for gas combustion) is required for discharging combustion exhaust. Constant ventilation with appropriate air volume is preferable for preventing foul odor.

- Ventilation of machine rooms: Control according to loads and heat generation is required for discharging heat generated by electric facilities (transformers, etc.). Significant reduction of the ventilation operation of machine rooms is possible at night through the control system linked to room temperatures.

- Ventilation of parking spaces: It is required to meet the minimum ventilation frequency stipulated in the Building Standards Act for discharging harmful components (mainly CO gas) in the exhaust of automobiles.

- Ventilation of machine rooms for sanitary systems (underground water tanks, storage spaces of sewage tanks, etc.): Controlling ventilation frequency to stabilize humidity in these rooms is satisfactory when these rooms are confirmed to be communicated with external air through vent tubes so as not to allow harmful gas to leak into basements.

Target Levels of Ventilation Systems

- When realizing a building satisfying ZEB Ready (energy saving rate of 50%), it is necessary to introduce ventilation systems with **<u>ventilation BEI of about 0.90 (reduction in ventilation energy consumption of 10% with respect to a reference value: for the example of the case study, refer to the followings)</u>**.

Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program

- The technologies for the energy saving of ventilation systems are classified into: ❶ mechanical method (introduction of high-efficiency ventilation systems (motors)); ❷ operation and control method (for general ventilation) (high-efficiency ventilation through control); and ❸ operation and control method (for kitchen) (high-efficiency ventilation through control).
- The targets of energy saving effect and approximate construction cost of main ventilation systems are as follows. The processes of calculating the energy saving effect using the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017) are explained on the following pages.

<u>Example of technologies for ZEB Ready (those in orange cells are used in the case study)</u>

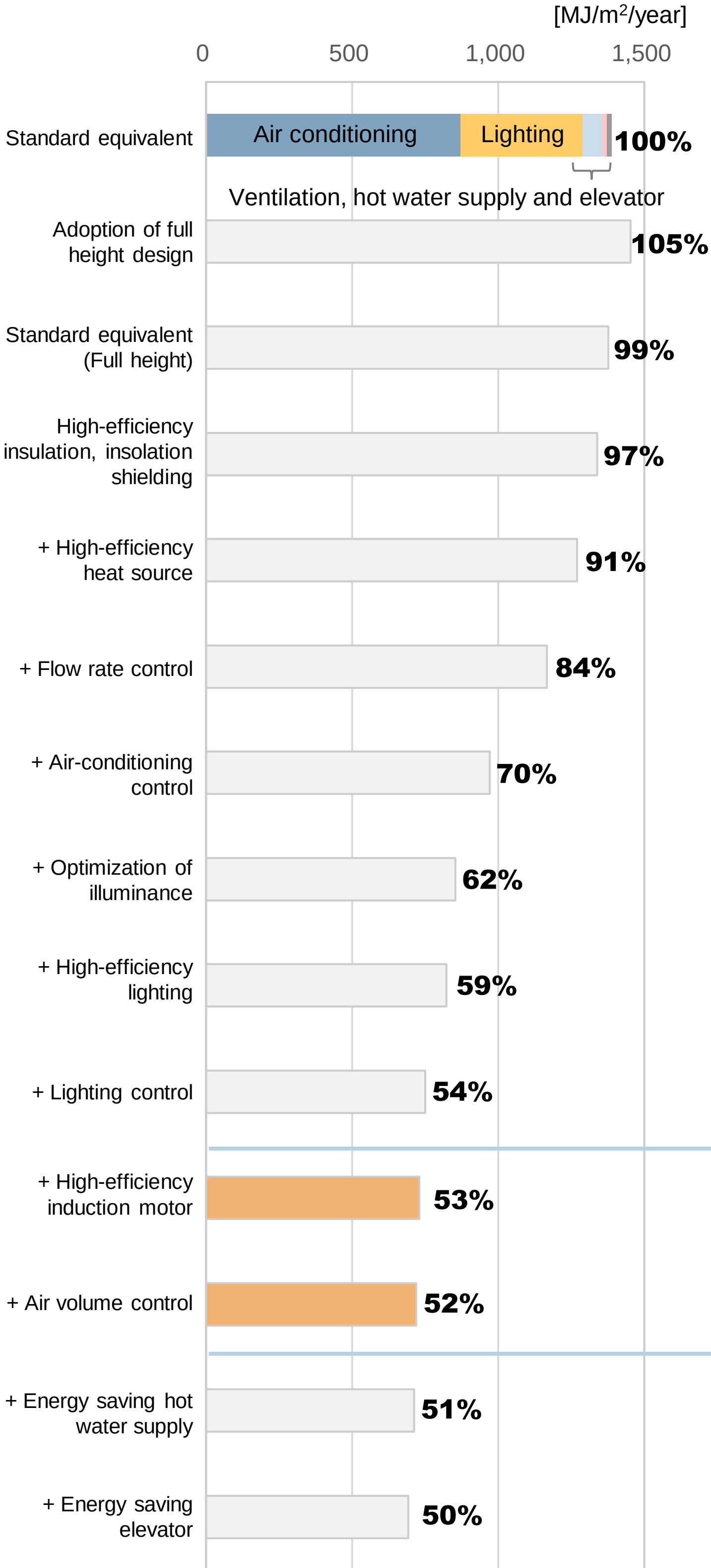
〇: Technology applicable to the evaluation with the program, △: Technology requiring attention when evaluated with the program, ×: Technology difficult to be evaluated with the program

Energy saving of ventilation system (example)			Applicability of energy consumption performance calculation program	Energy saving effect (target)	Approximate cost increment (target)
❶ Mechanical	High-efficiency induction motor	High-efficiency fan	〇	1%	About 0.2 million yen
❷ Operation and control (for general ventilation)	High-efficiency induction motor	Temperature control of machine room	〇	1%	About 0.2 million yen
❷ Operation and control (for general ventilation)	Air volume control	Inverter for manual control of fan	〇	1%	About 10 million yen
❷ Operation and control (for general ventilation)	Air volume control (out of scope of the case study)	CO or CO_2 concentration control with fans in a parking space	〇		
❷ Operation and control (for general ventilation)	Air volume control (out of scope of the case study)	Air current feeling creation fan and circulation fan	△ Input as air circulation		
❷ Operation and control (for general ventilation)	Air volume control (out of scope of the case study)	Displacement ventilation system	×		
❷ Operation and control (for general ventilation)	Air volume control (out of scope of the case study)	Ventilation control through motion sensors	×		
❷ Operation and control (for general ventilation)	Air volume control (out of scope of the case study)	On-off control of fans linked with the operation of combustion equipment in heat source machine rooms	×		
❸ Operation and control (for kitchen)	Air volume control (out of scope of the case study)	Control of kitchen outdoor unit and fan by switching air volume modes	〇		
❸ Operation and control (for kitchen)	Air volume control (out of scope of the case study)	High-efficiency kitchen ventilation systems	×		
❸ Operation and control (for kitchen)	Air volume control (out of scope of the case study)	Control of kitchen outdoor unit by switching ventilation modes	×		

Source: Modification of the material by the ZEB Roadmap Examination Committee

Case Study Result of Office Building Realizing ZEB Ready

Note: “The energy saving effect” is a result of calculating combined effect of plural technologies and does not necessarily correspond to the accumulated total of energy saving effects of individual technologies.



Energy saving technology		Energy saving effect[Note]
Passive technology **Envelope insulation, Insolation shielding**	· High-performance insulation material · High insulation window · Canopy and louver	8%
Active technology **Air-conditioning system**	· High-efficiency heat source	6%
	· Large temperature difference water delivery · Variable water volume control	7%
	· Total heat exchanger · Variable air volume control · External air cut · External air cooling control	14%
Active technology **Lighting system**	· Adoption of the illuminance of 500 lx (Office)	8%
	· LED lighting	2%
	· Motion detection control · Time schedule control · Initial illuminance correction · Luminance detection control	5%
Active technology **Ventilation system**	· High-efficiency induction motor, invertor	1%
	· Temperature control (Machine room)	1%
Active technology **Hot water supply system**	· Automatic hot water faucet	Less than 1%
Active technology **Elevator system**	· VVVF (with power regeneration, gearless)	1%

<Corresponding to data entry into "Form 3-2: (Ventilation) Air Supply and Exhaust Fans">

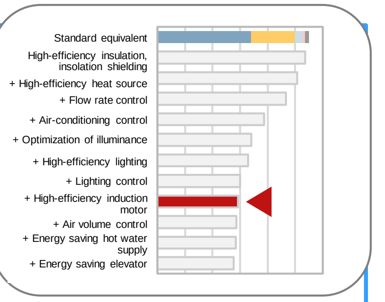
④: Correction through control (with or without high-efficiency induction motor)

- If ventilation systems are mounted with high-efficiency induction motors, the word "With" needs to be input and if not, the word "Without" needs to be input. The high-efficiency induction motors shall be those complying with JIS C 4212 (Low-voltage three-phase squirrel-cage high-efficiency induction motors) or JIS C 4213 (Low-voltage three-phase squirrel-cage motors – Low-voltage top runner motor).
    - With: motors complying with JIS C 4212 (Low-voltage three-phase squirrel-cage high-efficiency induction motors) or JIS C 4213 (Low-voltage three-phase squirrel-cage motors – Low-voltage top runner motor)
    - Without: Other than those above

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 3-2: (Ventilation) Air Supply and Exhaust Fan

① Name of ventilation system	② Design air volume [m³/h]	③ Rated output of motor [kW]	With or without control		
			④ With or without high-efficiency induction motor (Selection)	⑤ With or without inverter (Selection)	⑥ Air volume control (Selection)
EF-1	700	0.146	Without	Without	Without
EF-2	700	0.146	Without	Without	Without
EF-3	100	0.021	Without	Without	Without
EF-4	300	0.063	Without	Without	Without
EF-5	400	0.083	Without	Without	Without
EF-6	4,100	0.854	Without	Without	Without
SF-6	4,100	0.854	Without	Without	Without
EF-7	1,100	0.229	Without	Without	Without
EF-8	2,500	0.521	Without	Without	Without
SF-8	2,500	0.521	Without	Without	Without
EF-2-1	700	0.146	Without	Without	Without
EF-2-2	700	0.146	Without	Without	Without
EF-2-3	100	0.021	Without	Without	Without
EF-2-4	300	0.063	Without	Without	Without
EF-2-5	900	0.188	Without	Without	Without
EF-3-1	700	0.146	Without	Without	Without
EF-3-2	700	0.146	Without	Without	Without
EF-3-3	100	0.021	Without	Without	Without
EF-3-4	300	0.063	Without	Without	Without
EF-3-5	900	0.188	Without	Without	Without
EF-4-1	700	0.146	Without	Without	Without
EF-4-2	700	0.146	Without	Without	Without
EF-4-3	100	0.021	Without	Without	Without
EF-4-4	300	0.063	Without	Without	Without
EF-4-5	900	0.188	Without	Without	Without
EF-5-1	700	0.146	Without	Without	Without
EF-5-2	700	0.146	Without	Without	Without
EF-5-3	100	0.021	Without	Without	Without
EF-5-4	300	0.063	Without	Without	Without
EF-5-5	900	0.188	Without	Without	Without
EF-6-1	700	0.146	Without	Without	Without
EF-6-2	700	0.146	Without	Without	Without
EF-6-3	100	0.021	Without	Without	Without
EF-6-4	300	0.063	Without	Without	Without
EF-6-5	900	0.188	Without	Without	Without
EF-7-1	700	0.146	Without	Without	Without
EF-7-2	700	0.146	Without	Without	Without
EF-7-3	100	0.021	Without	Without	Without
EF-7-4	300	0.063	Without	Without	Without
EF-7-5	900	0.188	Without	Without	Without
EF-R1	2,000	0.417	Without	Without	Without
SF-R1	2,000	0.417	Without	Without	Without



<Corresponding to data entry into "Form 3-2: (Ventilation) Air Supply and Exhaust Fans">

⑤: Correction through control (with or without inverter)

- If ventilation systems are mounted with inverters, the word "With" needs to be input and if not, the word "Without" needs to be input.
- "With" can be input in the case of systems operated with fixed frequency instead of automatic control of frequency (with inverters used for adjusting air volume after the completion of buildings) in addition to the case of automatically controlling air volume with inverters.
  - Without: The case of ventilation systems without inverters (coefficient of 1.0)
  - With: The case of ventilation systems with inverters including the case of systems operated with fixed frequency instead of automatic control of frequency (coefficient of 0.6)

Example of Entry into Form 3-2: (Ventilation) Air Supply and Exhaust Fans

AFTER (ZEB Ready equivalent)

①	②	③	With or without control		
Name of ventilation system	Design air volume [m^3/h]	Rated output of motor [kW]	④ With or without high-efficiency induction motor (Selection)	⑤ With or without inverter (Selection)	⑥ Air volume control (Selection)
EF-1	700	0.146	Without	Without	Without
EF-2	700	0.146	Without	Without	Without
EF-3	100	0.021	Without	Without	Without
EF-4	300	0.063	Without	Without	Without
EF-5	400	0.083	Without	Without	Without
EF-6	4,100	0.854	With	With	Temperature control
SF-6	4,100	0.854	With	With	Temperature control
EF-7	1,100	0.229	Without	With	Temperature control
EF-8	2,500	0.521	Without	With	Without
SF-8	2,500	0.521	Without	With	Without
EF-2-1	700	0.146	Without	Without	Without
EF-2-2	700	0.146	Without	Without	Without
EF-2-3	100	0.021	Without	Without	Without
EF-2-4	300	0.063	Without	Without	Without
EF-2-5	900	0.188	Without	Without	Temperature control
EF-3-1	700	0.146	Without	Without	Without
EF-3-2	700	0.146	Without	Without	Without
EF-3-3	100	0.021	Without	Without	Without
EF-3-4	300	0.063	Without	Without	Without
EF-3-5	900	0.188	Without	Without	Temperature control
EF-4-1	700	0.146	Without	Without	Without
EF-4-2	700	0.146	Without	Without	Without
EF-4-3	100	0.021	Without	Without	Without
EF-4-4	300	0.063	Without	Without	Without
EF-4-5	900	0.188	Without	Without	Temperature control
EF-5-1	700	0.146	Without	Without	Without
EF-5-2	700	0.146	Without	Without	Without
EF-5-3	100	0.021	Without	Without	Without
EF-5-4	300	0.063	Without	Without	Without
EF-5-5	900	0.188	Without	Without	Temperature control
EF-6-1	700	0.146	Without	Without	Without
EF-6-2	700	0.146	Without	Without	Without
EF-6-3	100	0.021	Without	Without	Without
EF-6-4	300	0.063	Without	Without	Without
EF-6-5	900	0.188	Without	Without	Temperature control
EF-7-1	700	0.146	Without	Without	Without
EF-7-2	700	0.146	Without	Without	Without
EF-7-3	100	0.021	Without	Without	Without
EF-7-4	300	0.063	Without	Without	Without
EF-7-5	900	0.188	Without	Without	Temperature control
EF-R1	2,000	0.417	Without	With	Temperature control
SF-R1	2,000	0.417	Without	With	Temperature control

<Corresponding to data entry into "Form 3-2: (Ventilation) Air Supply and Exhaust Fans">

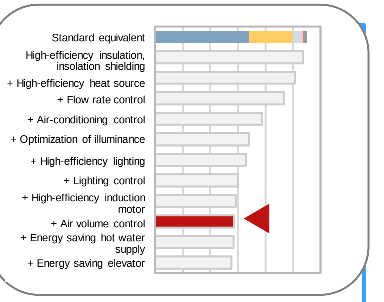
⑥: Correction through control (air volume control)

- The character strings selected from below can be input for the air volume control methods of ventilation systems. In the case of no air volume control, "Without" needs to be input.
  - Without: The case of no air volume control (coefficient of 1.0)
  - CO concentration control: The case of air volume control based on CO or CO_2 concentration in parking spaces, etc. (coefficient of 0.6)
  - Temperature control: The case of air volume control based on indoor temperatures in the spaces other than electric rooms (coefficient of 0.7)

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 3-2: (Ventilation) Air Supply and Exhaust Fan

① Name of ventilation system	② Design air volume [m³/h]	③ Rated output of motor [kW]	With or without control		
			④ With or without high-efficiency induction motor (Selection)	⑤ With or without inverter (Selection)	⑥ Air volume control (Selection)
EF-1	700	0.146	Without	Without	Without
EF-2	700	0.146	Without	Without	Without
EF-3	100	0.021	Without	Without	Without
EF-4	300	0.063	Without	Without	Without
EF-5	400	0.083	Without	Without	Without
EF-6	4,100	0.854	Without	Without	Without
SF-6	4,100	0.854	Without	Without	Without
EF-7	1,100	0.229	Without	Without	Without
EF-8	2,500	0.521	Without	Without	Without
SF-8	2,500	0.521	Without	Without	Without
EF-2-1	700	0.146	Without	Without	Without
EF-2-2	700	0.146	Without	Without	Without
EF-2-3	100	0.021	Without	Without	Without
EF-2-4	300	0.063	Without	Without	Without
EF-2-5	900	0.188	Without	Without	Without
EF-3-1	700	0.146	Without	Without	Without
EF-3-2	700	0.146	Without	Without	Without
EF-3-3	100	0.021	Without	Without	Without
EF-3-4	300	0.063	Without	Without	Without
EF-3-5	900	0.188	Without	Without	Without
EF-4-1	700	0.146	Without	Without	Without
EF-4-2	700	0.146	Without	Without	Without
EF-4-3	100	0.021	Without	Without	Without
EF-4-4	300	0.063	Without	Without	Without
EF-4-5	900	0.188	Without	Without	Without
EF-5-1	700	0.146	Without	Without	Without
EF-5-2	700	0.146	Without	Without	Without
EF-5-3	100	0.021	Without	Without	Without
EF-5-4	300	0.063	Without	Without	Without
EF-5-5	900	0.188	Without	Without	Without
EF-6-1	700	0.146	Without	Without	Without
EF-6-2	700	0.146	Without	Without	Without
EF-6-3	100	0.021	Without	Without	Without
EF-6-4	300	0.063	Without	Without	Without
EF-6-5	900	0.188	Without	Without	Without
EF-7-1	700	0.146	Without	Without	Without
EF-7-2	700	0.146	Without	Without	Without
EF-7-3	100	0.021	Without	Without	Without
EF-7-4	300	0.063	Without	Without	Without
EF-7-5	900	0.188	Without	Without	Without
EF-R1	2,000	0.417	Without	Without	Without
SF-R1	2,000	0.417	Without	Without	Without



AFTER (ZEB Ready equivalent)

Example of Entry into Form 3-2: (Ventilation) Air Supply and Exhaust Fan

① Name of ventilation system	② Design air volume [m³/h]	③ Rated output of motor [kW]	With or without control		
			④ With or without high-efficiency induction motor (Selection)	⑤ With or without inverter (Selection)	⑥ Air volume control (Selection)
EF-1	700	0.146	Without	Without	Without
EF-2	700	0.146	Without	Without	Without
EF-3	100	0.021	Without	Without	Without
EF-4	300	0.063	Without	Without	Without
EF-5	400	0.083	Without	Without	Without
EF-6	4,100	0.854	With	With	Temperature control
SF-6	4,100	0.854	With	With	Temperature control
EF-7	1,100	0.229	Without	With	Temperature control
EF-8	2,500	0.521	Without	With	Without
SF-8	2,500	0.521	Without	With	Without
EF-2-1	700	0.146	Without	Without	Without
EF-2-2	700	0.146	Without	Without	Without
EF-2-3	100	0.021	Without	Without	Without
EF-2-4	300	0.063	Without	Without	Without
EF-2-5	900	0.188	Without	Without	Temperature control
EF-3-1	700	0.146	Without	Without	Without
EF-3-2	700	0.146	Without	Without	Without
EF-3-3	100	0.021	Without	Without	Without
EF-3-4	300	0.063	Without	Without	Without
EF-3-5	900	0.188	Without	Without	Temperature control
EF-4-1	700	0.146	Without	Without	Without
EF-4-2	700	0.146	Without	Without	Without
EF-4-3	100	0.021	Without	Without	Without
EF-4-4	300	0.063	Without	Without	Without
EF-4-5	900	0.188	Without	Without	Temperature control
EF-5-1	700	0.146	Without	Without	Without
EF-5-2	700	0.146	Without	Without	Without
EF-5-3	100	0.021	Without	Without	Without
EF-5-4	300	0.063	Without	Without	Without
EF-5-5	900	0.188	Without	Without	Temperature control
EF-6-1	700	0.146	Without	Without	Without
EF-6-2	700	0.146	Without	Without	Without
EF-6-3	100	0.021	Without	Without	Without
EF-6-4	300	0.063	Without	Without	Without
EF-6-5	900	0.188	Without	Without	Temperature control
EF-7-1	700	0.146	Without	Without	Without
EF-7-2	700	0.146	Without	Without	Without
EF-7-3	100	0.021	Without	Without	Without
EF-7-4	300	0.063	Without	Without	Without
EF-7-5	900	0.188	Without	Without	Temperature control
EF-R1	2,000	0.417	Without	With	Temperature control
SF-R1	2,000	0.417	Without	With	Temperature control

Reference Information

Other Important Energy Saving Technologies (Example): Operation and Control of General Ventilation

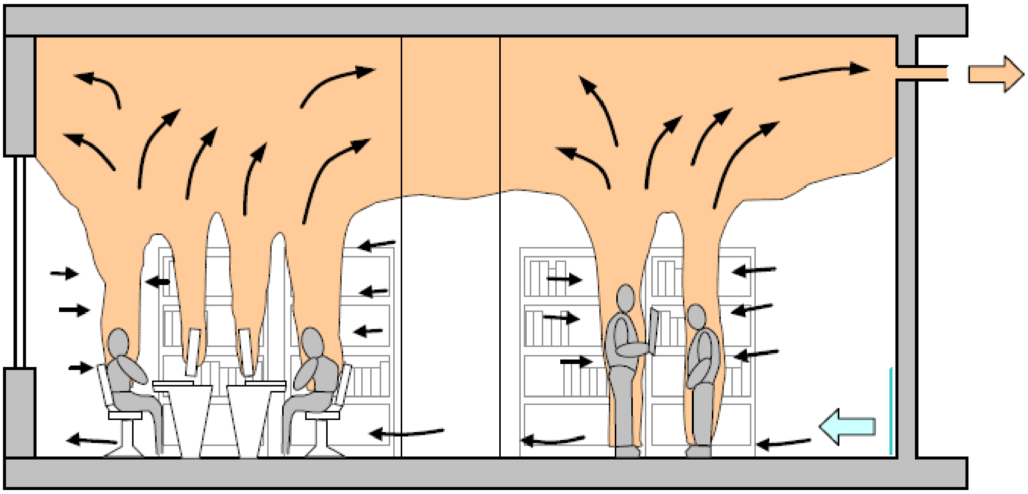
* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

Displacement Ventilation System

Outline of technology

- Being capable of producing air flows in the states close to those of piston flows, the displacement ventilation systems enable ventilation energy to be reduced with higher ventilation efficiency than general mixing ventilation systems, thereby contributing to the reduction in primary energy consumption.



Source: Modification of the “Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016,” Bureau of Environment, Tokyo Metropolitan Government

Ventilation Control through Motion Sensors

Outline of technology

- Automatically starting and stopping the operation of exhaust fans through the detections of motion sensors in toilets and kettle rooms enables: ventilation energy during overtime hours with air conditioners not in operation to be reduced; and air-conditioning energy to be reduced through the enhancement of the efficiency of total heat exchangers, thereby contributing to the reduction in primary energy consumption.

Source: Modification of the “Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016,” Bureau of Environment, Tokyo Metropolitan Government

On-off Control of Fans Linked with the Operation of Combustion Equipment in Heat Source Machine Rooms

Outline of technology

- Heat source machine rooms where combustion equipment such as boilers and direct fired absorption chiller heaters is installed require the supply of air not only for ventilation but also for combustion of fuel while equipment is in operation. Thus, there may be a case of wasteful energy consumption by supplying combustion air even when equipment is not in operation. Thus, controlling fans so as to start and stop them in conjunction with the start and stop of combustion equipment enables delivery energy to be reduced, thereby contributing to the reduction in primary energy consumption.

Source: Modification of the “Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016,” Bureau of Environment, Tokyo Metropolitan Government

Reference Information

Other Important Energy Saving Technologies (Example): Operation and Control of Kitchen Ventilation

* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

High-efficiency Kitchen Ventilation Systems

Outline of technology

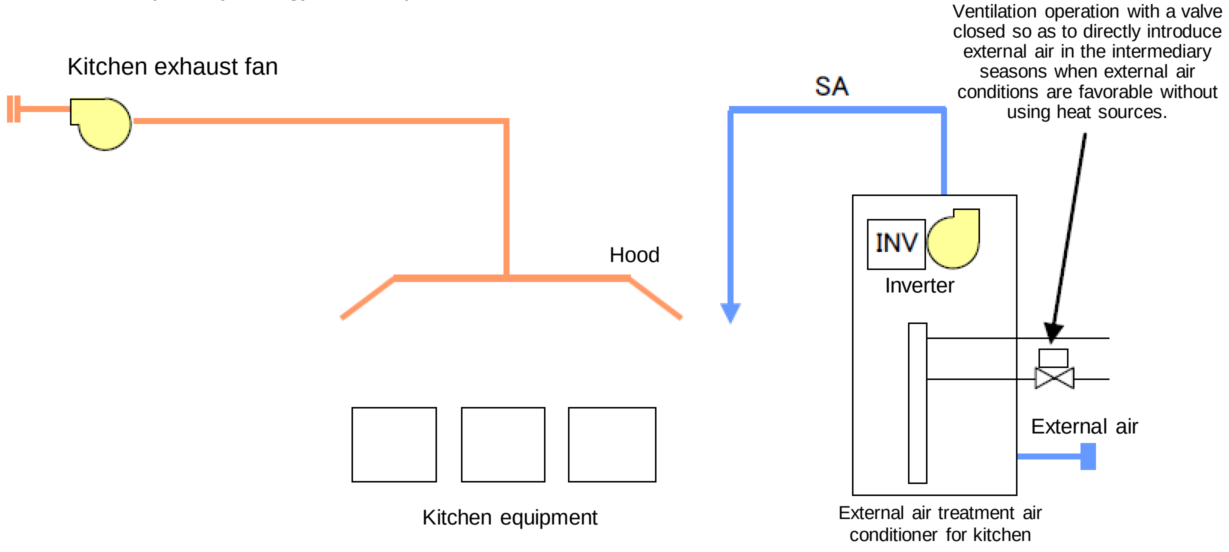
- Exhausting heat generated from kitchen equipment through displacement ventilation enables ventilation energy and air conditioning energy to be reduced in a manner that reduces ventilation air volume with the heat prevented from being mixed with air supplied through air conditioners, thereby contributing to the reduction in primary energy consumption.
- Using untreated external air for ventilation with air supply and exhaust hoods enables air conditioning energy to be reduced, thereby contributing to the reduction in primary energy consumption.

Source: Modification of the materials of Halton

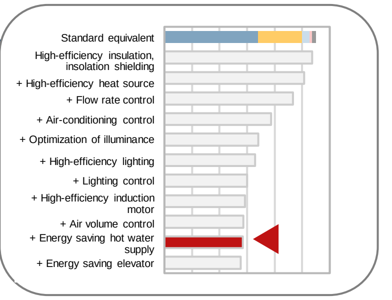
Control of Kitchen Outdoor Unit by Switching Ventilation Modes

Outline of technology

- Introducing external air not subject to external air treatment with cold water or hot water in the intermediary seasons when the external air conditions are favorable enables air-conditioning energy to be reduced, thereby contributing to the reduction in primary energy consumption.



Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government



4.4 Hot Water Supply Systems

Approaches toward Enhancing the Efficiency of Hot Water Supply Systems

Selection of hot water supply systems (water heaters)

- In office buildings, hot water is expected to be used for making hot drinks and washing in kettle rooms. Because the amount of hot water for these purposes is not so large and the utilization time of hot water is short, local water heaters have been generally used in office buildings.
- Gas water heaters have not been generally used in kettle rooms of office buildings because of the problems with ventilating exhaust gas and safety. Thus, electric water heaters have been popular. These electric water heaters include multipurpose types available for both making drinks and other general purposes and energy saving types mounted with timers so as to stop energization when hot water demand is low.

Source: Equipment Design Note Research Committee, *Office Building Equipment Design Notes for Architects*, Akio Chiku (ed.), Kajima Institute Publishing

Target Levels of Hot Water Supply Systems

- When realizing a building satisfying ZEB Ready (energy saving rate of 50%), it is necessary to introduce hot water supply systems with **hot water supply BEI of about 0.90 (reduction in hot water supply energy consumption of 10% with respect to a reference value: for the example of the case study, refer to the followings)**.

Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program

- The technologies for the energy saving of hot water supply systems are classified into: ❶ mechanical method (introduction of high-efficiency hot water supply systems (heat sources)); and ❷ hot water saving method (hot water saving system).
- The targets of energy saving effect and approximate construction cost of main hot water supply systems are as follows. The processes of calculating the energy saving effect using the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017) are explained on the following pages.

Example of technologies for ZEB Ready (those in orange cells are used in the case study)

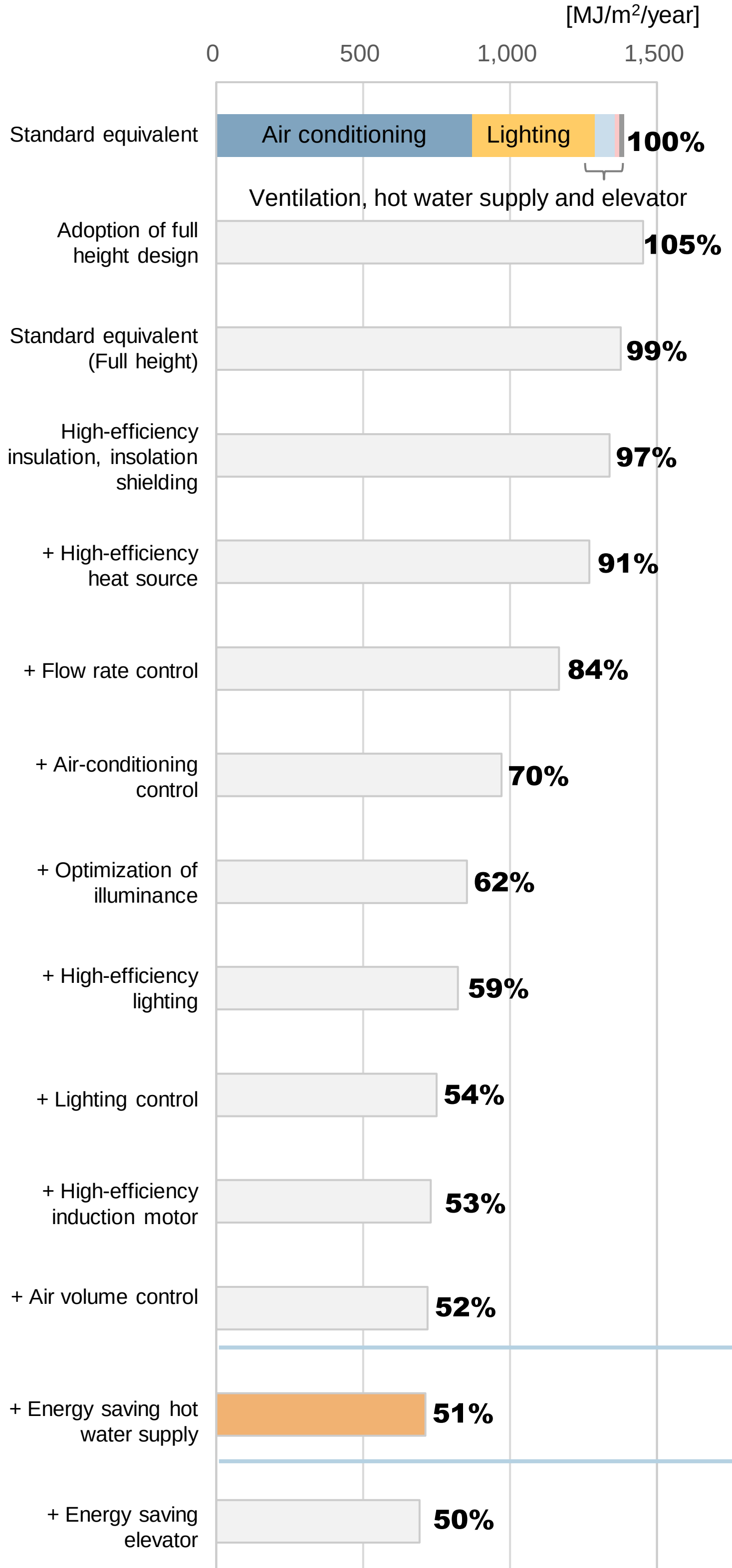
○: Technology applicable to the evaluation with the program, △: Technology requiring attention when evaluated with the program, ×: Technology difficult to be evaluated with the program

Energy saving of hot water supply system (example)			Applicability of energy consumption performance calculation program	Energy saving effect (target)	Approximate cost increment (target)
❶ Mechanical	Energy saving hot water supply (out of scope of the case study)	High-efficiency hot water supply heat pump unit	○		
		Natural refrigerant heat pump water heater	○		
		Latent heat recovery type water heater	○		
❷ Hot water saving	Energy saving hot water supply	Automatic faucet of wash basin	△ Only for hot water supply	0.4%	About 0.9 million yen

Source: Modification of the material by the ZEB Roadmap Examination Committee

Case Study Result of Office Building Realizing ZEB Ready

Note: “The energy saving effect” is a result of calculating combined effect of plural technologies and does not necessarily correspond to the accumulated total of energy saving effects of individual technologies.



Energy saving technology		Energy saving effect[Note]
Passive technology **Envelope insulation, Insolation shielding**	· High-performance insulation material, · High insulation window, · Canopy and louver	8%
Active technology **Air-conditioning system**	· High-efficiency heat source	6%
	· Large temperature difference water delivery · Variable water volume control	7%
	· Total heat exchanger · Variable air volume control · External air cut · External air cooling control	14%
Active technology **Lighting system**	· Adoption of the illuminance of 500 lx (Office)	8%
	· LED lighting	2%
	· Motion detection control · Time schedule control · Initial illuminance correction · Luminance detection control	5%
Active technology **Ventilation system**	· High-efficiency induction motor, invertor	1%
	· Temperature control (Machine room)	1%
Active technology **Hot water supply system**	· Automatic hot water faucet	Less than 1%
Active technology **Elevator system**	· VVVF (with power regeneration, gearless)	1%

1) Energy Saving Hot Water Supply (Automatic Hot Water Faucet)

<Corresponding to data entry into "Form 5-1: (Hot Water Supply) Hot Water Supply Destinations">

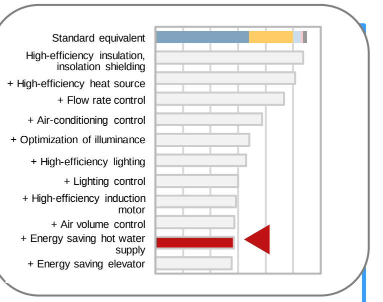
③: Hot water saving equipment

- When hot water saving equipment is used, the character strings corresponding to the hot water saving equipment selected from Table 1-5-1 "Specific Specifications of Hot Water Saving Equipment" needs to be input into the form or when hot water saving equipment is not used, "Without" needs to be input into the form.
    - Automatic hot water faucet: A type of faucet which is installed on a wash basin and automatically turns on and off. It electrically turns on and off with hands held out and pulled away from beneath a faucet. However, self-closing water valves (automatically turn off after running water for a predetermined period of time) which have already been widely prevalent as is the case with public bath houses are excluded from the category of automatic hot water faucet because their hot water saving effects have already been considered in the daily cumulative hot water consumption rates.
    - Type B1 hot water saving faucet: A mixing faucet satisfying the "compatibility conditions for faucets mounted with low flow rate water discharge mechanisms."
        - One of the compatibility conditions requires the water discharge force measured through the test method specified in the determination standards for hot water saving faucets to satisfy the following values:
        - A type of faucet which does not have a structure to mix air into running water → 0.60 N or more
        - A type of faucet which has a structure to mix air into running water → 0.55 N or more
    - Without: All other faucets other than those having the abovementioned mechanism.

BEFORE
2016 standards equivalent
(Full height)

Example of Entry into Form 5-1: (Hot Water Supply) Hot Water Supply Destination

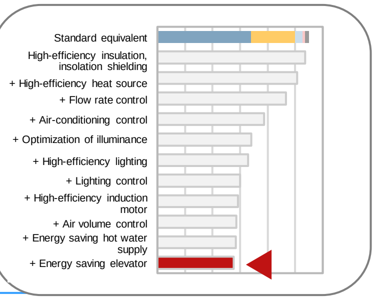
① Floor (Tran-scription)	① Room name (Transcription)	① Use of building (Transcription)	① Use of room (Transcription)	① Room area [m²] (Transcrip-tion)	② Hot water supply destination (Faucet installation location)	③ Hot water saving equipment (Selection)	④ Name of water heater (Transcription)
1F	Central control and guard rooms	Office, etc.	Central control room	39	Toilet 1	Without	EB2-11
					Toilet 2	Without	EB2-12
					Toilet 2	Without	EB2-13
1F	Resting room	Office, etc.	Changeroom or warehouse	29.25	Toilet 1	Without	EB2-11
					Toilet 2	Without	EB2-12
					Toilet 2	Without	EB2-13
					Resting room	Without	EB1-11
1F	Office 1	Office, etc.	Office	352.5	Toilet 1	Without	EB2-11
					Toilet 2	Without	EB2-12
					Toilet 2	Without	EB2-13
					Kettle room	Without	EB1-12
1F	Office 2	Office, etc.	Office	252	Toilet 1	Without	EB2-11
					Toilet 2	Without	EB2-12
					Toilet 2	Without	EB2-13
					Kettle room	Without	EB1-12
2F	Office 1	Office, etc.	Office	597	Toilet 1	Without	EB2-21
					Toilet 2	Without	EB2-22
					Toilet 2	Without	EB2-23
					Kettle room	Without	EB1-21
2F	Office 2	Office, etc.	Office	499.5	Toilet 1	Without	EB2-21
					Toilet 2	Without	EB2-22
					Toilet 2	Without	EB2-23
					Kettle room	Without	EB1-21
3F	Office 1	Office, etc.	Office	597	Toilet 1	Without	EB2-31
					Toilet 2	Without	EB2-32
					Toilet 2	Without	EB2-33
					Kettle room	Without	EB1-31
3F	Office 2	Office, etc.	Office	499.5	Toilet 1	Without	EB2-31
					Toilet 2	Without	EB2-32
					Toilet 2	Without	EB2-33
					Kettle room	Without	EB1-31



AFTER
(ZEB Ready equivalent)

Example of Entry into Form 5-1: (Hot Water Supply) Hot Water Supply Destination

① Floor (Transcription)	① Room name (Transcription)	① Use of building (Transcription)	① Use of room (Transcription)	① Room area [m²] (Transcription)	② Hot water supply destination (Faucet installation location)	③ Hot water saving equipment (Selection)	④ Name of water heater (Transcription)
1F	Central control and guard rooms	Office, etc.	Central control room	39	Toilet 1	Automatic hot water faucet	EB2-11
					Toilet 2	Automatic hot water faucet	EB2-12
					Toilet 2	Automatic hot water faucet	EB2-13
1F	Resting room	Office, etc.	Changeroom or warehouse	29.25	Toilet 1	Automatic hot water faucet	EB2-11
					Toilet 2	Automatic hot water faucet	EB2-12
					Toilet 2	Automatic hot water faucet	EB2-13
					Resting room	Without	EB1-11
1F	Office 1	Office, etc.	Office	352.5	Toilet 1	Automatic hot water faucet	EB2-11
					Toilet 2	Automatic hot water faucet	EB2-12
					Toilet 2	Automatic hot water faucet	EB2-13
					Kettle room	Without	EB1-12
1F	Office 2	Office, etc.	Office	252	Toilet 1	Automatic hot water faucet	EB2-11
					Toilet 2	Automatic hot water faucet	EB2-12
					Toilet 2	Automatic hot water faucet	EB2-13
					Kettle room	Without	EB1-12
2F	Office 1	Office, etc.	Office	597	Toilet 1	Automatic hot water faucet	EB2-21
					Toilet 2	Automatic hot water faucet	EB2-22
					Toilet 2	Automatic hot water faucet	EB2-23
					Kettle room	Without	EB1-21
2F	Office 2	Office, etc.	Office	499.5	Toilet 1	Automatic hot water faucet	EB2-21
					Toilet 2	Automatic hot water faucet	EB2-22
					Toilet 2	Automatic hot water faucet	EB2-23
					Kettle room	Without	EB1-21
3F	Office 1	Office, etc.	Office	597	Toilet 1	Automatic hot water faucet	EB2-31
					Toilet 2	Automatic hot water faucet	EB2-32
					Toilet 2	Automatic hot water faucet	EB2-33
					Kettle room	Without	EB1-31
3F	Office 2	Office, etc.	Office	499.5	Toilet 1	Automatic hot water faucet	EB2-31
					Toilet 2	Automatic hot water faucet	EB2-32
					Toilet 2	Automatic hot water faucet	EB2-33
					Kettle room	Without	EB1-31



4.5 Elevator Systems

Approach toward Enhancing the Efficiency of Elevator Systems

Variable voltage variable frequency control (VVVF control) of elevator systems

- The introduction of the VVVF control facilitates speed control of elevator systems, thereby improving floor landing performance and comfortability of elevator cars and reducing running time. The control performance improvement effects of the VVVF control include the enhancement of the efficiency of winding equipment (including the replacement of worm gears with helical gears, etc.), thereby contributing to energy saving.

Power regenerative control of elevator systems

- Because the motors of elevator systems are subject to braking force when hoisting empty elevator cars or lowering full elevator cars, they are capable of regenerative power generation with motors operated as generators. The power regenerative control enables regenerated power to be stored in nickel-hydrogen storage cells and efficiently used for the operation of the motors, thereby contributing to energy saving and the emergency low speed operation of elevator cars for about 10 minutes on the occurrence of power outages.

Group supervisory control of elevator systems

- Along with the increasing number of high-rise, large-scale and intelligent buildings, there have been the cases of introducing the group supervisory control which efficiently operates plural elevator cars as a control group taking into consideration waiting time. The group supervisory control can save energy and significantly reduce waiting time through the efficient operation of elevator cars with appropriate programs.

Automatic operation of escalators

- The automatic operation equipment is a technology to automatically start the operation of an escalator by detecting a passenger with a motion sensor mounted on a photoelectric gatepost at a loading zone and to stop the operation after a lapse of predetermined period of operation with no passengers.

Target Levels of Elevator Systems

- When realizing a building satisfying ZEB Ready (energy saving rate of 50%), it is necessary to introduce elevator systems with **elevator BEI of about 0.90 (reduction in elevator energy consumption of 10% with respect to a reference value)**.

Example of Technologies: Calculation Example of the Energy Consumption Performance Calculation Program

- The targets of energy saving effect and approximate construction cost of main elevator systems are as follows. The processes of calculating the energy saving effect using the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017) are explained on the following pages.

Example of technologies for ZEB Ready (those in orange cells are used in the case study)

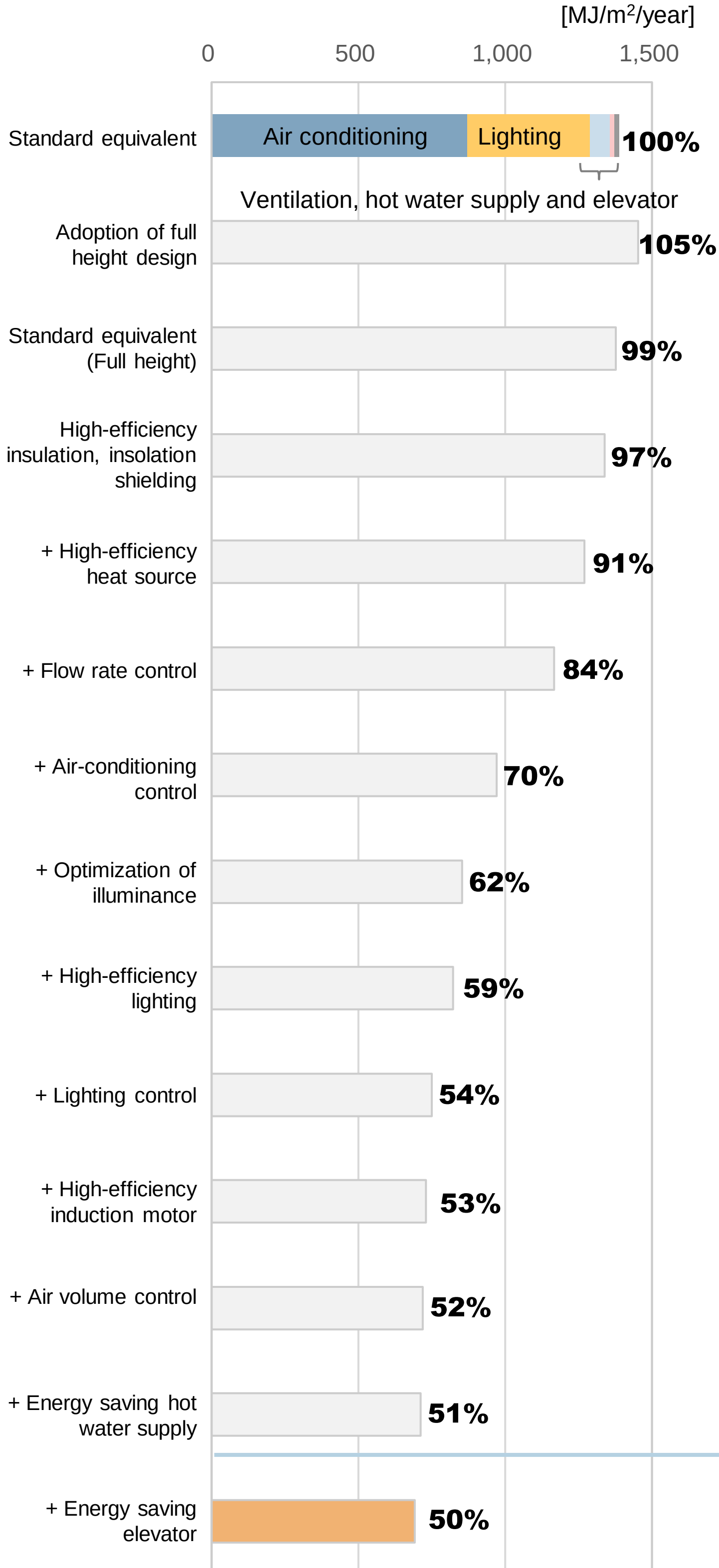
○: Technology applicable to the evaluation with the program, △: Technology requiring attention when evaluated with the program, ×: Technology difficult to be evaluated with the program

Energy saving of elevator system (example)			Applicability of energy consumption performance calculation program	Energy saving effect (target)	Approximate cost increment (target)
❶ Elevator	Energy saving elevator	1) VVVF control	○	1%	0%
❶ Elevator	Energy saving elevator and escalator (out of scope of the case study)	2) Power regenerative control	○		
❶ Elevator	Energy saving elevator and escalator (out of scope of the case study)	3) Group supervisory control	×		
❷ Escalator	Energy saving elevator and escalator (out of scope of the case study)	4) Automatic operation control and low-speed operation control	×		

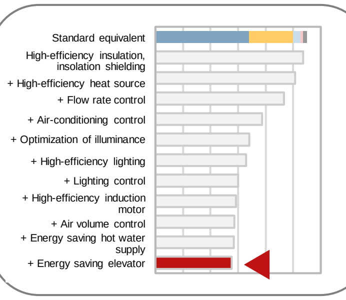
Source: Modification of the material by the ZEB Roadmap Examination Committee

Case Study Result of Office Building Realizing ZEB Ready

Note: “The energy saving effect” is a result of calculating combined effect of plural technologies and does not necessarily correspond to the accumulated total of energy saving effects of individual technologies.



Energy saving technology		Energy saving effect[Note]
Passive technology **Envelope insulation, Insolation shielding**	· High-performance insulation material · High insulation window · Canopy and louver	8%
Active technology **Air-conditioning system**	· High-efficiency heat source	6%
	· Large temperature difference water delivery · Variable water volume control	7%
	· Total heat exchanger · Variable air volume control · External air cut · External air cooling control	14%
Active technology **Lighting system**	· Adoption of the illuminance of 500 lx (Office)	8%
	· LED lighting	2%
	· Motion detection control · Time schedule control · Initial illuminance correction · Luminance detection control	5%
Active technology **Ventilation system**	· High-efficiency induction motor, invertor	1%
	· Temperature control (Machine room)	1%
Active technology **Hot water supply system**	· Automatic hot water faucet	Less than 1%
Active technology **Elevator system**	· VVVF (with power regeneration, gearless)	1%



1) Energy Saving Elevator System (VVVF Control and Power Regenerative Control)

<Corresponding to data entry into “Form 6 (Elevator) Elevator”>

⑦: Speed control system

- Character strings selected from the followings can be input provided, however, that one-byte characters need to be used for round and square brackets and double-byte characters for punctuation marks.
  - VVVF (with power regeneration, gearless): The case of introducing VVVF control (with power regeneration and gearless hoists) (Coefficient of 1/50)
  - VVVF (with power regeneration): The case of introducing VVVF control (with power regeneration) (Coefficient of 1/45)
  - VVVF (without power regeneration, gearless): The case of introducing VVVF control (without power regeneration but with gearless hoists) (Coefficient of 1/45)
  - VVVF (without power regeneration): The case of introducing VVVF control (without power regeneration) (Coefficient of 1/40)
  - AC feedback control: The case of introducing AC feedback control (Coefficient of 1/20)

    * “AC feedback control” also needs to be selected in the case of Ward Leonard system, static Leonard system (thyristor Leonard system) or AC double speed system.

Example of Entry into Form 6: (Elevator) Elevator

BEFORE
2016 standards equivalent
(Full height)

Main object room				②	③	④	⑤	⑥	⑦
① Floor (Tran-scription)	① Room name (Transcription)	① Use of building (Transcription)	① Use of room (Transcription)	Equipment name (Symbol in equipment list, etc.)	Number of equipment [Unit]	Loading capacity [kg]	Speed [m/min]	Carrying capacity factor [-]	Speed control system (Selection)
7F	Office 1	Office, etc.	Office	Service	2	800	60	1	AC feedback control
7F	Office 2	Office, etc.	Office	Service	2	800	60	1	AC feedback control

Example of Entry into Form 6: (Elevator) Elevator

AFTER
(ZEB Ready equivalent)

Main object room				②	③	④	⑤	⑥	⑦
① Floor (Tran-scription)	① Room name (Transcription)	① Use of building (Transcription)	① Use of room (Transcription)	Equipment name (Symbol in equipment list, etc.)	Number of equipment [Unit]	Loading capacity [kg]	Speed [m/min]	Carrying capacity factor [-]	Speed control system (Selection)
7F	Office 1	Office, etc.	Office	Service	2	800	60	1	VVVF (with power regeneration, gearless)
7F	Office 2	Office, etc.	Office	Service	2	800	60	1	VVVF (with power regeneration, gearless)

Reference Information

Other Important Energy Saving Technologies (Example): Elevator and Escalator

* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

Group Supervisory Control

Outline of technology

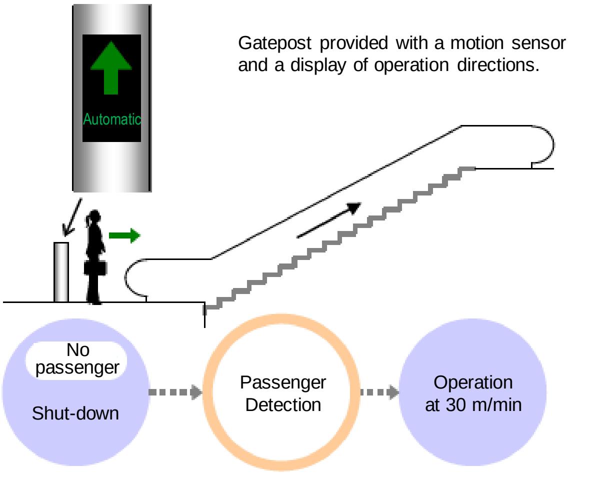
- The elevator group supervisory control is to assign the most appropriate elevator car to respond to a call in the case of a building provided with two or more elevator cars sharing common elevator halls and classified into a full-automatic group share-ride system and a full-automatic group supervisory control system.
- The full-automatic group share-ride system is an elevator operation system which is applicable to a small-to-medium-sized building provided with two elevator cars and achieves full-automatic share-ride operation in a manner that enables the two elevator cars to be rationally operated simultaneously with each other. This system is suitable for a building which has stable traffic demand with small fluctuations in the number of calls in two vertical directions on respective floors.
- The full-automatic group supervisory control system is an elevator operation system which is applicable to a building with relatively gradual increases in peak hour traffic demand and capable of dealing with wide fluctuations in traffic demand at normal times. This system is suitable for abuilding provided with three to five elevator cars.
- The introduction of the group supervisory control enables energy for operating elevators to be reduced by operating plural elevator cars as a group so as to transport passengers promptly and comfortably to their destination floors, thereby contributing to the reduction in primary energy consumption.

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Automatic Operation Control and Low-speed Operation Control

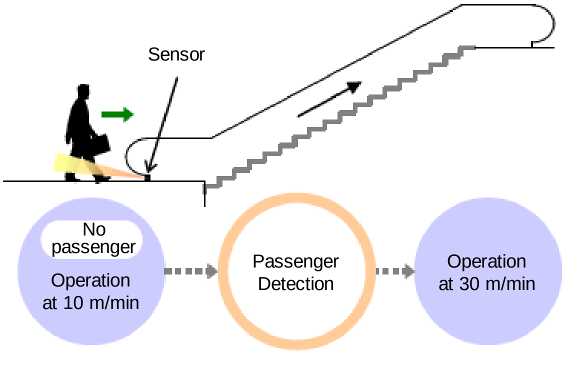
Outline of technology

- The automatic operation control is an escalator operation system which automatically stops escalator operation in the absence of passengers. The introduction of the automatic operation control enables the energy for operating escalators to be reduced with decreasing operation time in a manner that automatically starts the operation of an escalator by detecting a passenger with photoelectric gateposts (motion sensors) at loading zones of escalators and stops the operation after a lapse of predetermined period of operation with no passengers, thereby contributing to the reduction in primary energy consumption.
- The low-speed operation control is an escalator operation system which reduces operation speeds of escalators through inverter control in the absence of passengers. Because the low-speed operation control allows escalators to be started with reduced starting current, the introduction of the low-speed operation control can achieve larger reduction in energy for operating escalators than the automatic operation control with increasing frequency of repeating start and stop operation, thereby contributing to the reduction in primary energy consumption.



Automatic operation control

An escalator operation system to automatically start the operation of an escalator by detecting a passenger with a motion sensor mounted on a photoelectric gatepost at a loading zone and stop the operation after a lapse of predetermined period of operation with no passengers.



Low-speed operation control

An escalator operation system to operate an escalator at a low-speed of 10 m/min in the absence of passengers, gradually accelerate the speed to 30 m/min with an inverter when a sensor detects a passenger and automatically reduce the speed to the original low-speed after a lapse of a predetermined period of operation with no passengers.

Source: Modification of the "Guidelines for Certifying Superior Specified Business Operators Practicing Global Warming Countermeasures in Mandatory Total Emission Reduction and the Emission Trading System (Category 1 Business Establishment) (The Second Planning Period) April 2016," Bureau of Environment, Tokyo Metropolitan Government

Chapter 5

Renewable Energy Technologies (Active Technologies)

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5.1 Photovoltaic Power Generation

Purposes of Introducing the Technology

To produce energy from sunlight

- Huge amount of energy of the sun is shining down on the earth. Being ubiquitously beneficial, solar energy is the type of renewable energy which has been most generalized.

- In order to calculate usable amount of solar energy with photovoltaic power generation systems, it is necessary to consider several constraint factors. Major ones include electric conversion efficiency associated with a current technical constraint, installation locations associated with a geographical constraint, and construction costs associated with an economic constraint. These constraint factors also include regionally specific ones such as shadows due to neighboring buildings in urban areas and snow accumulation in snowy areas. Thus, it is necessary to estimate the usable amount of solar energy in consideration of these constraint factors.

Constraining factors for photovoltaic power generation

Photovoltaic power generation system	Technical	Battery material	Polycrystal silicon, monocrystal silicon, CIS, etc.
		Installation type	Trestle mounted, roof mounted, building material integrated, etc.
	Economic	System cost	System cost varies depending on a battery material and an installation type.
		Power selling price	Set power selling price affects the cash flow of power selling and the incentive to introduce a photovoltaic power generation system.
	Social	Building Standards Act	Building height limit, building coverage ratio, floor area ratio, etc.
		City Planning Act	Building height limit
		Electricity Business Act	Necessity of appointing a licensed electrician if power generation capacity is not less than 1,000 kW.
	Environmental	Insolation amount	Power generation amount varies depending on the amount of insolation.
		Temperature	Power generation efficiency is reduced with the increase in temperature.
		Shadowing obstacle	Power generation amount is reduced when insolation is blocked by buildings, trees or mountains.
		Snow accumulation	Snow accumulation in winter causes power generation amount to be reduced.

Source: Hideharu Niwa, *Energy Independent Buildings*, Kousakusha Co., Ltd., 2013

Factors for Enhancing the Efficiency of Photovoltaic Power Generation

Types of photovoltaic cells

- Photovoltaic cells are largely classified into a "silicon" type and a "compound" type. Different types have different characteristics. The types of photovoltaic cells which have been disseminated are monocrystal silicon, polycrystal silicon, amorphous and hybrids of these types.

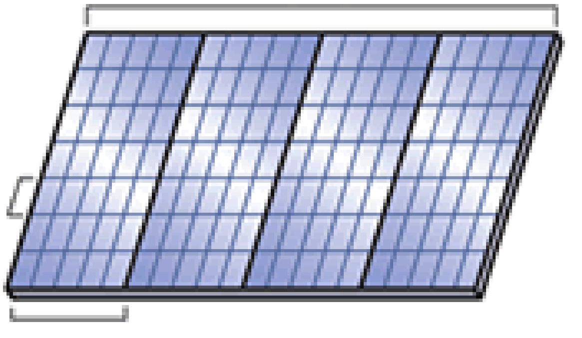
Silicon type	Monocrystal	Conventionally popular because of high conversion efficiency
	Polycrystal	Currently most popular because of low cost and other beneficial aspects
	Amorphous	High workability suitable for mass production
Compound type	Monocrystal	High power conversion efficiency but expensive. Mostly for the use in space.
	Polycrystal	Suitable for expanding areas and mass production

Cell, module and array

- Cell
  A photovoltaic cell element is simply called "cell" which serves as a basic unit of photovoltaic cells.
  The output voltage of a single cell is about 0.5 to 1.0 V in general.

- Module
  A module is packaged photovoltaic cells with the required number of photovoltaic cells arranged in a plane and coated with resin or reinforced glass so as to be used outdoors. The module is also called a solar panel.

- Array
  An array is a series of modules (panels) connected to one another.



Target of power production

- The power generation amount of photovoltaic power generation is proportional to the size and the number of photovoltaic modules. That is, the power generation amount is increased or decreased as the size or number of modules is increased or decreased. In contrast, the power generation efficiency is not affected by the size or number of modules. Therefore, the size and number of modules to be installed can be adjusted according to the power generation amount necessary for a building.

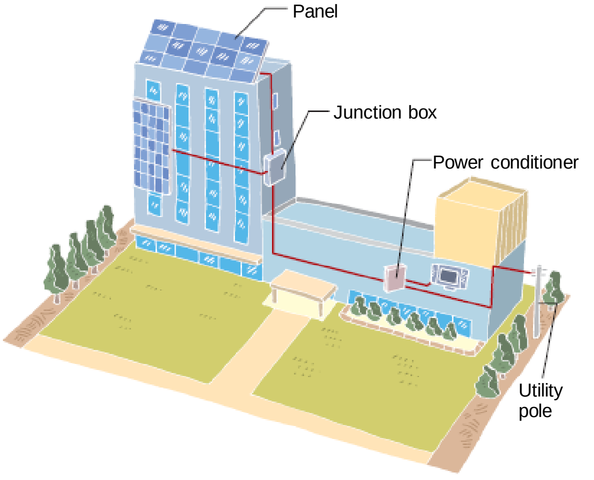
<Calculation method of photovoltaic cell capacity>
- Photovoltaic cell capacity = the maximum nominal output of a module × the number of modules.
- That is, the photovoltaic cell capacity of 10 pieces of modules with the maximum nominal output of 180 W each is 180 W × 10 pieces = 1.8 kW.

<Output of photovoltaic power generation systems>
- Actual photovoltaic power generation systems do not output as calculated above. The target output (instantaneous values) on sunny days is considered to be about 60 to 80% of photovoltaic cell capacity. This is because of the loss of generated power due to the following factors:
  - Changes in insolation (depending on regions, seasons, time and weather);
  - Increase in cell temperature (the increases in cell temperature causes power generation efficiency to be lowered);
  - Installation conditions (angles and surrounding environments); and
  - Power loss when converting direct current to alternate one with power conditioners.

Source: "A to Z for Companies Introducing Photovoltaic Power Generation" by the Agency for Natural Resources and Energy and the New Energy Foundation

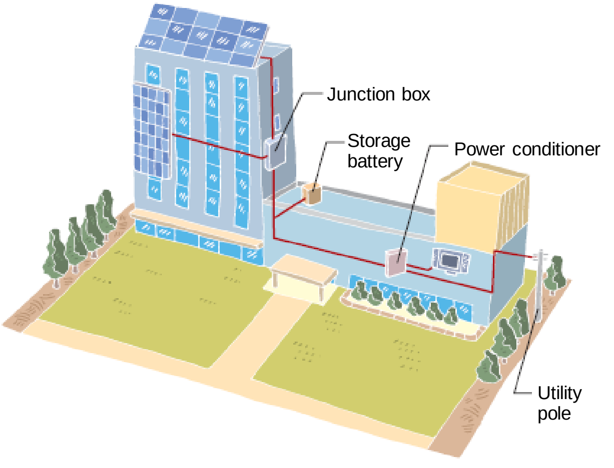
Examples of Photovoltaic Power Generation System Configurations

Grid connection type



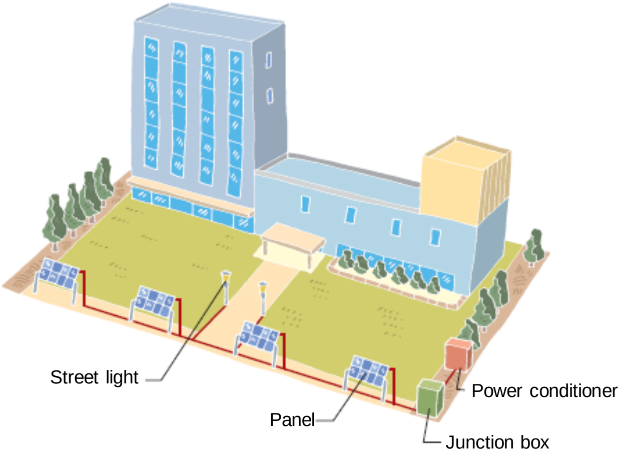
- The grid connection type is a general configuration for generating power with photovoltaic modules and consuming the generated power in a building. The shortage in power supply is compensated for by conventional power supply from an electric power company. Meanwhile, surplus power can be sold to the electric power company. The grid connection type is further classified into a high voltage grid connection available for office buildings and factories and a low voltage grid connection available for general houses.
- Thus, the grid connection type is widely applicable to office buildings, factories, stores, warehouses, etc.

Disaster prevention type



- The disaster prevention type is basically the same as the grid connection type but it is operated together with storage batteries which can be used as an emergency power supply to predetermined specific loads when commercial power supply from an electric company is cut off due to disasters.
- The disaster prevention type is applicable to hospitals, schools, public facilities, etc.

Independent type



- The independent type is a simple configuration because of no grid connection. The example shows a case of using photovoltaic power generation as a power source for street lighting with combined use of storage batteries for nighttime operation in consideration of power demand at night.
- The independent type is applicable to buildings located in the areas with no street lights, traffic signs, watches, power transmission facilities, etc.

Source: “A to Z for Companies Introducing Photovoltaic Power Generation” by the Agency for Natural Resources and Energy and the New Energy Foundation

* Renewable energy technologies encompass not only photovoltaic power generation systems but also wind power generation systems and biomass power generation systems, and have been developed by getting technical assistance of the New Energy and Industrial Technology Development Organization (NEDO), etc. Additional cases of renewable energy technologies introduced in actual projects such as ZEB verification ones will be added to these guidelines.

Column: Verification of Renewable Energy Technologies Integrated with Building Materials (Example): Wall Mounted Photovoltaic Power Generation System

- It is important to promote ZEB by introducing photovoltaic power generation systems into not only roofs but also walls so as to enhance energy self-sufficiency rates of respective buildings. However, introducing photovoltaic power generation systems into building walls requires careful attention to the risk of being a source of light pollution, etc. for surroundings due to the reflection of sunlight on photovoltaic modules. The NEDO and Kaneka Corporation have jointly developed a low reflection photovoltaic module capable of: reducing mirror reflection through light scattering with a corrugated structure on the surfaces of the photovoltaic module; and enhancing power generation efficiency using a technology to keep sunlight inside the photovoltaic module. The low reflection photovoltaic module has undergone evaluation to optimize the surface structure in the verification building of the research laboratory owned by PV & Energy Management Division, Kaneka Corporation.

- Also, in the course of the “Verification Project of Multipurpose Photovoltaic Power Generation System,” Kaneka Corporation has implemented a verification test to confirm power generation characteristics of the low reflection environment-friendly photovoltaic power generation system which is a wall mounted type photovoltaic module with enhanced aesthetic property by installing the system in the Taisei Advanced Center of Technology.

- The system has: an antiglare function to solve the problem of a wall mounted photovoltaic modules with light pollution; enhanced aesthetic property with the availability of a wide selection of colors; and workability to be installable without frames. The verification test is planned to verify whether or not the wall mounted type photovoltaic power generation system can increase annual power generation amount when installed on walls subject to oblique incident light almost throughout the year with the new technology to keep sunlight inside the low reflection module with larger flexibility in the selection of colors. These efforts have been made with the expectation to commercialize the wall mounted type photovoltaic power generation system which is applicable to those installation locations where light pollution has been the obstacle to realize ZEB and enhances aesthetic property to enable buildings to fit in with environs.

Low reflection photovoltaic modules with different colors mounted on a wall

Source: The news release of NEDO (February 25, 2016)

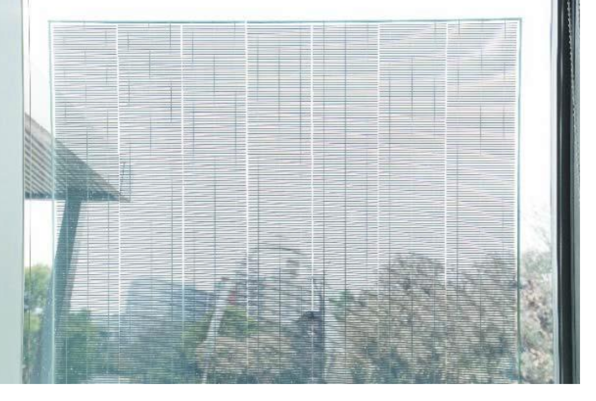
* Renewable energy technologies encompass not only photovoltaic power generation systems but also wind power generation systems and biomass power generation systems and have been developed by getting technical assistance of the New Energy and Industrial Technology Development Organization (NEDO), etc. Additional cases of renewable energy technologies introduced in actual projects such as ZEB verification ones will be added to these guidelines.

Column: Verification of Renewable Energy Technologies Integrated with Building Materials (Example): Window Mounted Thin Film Photovoltaic Power Generation System

- Low-E glass with a photovoltaic power generation function, called Attoch® system (with the specification for photovoltaic power generation), developed by AGC for upgrading windows to energy saving ones, has been used in a tasting room of Kirin Brewery Yokohama (in Yokohama City, Kanagawa). Kirin Brewery Yokohama was renovated to be an energy-friendly beverage factory but the tasting room had a problem with a high indoor temperature because of strong sunlight through a large opening facing south west. Thus, there was a demand for window glass having a heat shielding function and capable of photovoltaic power generation while ensuring a view.
- In addition to the photovoltaic power generation function, Attoch® system has several advantages including: ① lower construction costs than conventional window retrofitting because the system can be installed from an indoor side without requiring scaffolding; ② short installation work period per window with no limitation in working hours so as not to interfere the activities of users in a room; and ③ ability to alleviate hot temperatures in summer and cold temperatures in winter while curbing uncomfortable dew condensation.
- "Thin Film Photovoltaic Cell Dissemination and Propagation Project" is a project to promote the introduction of renewable energy centering on photovoltaic power generation as a part of the "Kanagawa Smart Energy Plan" established by Kanagawa Prefecture. In the project, Kanagawa Prefecture has publicly solicited for ideas of business operators such as the application of thin film photovoltaic cells to roofs and walls of buildings, road and railway facilities, insolation shielding blinds, etc., to promote the diversification of the use of thin film photovoltaic cells and to reduce their costs and has assisted the business operators who proposed attractive ideas.

Tasting room of Kirin Brewery Yokohama

Window with Attoch® system (with the specification for photovoltaic power generation)



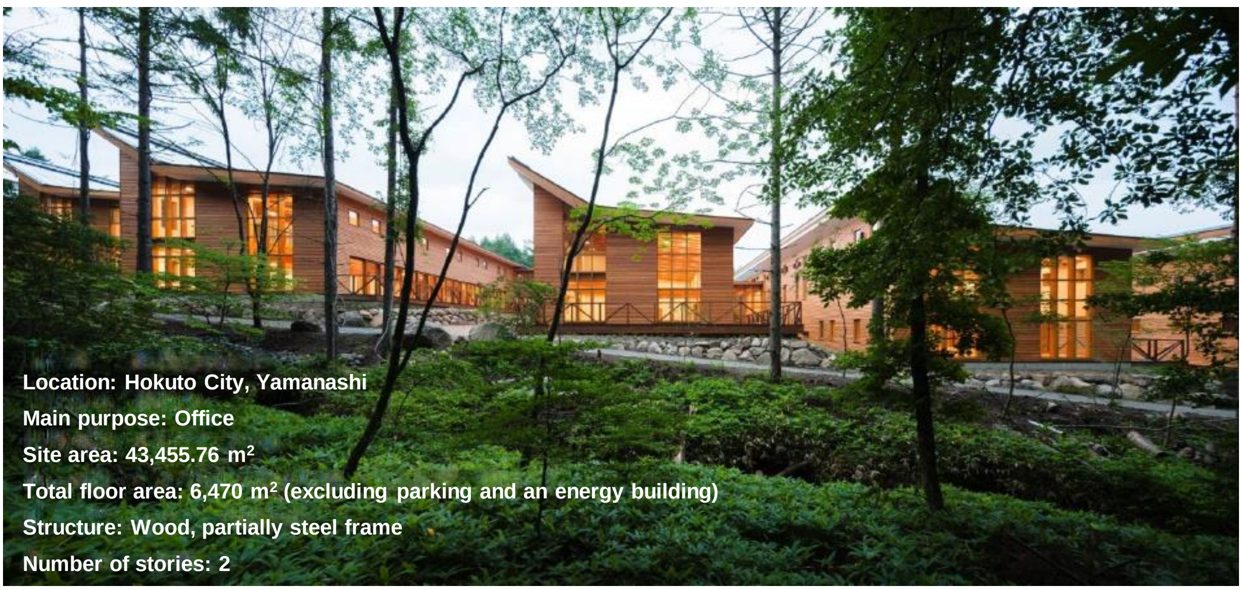
Source: The news release of AGC (April 27, 2016)
"About Thin Film Photovoltaic Cell Dissemination and Propagation Project" by Kanagawa Prefecture (July 1, 2016)

- For building-integrated photovoltaics (BIPV), a reference published by the Solar Design Consortium introduces not only the design, construction and maintenance methods of BIPV but also actual cases of BIPV in Japan and foreign countries.

* Renewable energy technologies encompass not only photovoltaic power generation systems but also wind power generation systems and biomass power generation systems and have been developed by getting technical assistance of the NEDO (New Energy and Industrial Technology Development Organization), etc. Additional cases of renewable energy technologies introduced in actual projects such as ZEB verification ones will be added to these guidelines.

Column Other Renewable Energy Utilization Technologies (Example): Woody Biomass Power Generation System

- The “Office in the Forest” of Seicho-no-ie has realized a zero-energy building in a manner that: promotes thorough energy saving through natural energy utilization such as natural ventilation, natural lighting and solar heat utilization taking advantage of cool weather at an altitude of 1,320 m and high percentages of possible sunshine; and proactively adopts energy creating technologies such as photovoltaic and biomass power generation.
- Taking advantage of ample local resources, an energy supply system utilizing woody biomass has been established as a cogeneration system which generates power through the gasification of wood chips produced from scrap wood of local lumbermills and recovers exhaust heat of gasification and power generation.
- Together with the recovered exhaust heat, a wood pellet boiler has been used for enabling the premises to be supplied with hot water, indoor heating and road heating.

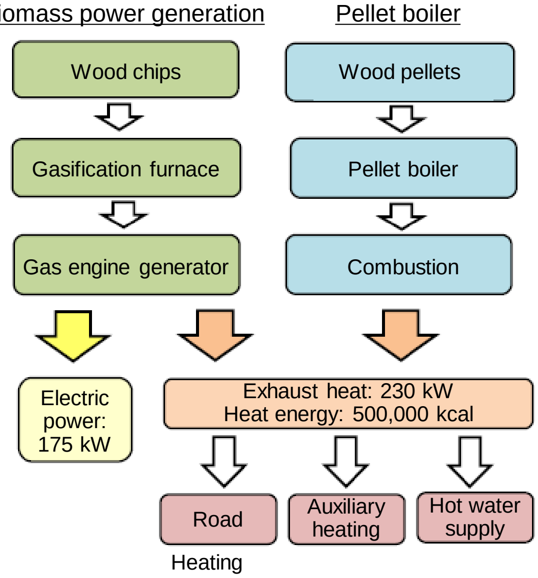


Wood chips

Wood pellets

Cogeneration through the gasification of woody biomass

Biomass power generation / Pellet boiler



“Office in the Forest” by Seicho-no-ie, the first zero energy building in Japan
Basic design by Masamitsu Nozawa, Saburo Takama
Design and Construction by Shimizu Corporation

Chapter 6

Energy Saving Technologies for Building Operation (Management)

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Chapter 6 Energy Saving Technologies for Building Operation (Management)

6.1 Necessity of Energy Saving for Building Operation

Necessity of Energy Saving for Building Operation

- In order to further enhance the effectiveness of energy saving measures, it is important to integrate the measures in the design stages with those in the operation stage.

- At the time of completion, buildings are subject to commissioning before being taken over to owners. Such commissioning is implemented with several loads set at design peak values and most buildings are successively operated with the peak load settings unchanged. Each building has its own characteristics. These characteristics have gradually become clear as operators have got familiar with operation and management of a building. Also, because the requirements of tenants change year by year, the way of energy saving setting and operation can be found by understanding existing characteristics of a building such as indoor heat generation due to office workers and OA equipment currently in operation in the building. Thus, what is required for energy saving building operation and management is “fine tuning for energy saving” through the understanding of individual characteristics of a building and the unique adjustment of facilities, equipment and systems according to the characteristics.

- According to the following description in the “Summary of the Discussions in ZEB Roadmap Examination Committee” (December 2015) (p. 17), it is preferable to effectively introduce energy saving measures not only in the design stage but also in operation stage.

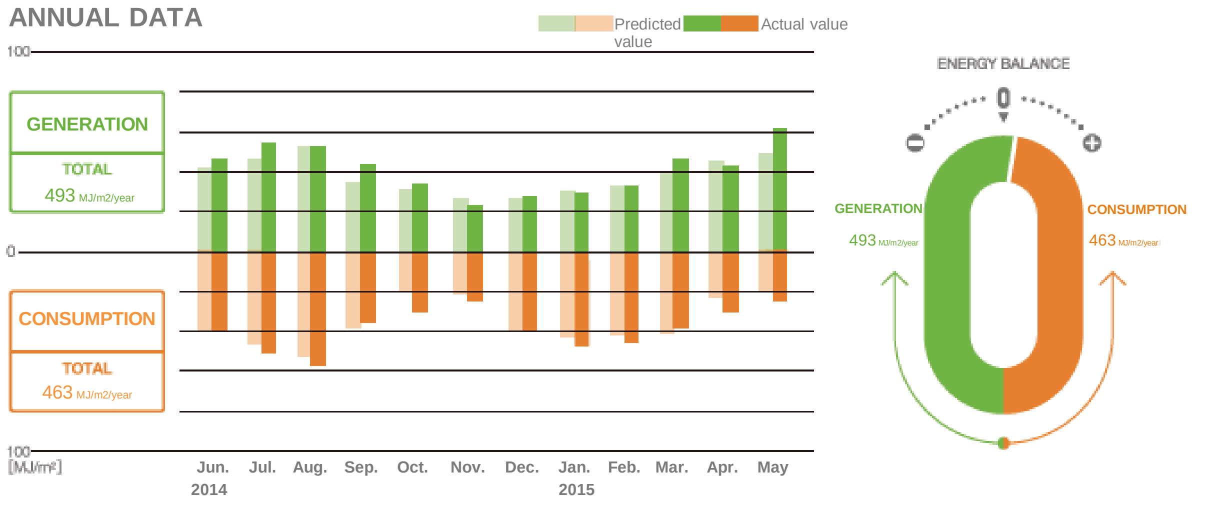
  Although this examination committee has focused on the measures to realize and disseminate ZEB in the design stage of new buildings, energy saving measures not only in the design stage but also in operation stage are indispensable for the reduction in energy consumption by civilian sectors. Thus, in addition to the deliberation in the examination committee, it is required to have opportunities to examine operational improvement for energy saving such as optimization of work style and energy saving activities of office workers and energy saving diagnoses through the sophistication of energy management system using ICT.

- Subsequent pages describe the outlines of technologies for “Substation Systems and Receptacles” and “Energy Management” necessary for achieving energy saving in operation stage.

Column — Example of Buildings Satisfying ZEB Including Operation

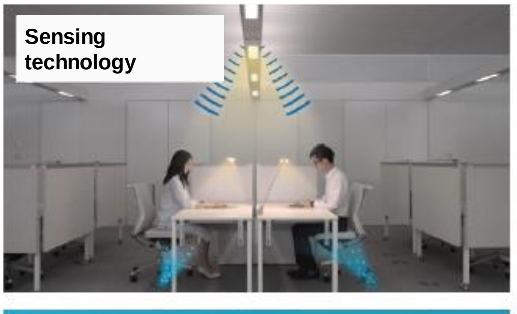
Achievement of Zero balance of annual energy consumption

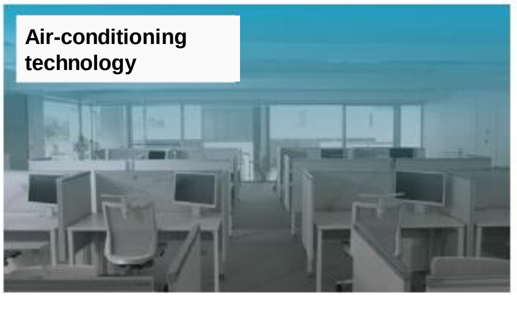
- The ZEB experimental building of Taisei Corporation achieved zero balance of annual energy consumption from the commencement of experimental operation in June 2014 to May 2015 with the energy consumption of 463 MJ/m^2/year about 1/4 of general buildings and the energy creation of 493 MJ/m^2/year. This is the first case of a single building achieving ZEB including operation in Japanese urban areas and a very rare advanced case even in the world.



Verification of the effects of technologies for ZEB

- The experimental building for ZEB verified that Taisei's unique sensing technology, newly developed daylighting equipment and lighting control technology introducing a new concept of light environments, have contributed to the simultaneous achievement of both extreme energy saving and comfortability. Also, it was verified that the experimental building for ZEB achieved zero balance of annual energy consumption as previously simulated through the collection and analyses of actual measurement data on the effects of the task ambient air-conditioning system using exhaust heat of next generation high-efficiency fuel cells, the energy creation effect of organic thin film photovoltaic power generation and other effects.





Source: The webpage of Taisei Corporation

6.2 Substation Systems and Receptacles

Purposes of Introduction the Technologies

Electric energy saving can be separately considered in the following two phases: ❶ transformation (voltage transformation) phase; and ❷ consumption phase.

❶ To save energy in transformation phase

- Offices and commercial facilities receive power supply from electric companies at high voltage such as 6.6 kV or 66 kV. Because users in these buildings or facilities consume power at the voltage of 100 and 200 V, it is necessary to transform voltage with transformers and such transformation inevitably causes power losses.

- Here, the important index affecting the magnitude of power losses in transformation phase is a “load factor” which is a ration of average power to maximum power in a certain period. Power losses are small when load factors are high. Therefore, energy saving in transformation phase can be achieved by appropriately predicting power demand when designing transformers so as to increase the load factors in average although the energy saving effects in transformation phase are limited.

❷ To save energy in consumption phase

- The factor affecting the challenge of saving energy in consumption phase is standby power consumption by drive circuits of office machines when they are not in operation. It has been said that the standby power consumption accounts for about 10% of total energy consumption by office machines.

- When purchasing office machines such as personal computers, it is important to select the types of machines with international ENERGY STAR marks certifying that these machines achieve a certain level of reductions in standby power consumption or alternatives having standby energy saving performance equivalent to or higher than the certified ones.

- Also, the legal measure related to machinery and appliances (called Top Runner Standards) stipulated in the Act on the Rational Use of Energy has obligated manufacturers to satisfy standard values set for energy saving products. Thus, it is important to select energy saving products with reference to these standards.

6.3 Energy Management

Purpose of Introducing the Technology

To appropriately control energy consumption through visualization

- A building energy management system (BEMS) is a technology to start and stop air-conditioning, substation and sanitary systems as well as monitor their operation states and malfunctions through computers and to appropriately manage the operation of planned buildings and systems so that they can deliver intended performance through several high-efficiency control using arithmetic control functions.

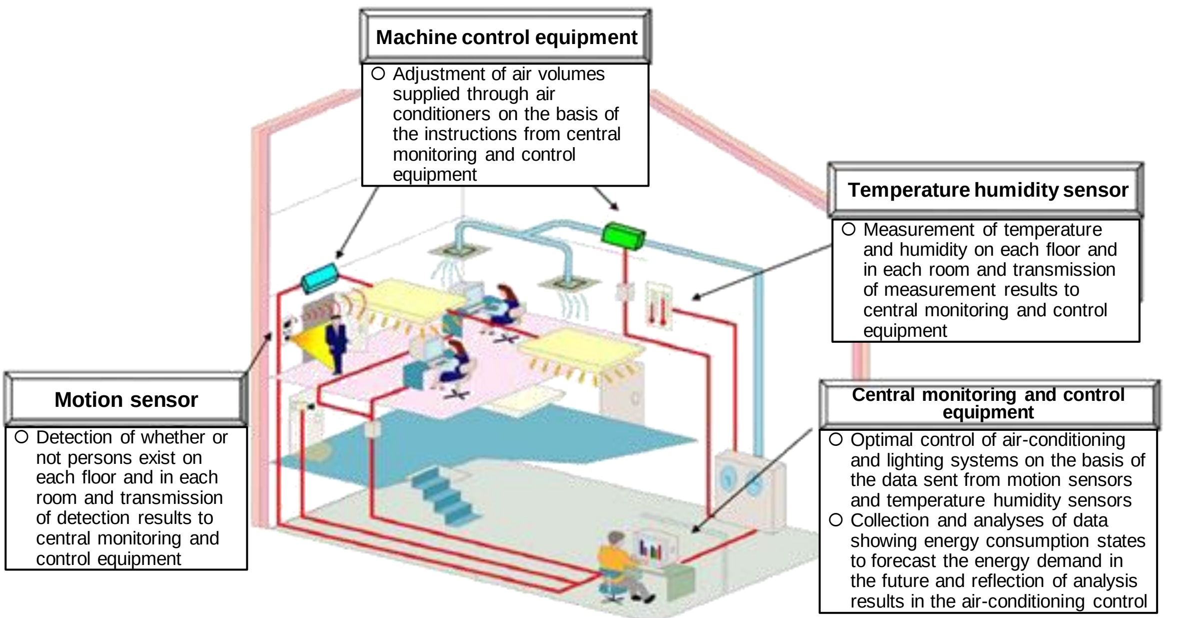
<Necessity of measuring energy consumption of an entire building>

- It is necessary to identify the sections having failures in a building through monitoring the energy consumption by system and equipment, evaluate the severity of failures by comparing energy losses due to the failures with the energy consumption plan of an entire building, and determine the priorities of countermeasures against the failures.

<Necessity of measuring energy consumption by system category>

- It is necessary to measure energy consumption in a building by use and system so as to enable the efficiency of energy consumption of a building to be improved by optimizing energy efficiency of not in the unit of each equipment for example air-conditioning heat source efficiency or pump delivery efficiency but in the unit of individual systems for example an entire air-conditioning system.

Outline of BEMS



Source: The webpage of the Ministry of the Environment

Roles of BEMS

General name	Building Automation System (BAS)	Energy Management System (EMS)	Building Management System (BMS)	Facility Management System (FMS)
User	• Building management engineer	• Building management engineer • Designer and contractor • Person in charge of performance test	• Building management engineer	• Building owner • Building management engineer
Main function	• Operation state monitoring • Security monitoring • Operation management • Automatic control of equipment	• Energy management • Indoor environment management • Equipment operation and management	• Equipment ledger management • Repair record management • Maintenance schedule management • Charge data management	• Asset management • Life cycle management (LCM) • Drawing management (CAD)

Source: SHASE-G0012-2008 "Technical Guide for Energy Saving of Buildings and Equipment, Non-residential Buildings" by the Society of Heating, Air-conditioning and Sanitary Engineers of Japan

Effects of introducing BEMS

- BEMS enables building operation and maintenance to be streamlined through, for example, the reduction in wasteful energy consumption associated with building operation and management. Also, BEMS enables operation and maintenance costs to be reduced through efficient operation management and optimal maintenance planning.

Design method

<Important points about designing BEMS>

- It is important to practice the PDCA procedure in a manner that creates BEMS operation plan, energy saving plan and implementation plan including implementation system and makes self-assessment of BEMS operation. Also, in order to properly analyze data accumulated through BEMS, it is necessary to study and determine the methods for processing accumulated data and graphic displays of analysis results in the design stage of BEMS.

<Control system>

- When introducing BEMS, it is preferable to control building operation in a manner that simultaneously achieves energy saving, comfortable indoor environments, and high productivity according to the fluctuation of building loads through the control of not only the performance of individual equipment but also the linkage of such performance and the optimization of the overall performance of a building as a whole. The examples of system control technologies include: an inter-equipment integrated control system which maintains the quality of the indoor space of a building with minimum energy by combining air-conditioning and lighting systems as well as IT equipment; and a load control system which enables equipment to be efficiently operated through sophisticated load following control, prediction control or load control of a building itself using natural energy

Operation method

- BEMS enables users to obtain power consumption and energy consumption states of air-conditioning, heat source and lighting systems. Then, with the obtained energy consumption states, users can prevent wasteful energy consumption, adjust automatic control to create comfortable indoor environments and take appropriate energy saving measures through the analyses of accumulated data.

Source: "2016 Subsidy Project for Promoting the Introduction of Innovative Energy Saving Technologies for Houses and Buildings" the Sustainable Open Innovation Initiative,
"Investigative Research on the Effective Utilization of BEMS in Government Buildings" by the Ministry of Land, Infrastructure, Transport and Tourism,
"About the Thorough Implementation of the Visualization of Energy Consumption and Energy Management" by the Global Warming Prevention Headquarters, and
"Effects of the Entire Project to Support the Introduction of BEMS (Data Management)" by NEDO

Other Important Energy Saving Technologies (Example): BEMS (1/2)

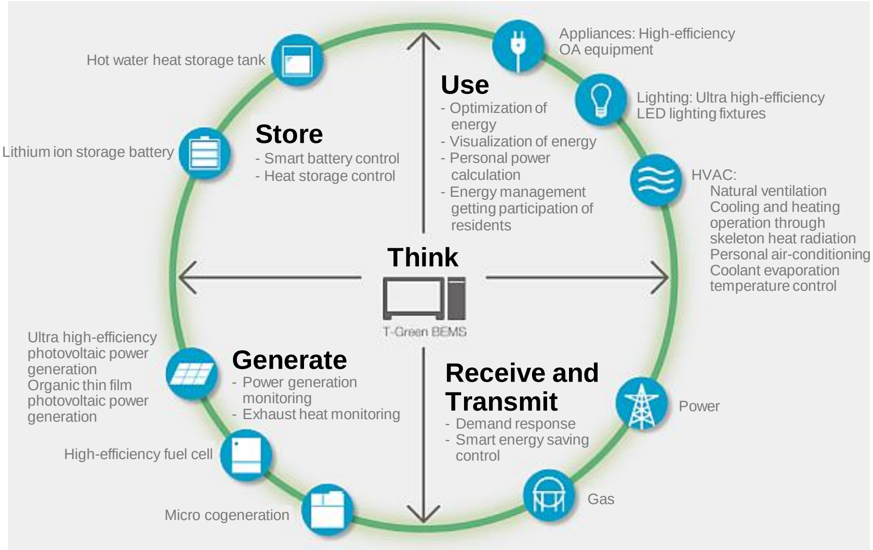
* Out of scope of the case study

* Calculation is not available with the energy consumption performance calculation program

Energy Management inside Buildings

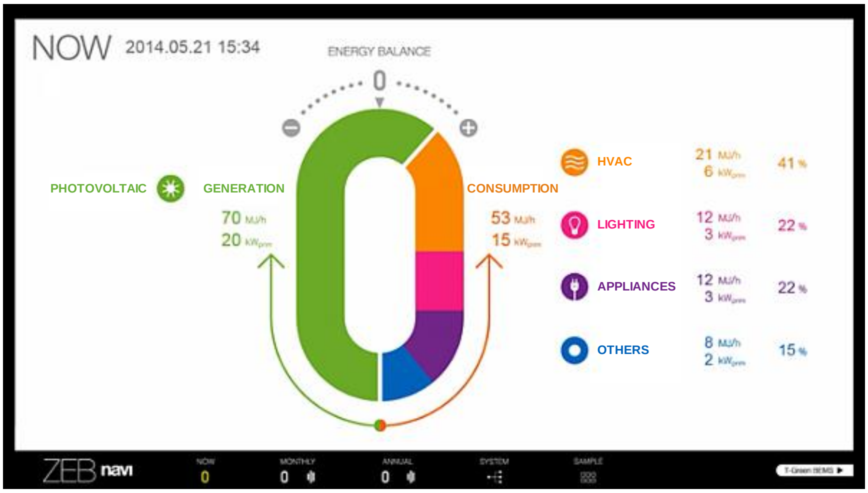
Appropriate energy management in building operation

- The ZEB experimental building of Taisei Corporation has successfully achieved ZEB including operation and the main contributing factor to such an achievement is appropriate energy management. The building energy management system called T-Green BEMS introduced into the ZEB experimental building is capable of optimally control power generation and energy consumption through all-in-one operation of the visualization of energy, energy management, data analyses and control.



Visualization of Energy with "ZEB Navi"

- The energy produced through photovoltaic power generation and the energy consumed in the ZEB experimental building is visualized on the screens of "ZEB Navi." The visualization of consumed energy can be made for: HVAC; lighting; appliances; and others including their proportions.



Source: The webpage of Taisei Corporation

Other Important Energy Saving Technologies (Example): BEMS (2/2)

* Out of scope of the case study
* Calculation is not available with the energy consumption performance calculation program

Energy Management of Building Cluster

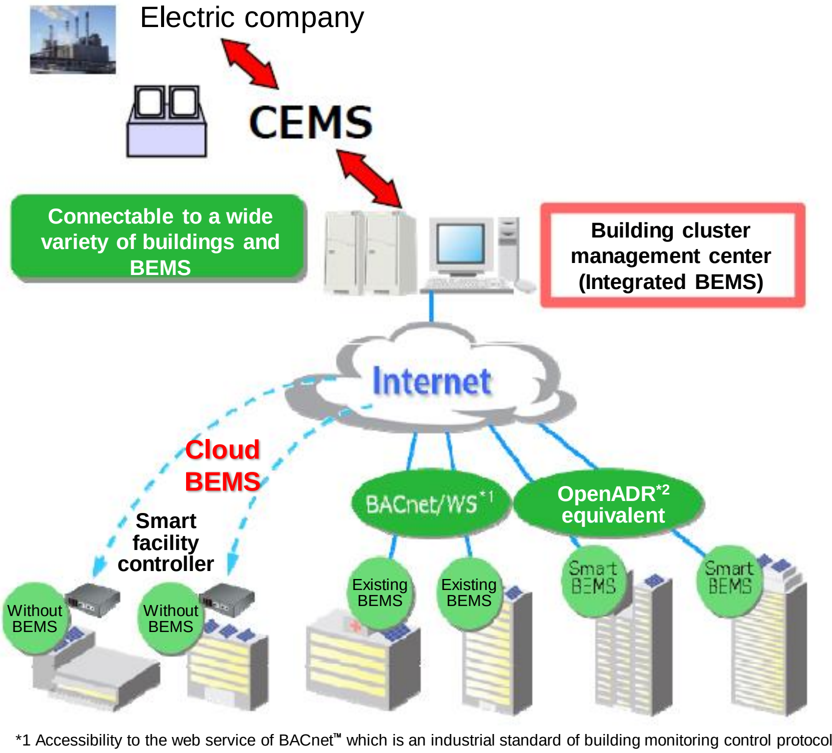
Integrated BEMS technology for collective management of building cluster

- Collective management of energy in a cluster of plural buildings using integrated BEMS enables demand control (maintaining of contract power), peak cut (reduction in the maximum annual power demand), demand response (reduction in power consumption in response to the request from an electric company), and load control (direct control of the loads of consumers for demand response) to be realized. Also, collective management of energy in a cluster of plural buildings is expected to realize larger load adjustment capacity than the management of energy in individual buildings.

- Integrated BEMS has the following characteristics:

① Optimal distribution of a demand response amount according to the load adjustment capacity of respective buildings;
② Maximization of the demand response capacity of an entire cluster of buildings through collective control capable of flexible management of load adjustment capacity of respective buildings;
③ Visualization of information on integrated energy use in a cluster such as the comparison of energy consumption among buildings and highly sophisticated information;
④ Availability of a cloud type BEMS service enabling a medium-to-small scale building without the introduction of BEMS to access energy management functions equivalent to BEMS; and
⑤ Achievement of CO_2 emission reduction of 10 to 25% as the load equalization effect through energy saving and demand response control.

- One of the examples of integrated BEMS is the “Yokohama Smart City Project (YSCP)” through which the world largest smart city has been established with the Yokohama Landmark Tower and Minatomirai Grand Central Tower and other buildings integrated as a cluster of buildings in Minatomirai district subject to collective energy management. As a part of the project, a verification test of demand response using integrated BEMS was implemented in January and July to September in 2013 and the test successfully achieved peak cut up to 20%.



*1 Accessibility to the web service of BACnet™ which is an industrial standard of building monitoring control protocols
*2 The U.S. standards for automatic demand response

Source: ©2014 Toshiba Corporation

Chapter 7

Examples

PDF変換後に、
表紙・中扉の差し替えをお願いします

7.1 Example of Building Design for ZEB

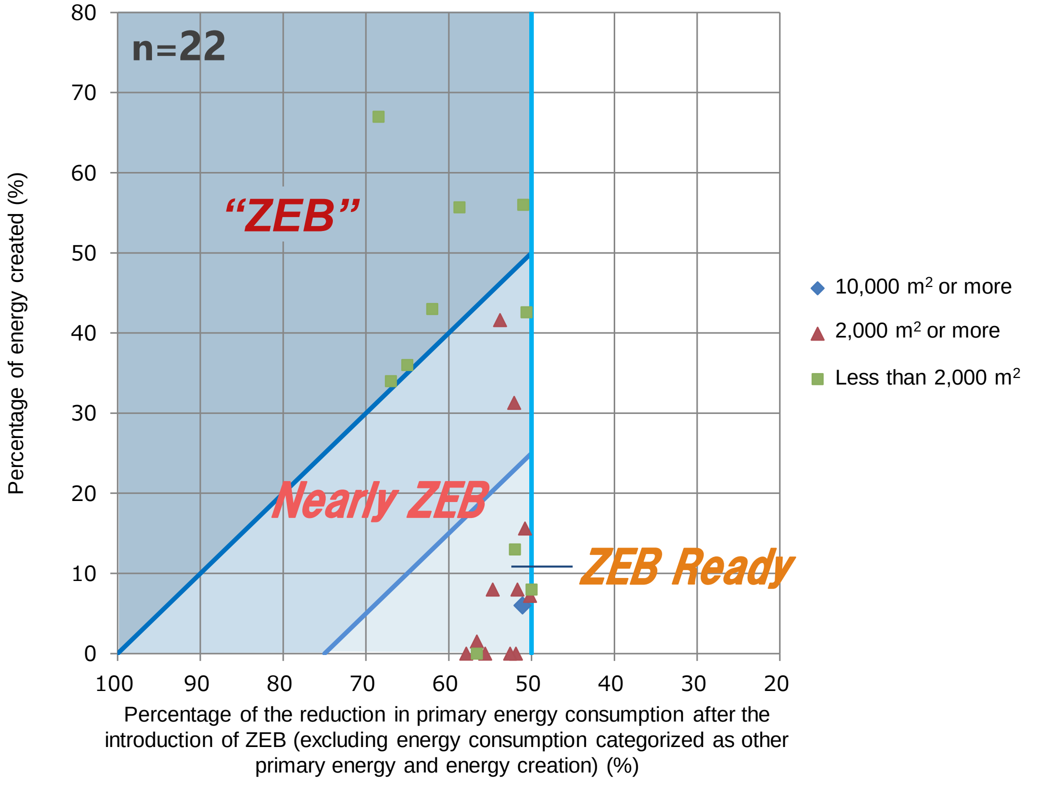
Outline of the Systems Introduced in the (Office) Buildings Applied for a Subsidy Project

- The ZEB verification project is a subsidy project to financially assist the introduction of high-efficiency systems and equipment into buildings which are designed to realize, disseminate and propagate ZEB and use these high-efficiency systems and equipment as component element of ZEB for realizing high energy saving performance.

- In 2017, 45 buildings satisfying the following requirements were granted for the subsidy.

① Individuals or companies who have business bases in Japan and intend to introduce high-efficiency systems and equipment into their buildings.
② Individuals or companies who can assent to the disclosure of design data for establishing ZEB Design Guidelines.
③ Capability of reducing primary energy consumption of entire buildings by 50% or more provided, however, that the energy consumption categorized as other primary energy and power generation utilizing renewable energy is excluded from the calculations of the reductions in primary energy consumption. Such calculations shall be based on the standards for building energy consumption performance published in 2013 or 2016.
④ The envelope performance of nonresidential buildings complies with the PAL* Standards specified for the use and locations of buildings. The envelope performance of respective residential units of rented housing complex shall be equal to or higher than the reinforced envelope standards specified for respective regions. The calculation of envelope performance shall be based on the standards for building energy consumption performance published in 2013 or 2016.
⑤ Mandatory introduction of BEMS equipment including equipment for measurement, control, monitoring, and data storage, analysis and diagnosis.
⑥ Mandatory establishment of an energy management system capable of: measuring energy for respective measurement category of heat source (chiller, heat pump, cooling tower, pump, etc.), lighting fixture and receptacle and others; collecting, analyzing and evaluating measured data; and continuously making reports on energy consumption and improving energy saving performance.
⑦ Mandatory acquisition of the certificates for the energy saving performance issued by third party evaluation institutions based on Article 7 of the Building Energy Efficiency Act in either category of ZEB, Nearly ZEB or ZEB Ready basically by the end of the project.
⑧ Capability of implementing the subsidy project (with social credibility, financial resources and implementation structures to ensure the continuity of business).

Certificate acquisition by the office buildings participated in ZEB verification project by the government (2014 to 2016)



Category		Energy saving technology for ZEB	Total (49 buildings)	Office (14 buildings)	Hotel and Japanese inn (2 buildings)	Hospital (7 buildings)	Elder care and welfare facilities (16 buildings)	Market (8 buildings)	University and other schools (1 building)	Gymnasium (1 building)
Building energy saving technology (Passive technology)		• Building layout plan	8	3	0	1	1	3	0	0
		• Enhancement of envelope performance (PAL* reduction rate ≥ 10%)	47	14	2	6	16	7	1	1
		• Envelope insulation	49	14	2	7	16	8	1	1
		Glass wool insulation material	21	6	2	1	4	8	0	0
		Rock wool insulation material	3	1	0	1	0	1	0	0
		Polystyrene foam heat insulation board	26	7	1	5	10	1	1	1
		Urethane foam heat insulation material	22	6	1	6	7	1	1	0
		• Low-E double glass	32	11	2	5	10	4	0	0
		Dry air layer	21	8	2	3	6	2	0	0
		Insulation gas layer	7	3	0	1	1	2	0	0
		Vacuum	6	1	0	1	4	0	0	0
		• Metal resin composite sash	11	2	0	2	7	0	0	0
		• Insolation shielding	22	9	1	2	8	2	0	0
		Canopy	16	5	1	1	7	2	0	0
		Blind (solar tracking type)	2	1	0	0	1	0	0	0
		Gradation blind	1	1	0	0	0	0	0	0
		Louver (insolation following type)	2	2	0	0	0	0	0	0
		Wall greening	2	0	0	1	0	1	0	0
		• Natural ventilation	12	7	0	1	3	0	0	1
		Utilization of wind pressure	8	6	0	0	1	0	0	1
		Utilization of temperature difference (chimney effect)	7	4	0	1	2	0	0	0
		Hybrid type (combined with mechanical ventilation)	1	0	0	0	0	0	0	1
		• Daylighting	13	6	1	1	2	2	0	1
		Light shelf	2	1	0	0	0	0	0	1
		Atrium	5	3	0	0	2	0	0	0
		Daylighting cloth	3	3	0	0	0	0	0	0
		Daylighting window film or panel	6	2	1	1	0	2	0	0
		Top light	3	2	0	0	1	0	0	0
		Light duct	3	2	0	0	0	1	0	0
		Daylighting blind	1	1	0	0	0	0	0	0
System energy saving technology (Active technology)	Air conditioning	• High-efficiency air-conditioner (independent dispersion type)	49	14	2	7	16	8	1	1
		Room air conditioner	14	3	1	2	8	0	0	0
		Packaged air conditioner (building multiple, EHP)	48	13	2	7	16	8	1	1
		Packaged air conditioner (building multiple, GHP)	2	1	0	0	0	1	0	0
		• High-efficiency heat source equipment (central type)	4	2	0	1	1	0	0	0
		Chilling unit (air cooled type)	4	2	0	1	1	0	0	0
		Absorption chiller	1	0	0	1	0	0	0	0
		• Auxiliary heat source utilization system	9	5	0	1	2	0	0	1
		Ground source heat utilization system (HP)	2	1	0	0	1	0	0	0
		Ground source heat utilization system (cooling, heat tube)	5	2	0	1	1	0	0	1
		Well water heat utilization system	4	3	0	0	0	0	0	1
		Solar heat utilization system	2	2	0	0	0	0	0	0
		Cogeneration exhaust heat utilization system (including fuel cell)	2	2	0	0	0	0	0	0
		• External air utilization control system	41	13	2	5	16	3	1	1
		Total heat exchanger system	39	12	2	5	16	2	1	1
		Total heat exchanger bypass control system	7	1	0	1	5	0	0	0
		External air cooling system	21	8	1	3	5	3	1	0
		Night purge system (enthalpy control)	19	6	1	1	8	2	0	1
		Minimum external air volume control system (CO_2 control)	19	11	0	1	5	1	0	1
		• Variable volume system	9	4	0	3	1	0	0	1
		VAV air-conditioning system (INV)	7	4	0	3	0	0	0	0
		VWV air-conditioning system (INV)	6	3	0	1	1	0	0	1
		Large temperature difference water delivery system	3	1	0	1	0	0	0	1
		• Other air-conditioning system	10	7	0	0	1	1	0	1
		Radiation cooling and heating system	4	3	0	0	1	0	0	0
		Desiccant air-conditioning system	7	6	0	0	0	1	0	0
		Ice heat storage system	2	1	0	0	0	0	0	1
		Floor air-conditioning system	1	1	0	0	0	0	0	0
		Task ambient air-conditioning system	4	4	0	0	0	0	0	0

Category		Energy saving technology for ZEB	Total (49 buildings)	Office (14 buildings)	Hotel and Japanese inn (2 buildings)	Hospital (7 buildings)	Elder care and welfare facilities (16 buildings)	Market (8 buildings)	University and other schools (1 building)	Gymnasium (1 building)
System energy saving technology (Active technology)	Air conditioning	• Other air conditioner	4	3	0	0	0	0	0	1
		HP desiccant external air conditioner	2	2	0	0	0	0	0	0
		Desiccant total heat exchanger	2	2	0	0	0	0	0	0
		Evaporation type chiller	2	1	0	0	0	0	0	1
		High sensible heat building multiple air conditioner	1	1	0	0	0	0	0	0
		• Air-conditioning control system	15	6	1	2	3	1	1	1
		Motion detection control system	12	6	0	2	3	0	1	0
		Motion detection (camera) control system	2	0	0	0	1	1	0	0
		Predicted mean vote (PMV) control system	2	0	0	1	0	0	0	1
		Radiation temperature control system	1	0	0	1	0	0	0	0
		Time schedule control system	1	1	0	0	0	0	0	0
		Heat source integration control system	5	2	1	2	0	0	0	0
	Mechanical ventilation	• High-efficiency induction motor (JIS C4212, 4213)	11	2	1	1	2	4	1	0
		• DC motor	3	1	0	1	1	0	0	0
		• Air volume control	20	5	1	4	6	4	0	0
		CO_2 concentration	9	1	0	2	3	3	0	0
		Temperature	7	3	0	0	1	3	0	0
		Enthalpy	1	1	0	0	0	0	0	0
		Motion detection	2	0	0	1	1	0	0	0
		Gas usage	2	0	0	1	1	0	0	0
		Power usage	1	0	1	0	0	0	0	0
		Exhaust gas detection	2	0	0	2	0	0	0	0
	Lighting	• High-efficiency lighting fixture	49	14	2	7	16	8	1	1
		LED lighting fixture	49	14	2	7	16	8	1	1
		• Lighting method	7	5	1	0	0	0	0	1
		Task ambient lighting	7	5	1	0	0	0	0	1
		• Lighting control	46	14	2	6	14	8	1	1
		Luminous detection control system	41	14	2	5	13	5	1	1
		Motion detection control (including motion sensor and camera)	39	14	2	5	10	6	1	1
		Time schedule control system	27	11	1	3	6	4	1	1
		Initial illuminance control	5	2	0	1	2	0	0	0
		Digital independent control system	11	6	1	1	1	2	0	0
	Hot water supply	• High-efficiency water heater	38	8	2	7	16	5	0	0
		Heat pump water heater	33	7	2	6	13	5	0	0
		Latent heat recovery type water heater	6	1	1	1	3	0	0	0
		• Auxiliary heat source utilization system	12	1	2	1	7	1	0	0
		Solar heat utilization system	10	0	2	1	6	1	0	0
		Ground source heat utilization system	2	0	0	1	1	0	0	0
		Well water heat utilization system	1	1	0	0	0	0	0	0
		Cogeneration exhaust heat utilization system	7	1	1	1	4	0	0	0
		PV panel heat utilization system	1	1	0	0	0	0	0	0
	Elevator	• VVVF control and power regenerative control	15	7	1	1	2	3	1	0
	Substation	• Secondary top runner transformer	37	10	2	5	12	6	1	1
		• Cogeneration system	8	2	1	1	4	0	0	0
		Fuel cell	2	2	0	0	0	0	0	0
		• Storage battery system (linked with energy creation)	5	4	0	0	0	1	0	0
Renewable energy		• Power generation system	28	9	2	4	9	4	0	0
		Photovoltaic power generation system	28	9	2	4	9	4	0	0
		Wind power generation system	2	1	0	0	0	1	0	0
Energy management		• Inter-equipment integrated control system	8	3	1	1	2	0	0	1
		• Equipment-user linkage control system	29	10	1	3	9	4	1	1
		• Load control	23	10	0	3	7	2	0	1
		• Inter-building integrated control system	0	0	0	0	0	0	0	0
		• Energy management in operation stage including tuning	48	14	2	7	15	8	1	1

- (white) : Technology for which web calculation is available
- (grey) : Technology for which web calculation is not available
- (light green) : Technology for ZEB introduced into buildings accounting for 50% or more of the total
- (green) : Technology for ZEB introduced into buildings accounting for 80% or more of the total

(including technologies not eligible for subsidy)

7.1 Example of Building Design for ZEB

Example 01: Proactive Introduction of Energy Saving Equipment for Manufacturing that Cares for People and Environments

<Concept for realizing ZEB>

As a part of the project to mark the 70th anniversary of its founding in October this year, the company plans to construct a new office building and utilize it as a global development base. The new office building is designed to proactively introduce energy saving equipment and systems with “realization of manufacturing which cares for people and environments to preserve beautiful earth for the next generation” as a slogan for environmental conservation.

After getting certified as a building satisfying ZEB by a third party evaluation institute, the company is planning to proactively advertise the building satisfying ZEB through its web page and corporate brochures.

<Outline of the building>

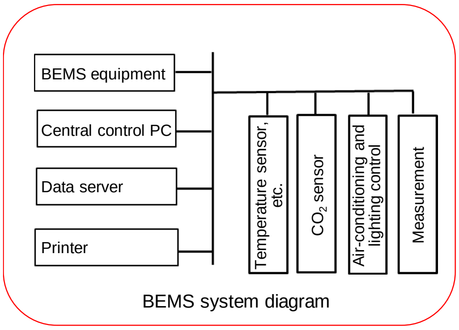
- Location: Kanagawa Prefecture (Area 6)
- Site area: 38,841 m^2
- Building area: 2,064 m^2
- Total floor area:12,726 m^2
- Structural type: Steel
- Number of stores: 7 stories above ground and 1 story below ground
- Building use: Office and others
- Annual workdays: 244 days

<Cost per unit floor area>

- Procurement cost for the portion of the building eligible for subsidy: 26,329 yen/m^2
- Procurement and installation costs for the portion of the building eligible for subsidy: 47,061 yen/m^2

External view of the building

BEMS system diagram



BEMS system diagram

<Outline of systems introduced>

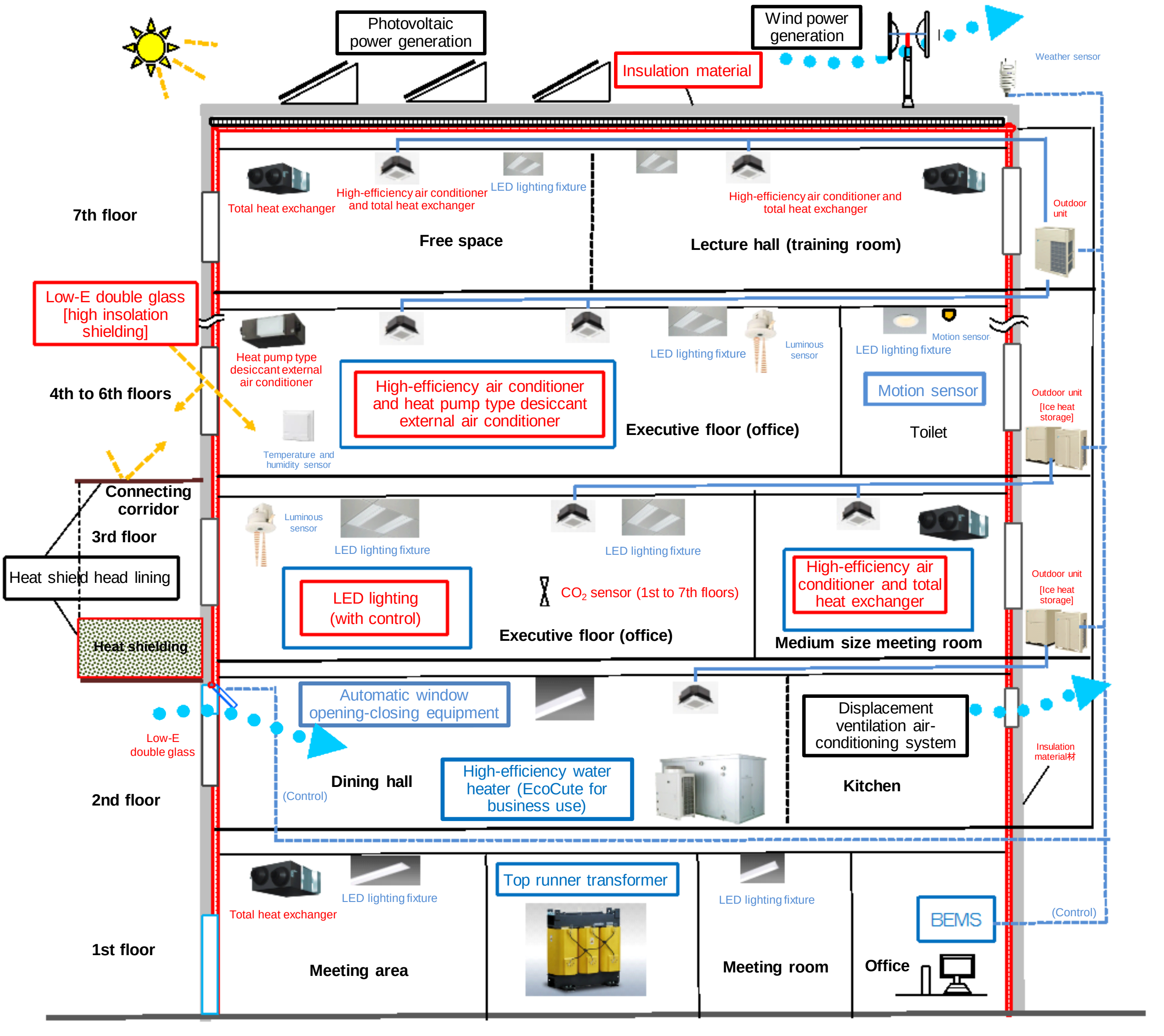
Envelope	External wall	• Glass wool (24K) 100 mm
	Roof	• Extruded polystyrene foam 35 mm
	Window	• Low-E double glass (high insolation shielding)
Air conditioning	Heat source type	• Independent
	Equipment	• EHP
	System I	• High-efficiency building multiple air conditioner (ice heat storage) • Heat pump type desiccant external air conditioner★
	System II	• Total heat exchanger • Heat pump type desiccant external air conditioner★ • CO^2 sensor control • Night purge control • Temperature and humidity sensor control • Displacement ventilation air-conditioning

Mechanical ventilation	Equipment	• Type 1 ventilation • Local ventilation
	System	• CO_2 sensor • Natural ventilation★ • Temperature sensor
Lighting	Equipment	• LED
	System	• Luminance detection control (illuminance sensor) • Time schedule control • Motion detection control (motion sensor)
Hot water supply	Heat source type	• Independent
	System	• EcoCute for business use, EHP
Renewable energy, etc.		• Photovoltaic power generation • Wind utilization★ • Top runner transformer★ • Wind power generation★
System control, etc.		• Load control★ • Energy management in operation stage such as tuning★

Note: ★ means that a system or equipment cannot be quantitatively evaluated with the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017).

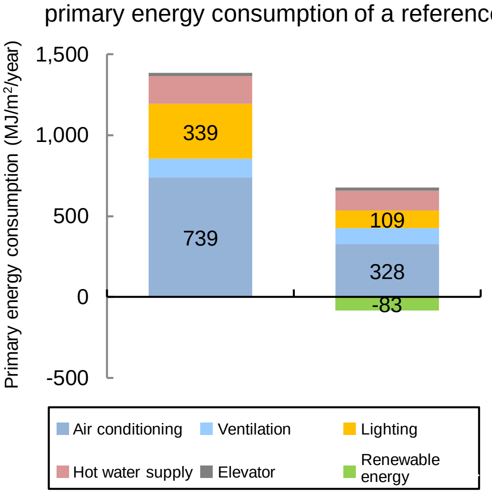
<Outline of systems and equipment>

- The building is a technology center accommodating business functions such as research and development divisions and has energy characteristics similar to an office building.



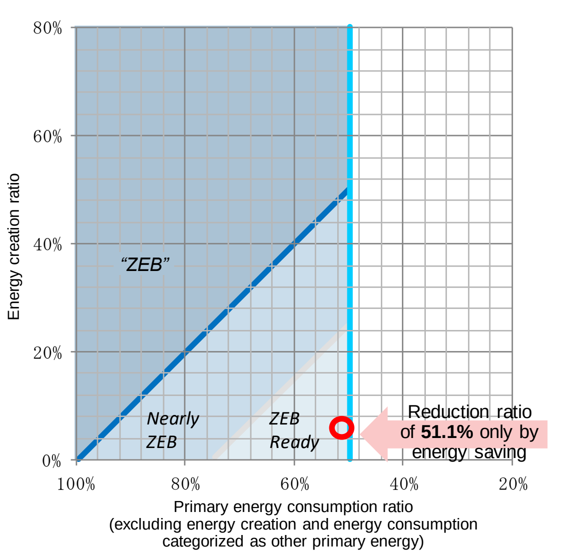
<Energy performance evaluation>

- The primary energy consumption of the building is 677 MJ/m²/year (594 MJ/m²/year including renewable energy creation) which corresponds to about 51% reduction from the primary energy consumption of a reference building.



Unit: MJ/m²/year

	Reference	Design	BPI/ BEI
Envelope	450	345	0.77
Air condition-ing	739	328	0.44
Ventilation	114	99	0.87
Lighting	339	109	0.32
Hot water supply	172	122	0.71
Elevator	22	20	0.89
Total	1,386	677	0.49
Renewable energy	0	-83	-
Total	1,386	594	0.43



Example 02: Energy Saving Mainly through Passive Building Design

<Concept for realizing ZEB>

The realization of a headquarter building satisfying ZEB was made possible first through the passive building design including the reinforcement of envelope performance and the optimal utilization of daylighting and natural ventilation, thereby reducing the energy load of an entire building. Then, residual energy load was thoroughly alleviated through the introduction of high-efficiency air-conditioning, lighting and hot water supply systems. In addition to the energy saving measures in design stage, the reduction in energy consumption has been achieved in operation stage through appropriately observing and evaluating the actual state of energy consumption with BEMS.

<Outline of the building>

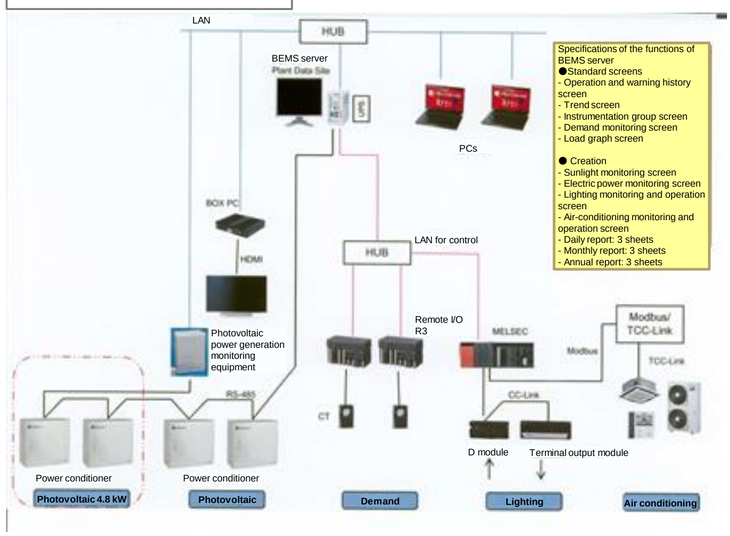
- Location: Shizuoka Prefecture (Area 6)
- Site area: 2,307 m^2
- Building area: 1,003 m^2
- Total floor area: 3,704 m^2
- Structural type: Steel
- Number of stories: 4 stories above ground
- Building use: Office and others
- Annual workdays: 254 days

<Cost per unit floor area>

- Procurement cost for the portion of the building eligible for subsidy: 36,913 yen/m^2
- Procurement and installation costs for the portion of the building eligible for subsidy: 50,478 yen/m^2

External view of the building

BEMS system diagram



<Outline of systems introduced>

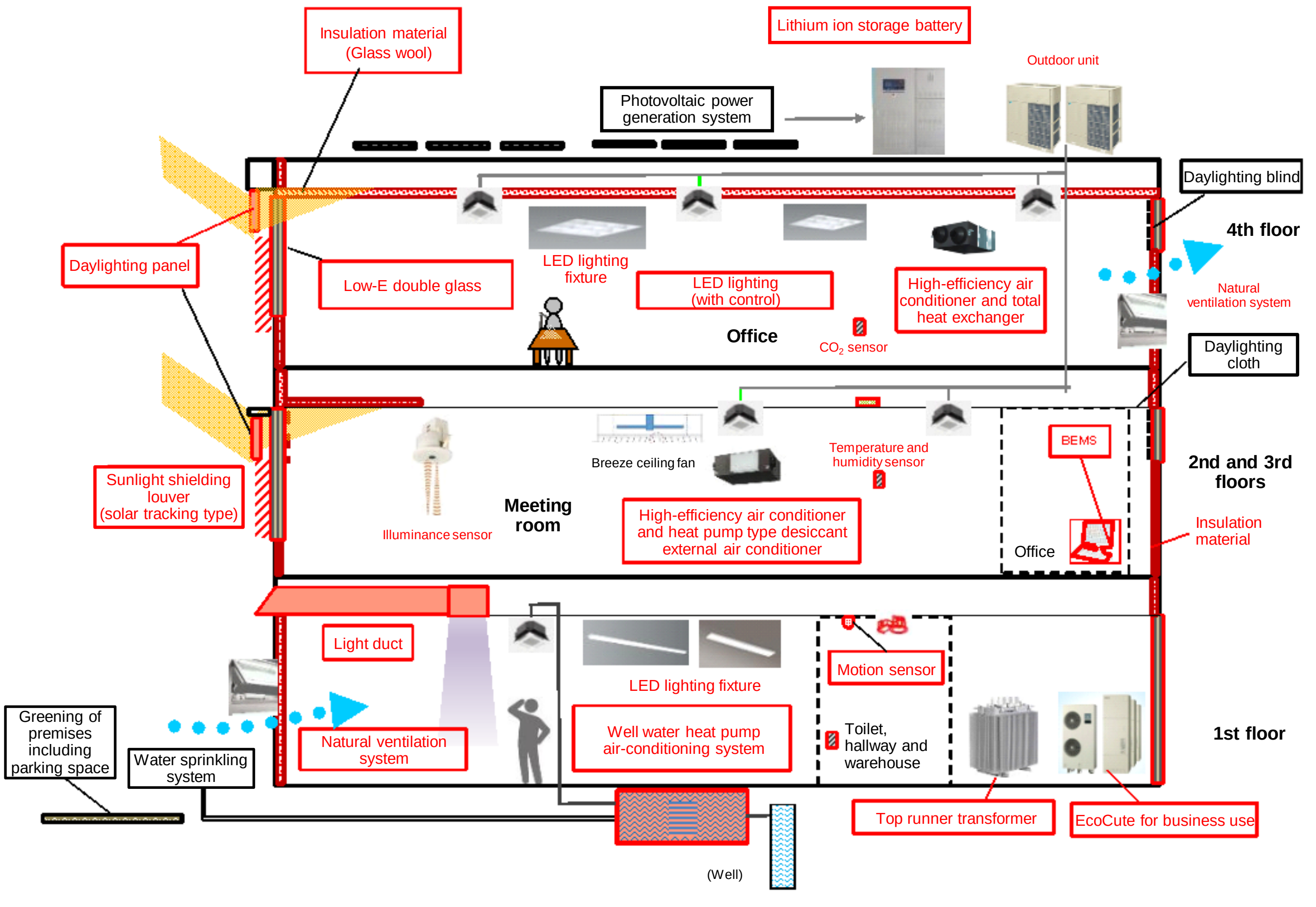
Envelope	External wall	• Glass wool (24K) 50 mm
	Roof	• Glass wool (24K) 100mm
	Window	• Low-E double glass • Heat shielding louver (solar tracking type)★
Air conditioning	Heat source type	• Central and independent combined
	Equipment	• EHP (building multiple air conditioning) • Well water heat utilization heat pump★
	System I	• High-efficiency building multiple air conditioning • High-efficiency building multiple air conditioning (high sensible heat type) • Heat pump type desiccant external air conditioning (DESICA)★ • Utilization of untapped energy (well water)★
	System II	• Total heat exchanger • Heat pump type desiccant external air conditioner (DESICA)★ • Night purge control • Temperature and humidity sensor control

Mechanical ventilation	Equipment	• Type 1 ventilation • Type 3 ventilation
	System	• CO_2 sensor • Natural ventilation★
Lighting	Equipment	• LED • High brightness guide light
	System	• Luminous detection control • Time schedule control • Motion detection control
	Daylight utilization	• Daylighting window film • Daylighting cloth★ • Light duct★
Hot water supply	Heat source type	• Central
	System	• EHP (CO_2 coolant heat pump)
Renewable energy, etc.		• Photovoltaic power generation • Utilization of wind★ • Utilization of earth thermal • Storage battery★ • Top runner transformer 2014★
System control, etc.		• Load control★ • Energy management in operation stage such as tuning★

Note: ★ means that a system or equipment cannot be quantitatively evaluated with the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017).

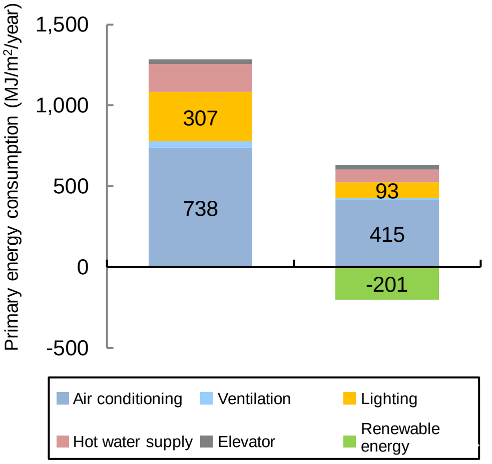
<Outline of systems and equipment>

- The building is a medium-size office building constructed in Hamamatsu City, Shizuoka Prefecture (Area 6) and comprising offices, meeting rooms, a dining hall and showrooms with spaces for trial production and light work.



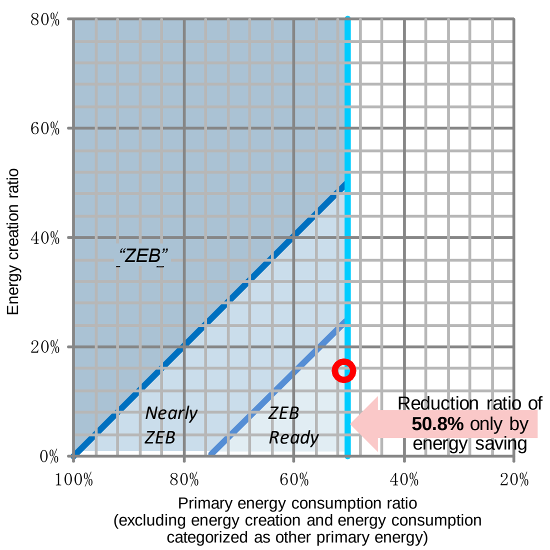
<Energy performance evaluation>

- The primary energy consumption of the building is 632 MJ/m²/year (431 MJ/m²/year including renewable energy creation) which corresponds to about 51% reduction from the primary energy consumption of a reference building.



Unit: MJ/m²/year

	Reference	Design	BPI/BEI
Envelope	470	304	0.65
Air conditioning	738	415	0.56
Ventilation	38	14	0.38
Lighting	307	93	0.30
Hot water supply	173	81	0.47
Elevator	29	29	1.00
Total	1,286	632	0.49
Renewable energy	0	-201	-
Total	1,286	431	0.34



Example 03: Office Building Satisfying ZEB and Comfortability Tailored to Work Style

<Concept for realizing ZEB>

The building is designed in consideration of its locational conditions.
On the basis of the company's environmental policy, the building is designed to realize significant reduction in energy consumption through: ① the reinforcement of insulation on the ceiling of the highest floor; ② the introduction of Low-E double glass; ③ the introduction of high-efficiency air conditioners; ④ CO_2 control; and ⑤ the introduction of LED lighting fixtures with control and the utilization of BEMS equipment. The building is developed as an experimental facility which: goes beyond an energy saving office building reducing overall energy use in an entire building and into the realm of an office building satisfying ZEB, zero energy consumption; and to realize comfortable office space tailored to work style.

<Outline of the building>

- Location: Nagano Prefecture (Area 4)
- Site area: 46,104 m^2
- Building area: 962 m^2
- Total floor area: 3,704 m^2
- Structural type: Steel
- Number of stories: 4 stories above ground
- Building use: Office and others
- Annual workdays: 246 days

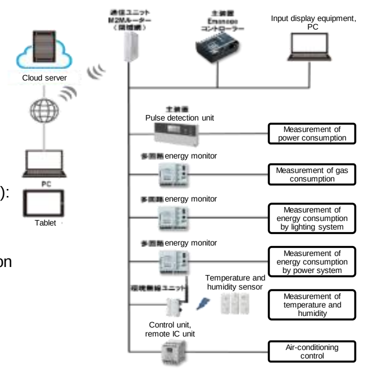
<Cost per unit floor area>

- Procurement cost for the portion of the building eligible for subsidy: 27,707 yen/m^2
- Procurement and installation costs for the portion of the building eligible for subsidy: 34,274 yen/m^2

External view of the building

BEMS system diagram

[BEMS equipment]
Management type: Independent
Number of management points: 128 points
Usage measurement (power and gas): 123 pints
Temperature and humidity measurement: 5 points
Measuring function: energy consumption amount
Monitoring function: power demand
Data management function
Graphic display of several measurements
Data output in CSV format



<Outline of systems introduced>

Envelope	External wall	• Rock wool 50 mm
	Roof	• Glass wool 150 mm
	Window	• Low-E double glass
Air conditioning	Heat source type	• Independent
	Equipment	• GHP outdoor unit • GHP indoor unit
	System I	• Gas heat pump air conditioner
	System II	• CO_2 sensor control • Quantity control
Mechanical ventilation	Equipment	• Type 1 ventilation • Type 3 ventilation
	System	• Temperature sensor
Lighting	Equipment	• LED
	System	• Luminous detection control • Time schedule control • Motion detection control • Initial illuminance correction function

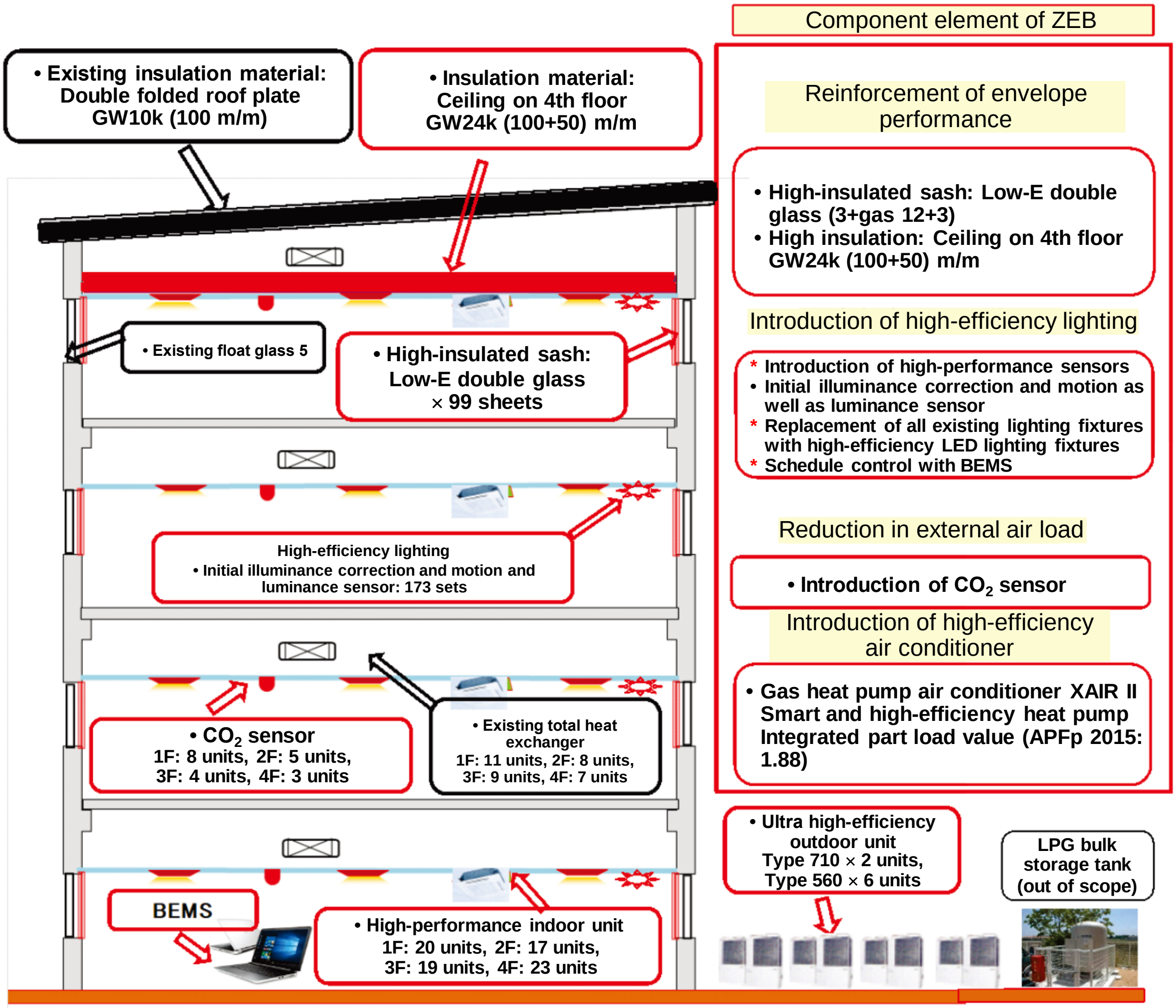
Hot water supply	Heat source type	• Independent
	System	• Electric water heater
BEMS★		• Data output function • Optimal start and stop control • Display and output of daily, monthly, annual reports • Display of trend graphs • Time program control • Visualization • Optimization control • Equipment history management • Warning data management • Energy consumption analysis management • Energy use calculation plan
System control, etc.		• Inter-equipment integrated control system★ • Inter-building integrated control system★ • Load control★ • Energy management in operation stage such as tuning★

Note: ★ means that a system or equipment cannot be quantitatively evaluated with the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017).

<Outline of systems and equipment>

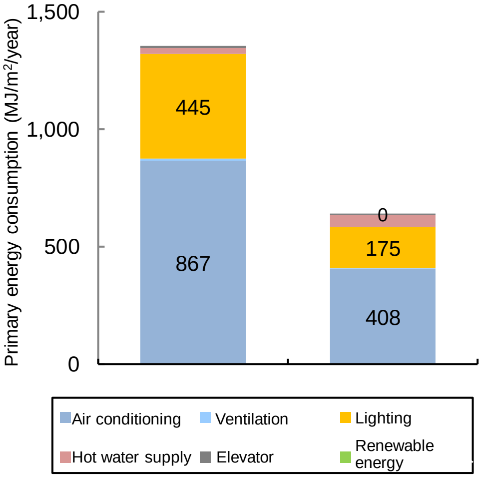
Facing mountains on the east and west sides, the building has favorable insolation condition with no high buildings nearby. A photovoltaic power generation system with capacity of 50 kW is installed on the roof of the molding technology building.

Also, taking advantage of the "Feed-in Tariff System for Renewable Energy," an additional photovoltaic power generation system with capacity of 500 kW has been in operation since August 2013 on the adjacent area. According to the report made by the Building-Energy Manager's Association of Japan, the average annual energy consumption of office buildings is 1,488 MJ/m^2/year. In contrast, the building had the annual energy consumption of 1,231 MJ/m^2/year (in 2014) before the introduction of ZEB and 1,022 MJ/m^2/year after the introduction of ZEB. Thus, it can be said that the building is a model project serving as a "source to offer information" on energy saving in the region.



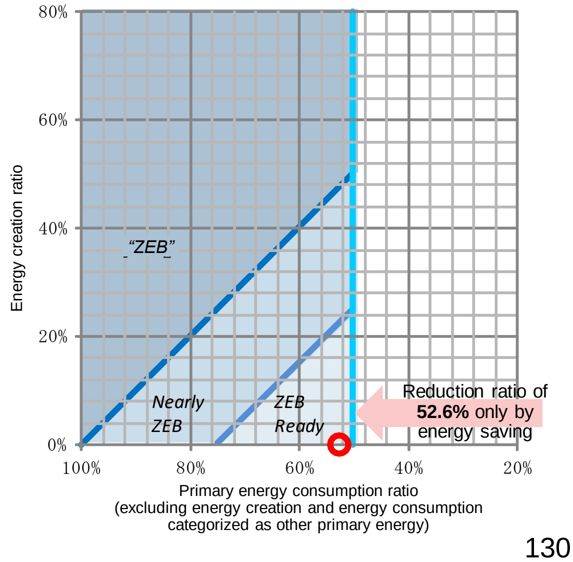
<Energy performance evaluation>

- The primary energy consumption of the building is 641 MJ/m^2/year which corresponds to about 52.6% reduction from the primary energy consumption of a reference building.



Unit: MJ/m^2/year

	Reference	Design	BPI/BEI
Envelope	470	338	0.72
Air conditioning	867	408	0.47
Ventilation	9	2	0.22
Lighting	445	175	0.39
Hot water supply	26	49	1.90
Elevator	8	6	0.80
Total	1,354	641	0.47
Renewable energy	0	0	-
Total	1,354	641	0.47



Example 04: Energy Saving through Renovation and Introduction of Pioneering Technologies and Energy Creation

<Concept for realizing ZEB>

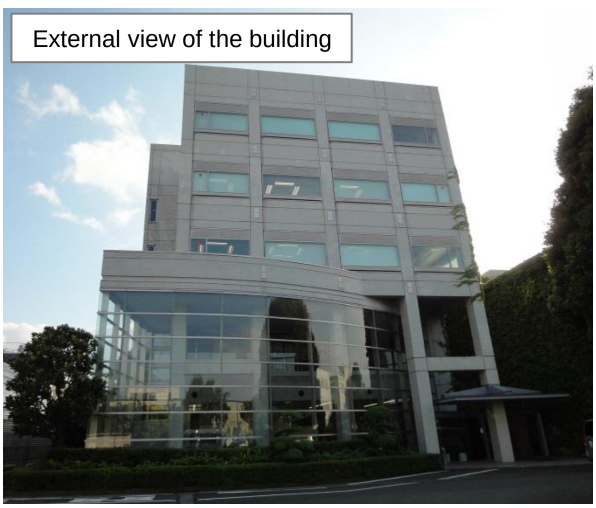
The purposes of the renovation work were: to significantly reduce energy consumption through “① the reinforcement of the insulation performance of an envelope,” and “② the introduction and renewal of high-efficiency lighting and air-conditioning systems”; and to introduce “③ the utilization of renewable energy” such as utilization of earth heat and photovoltaic power generation, and “④ pioneering and commercialized systems” such as desiccant air-conditioning, illuminance and schedule control of lighting, and task ambient control of lighting and air conditioning.

<Outline of the building>

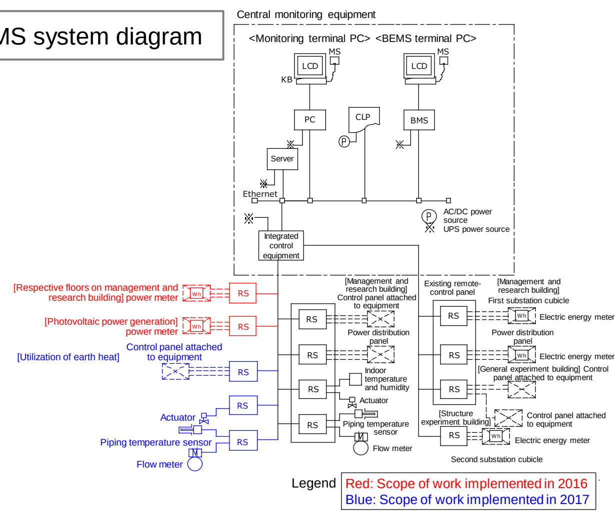
- Location: Kanagawa Prefecture (Area 6)
- Site area: 11,346 m^2
- Building area: 1,146 m^2
- Total floor area: 3,859 m^2
- Structural type: RC
- Number of stories: 6 stories above ground and 1 story below ground
- Building use: Office and others
- Annual workdays: 240 days

<Cost per unit floor area>

- Procurement cost for the portion of the building eligible for subsidy: 33,750 yen/m^2
- Procurement and installation costs for the portion of the building eligible for subsidy: 61,047 yen/m^2


External view of the building

BEMS system diagram



<Outline of systems introduced>

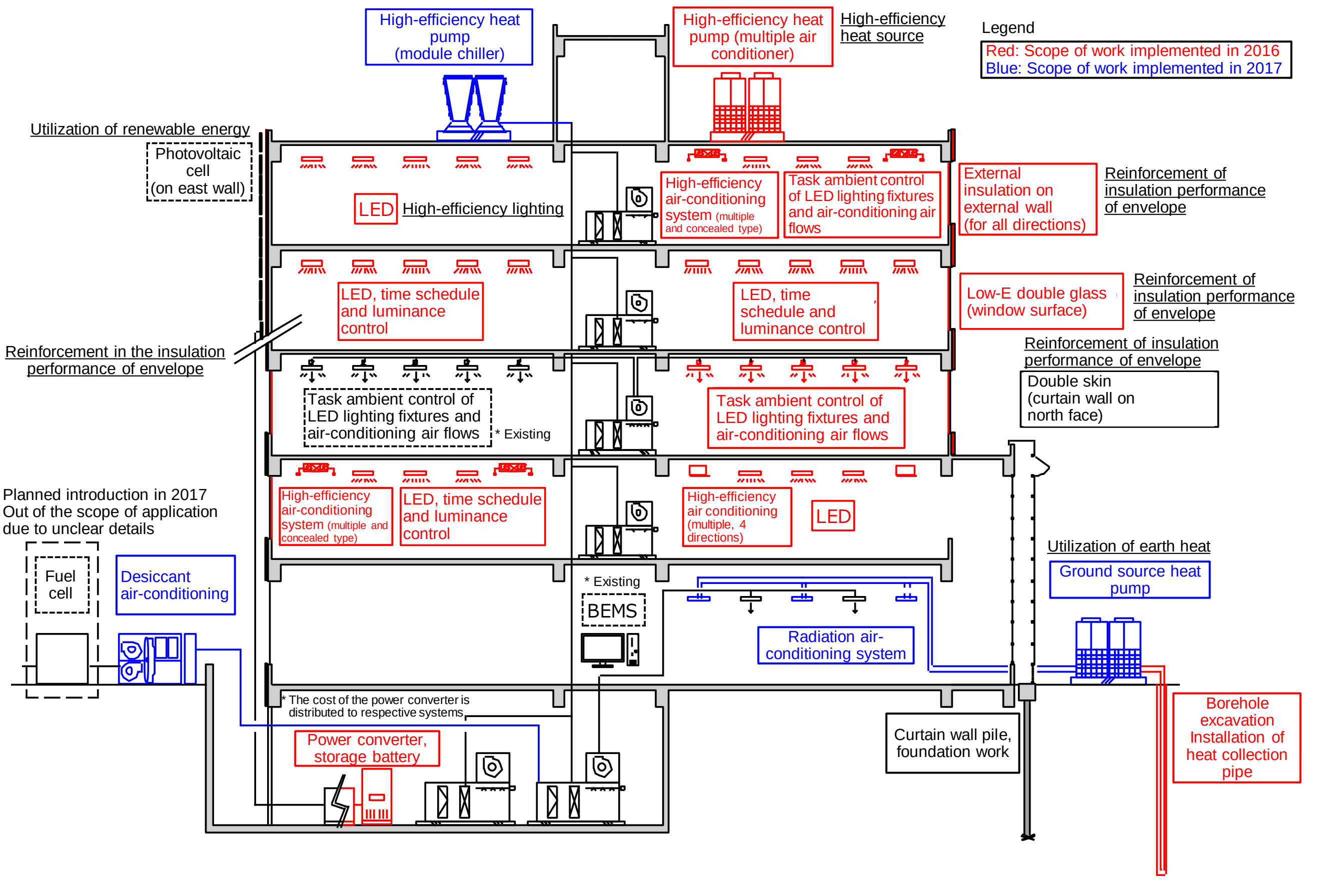
Envelope	External wall	• Bead method polystyrene 70 mm
	Roof	• Extruded polystyrene foam 20 mm
	Window	• Low-E double glass • Double skin
Air conditioning	Heat source type	• Central and independent combined
	Equipment	• Air-cooled HP chiller • Ground source HP • EHP • Desiccant air conditioner
	System I	• Utilization of untapped energy★ • Fuel cell • Quantity control
	System II	• Radiation air-conditioning★ • Temperature and humidity sensor control • Motion sensor control • Task ambient air-conditioning★ • Latent and sensible heat separation air-conditioning • CO_2 sensor control • External air cooling • VAV

Lighting	Equipment	• LED
	System	• Luminance detection control • Time schedule control • Motion detection control • Digital independent control • Task ambient lighting
	Daylight utilization	• Atrium
Renewable energy, etc.		• Photovoltaic power generation • Utilization of earth heat • Storage battery★
BEMS★		• Centralized metering • Data output function • Time program control • Optimal start and stop control • List output • Display and output of daily, monthly, annual reports • Display of trend graphs • Operation performance management • Warning data management • Visualization • Energy consumption analysis management • Energy use calculation plan
System control, etc.		• Inter-equipment integrated control system★ • Equipment-user linkage control system★ • Load control★ • Energy management in operation stage such as tuning★

Note: ★ means that a system or equipment cannot be quantitatively evaluated with the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017).

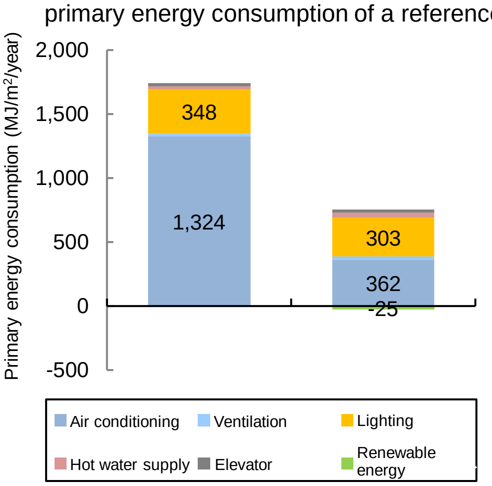
<Outline of systems and equipment>

At the time of its renovation, the building was 24 years old and had an envelope with poor insulation performance. In 2005, the building underwent the renewal of air-conditioning equipment including the replacement of a central heat source to a new model but the efficiency of the model at that time was not so high compared to the latest one. Since the introduction of BEMS in 2011, the trends of usage of several types of energy have been observed. As a result, it has been identified that rooms have been used by less workers and less frequently than original design and therefore the existing air-conditioning system has been in inefficient operation state with low loads.



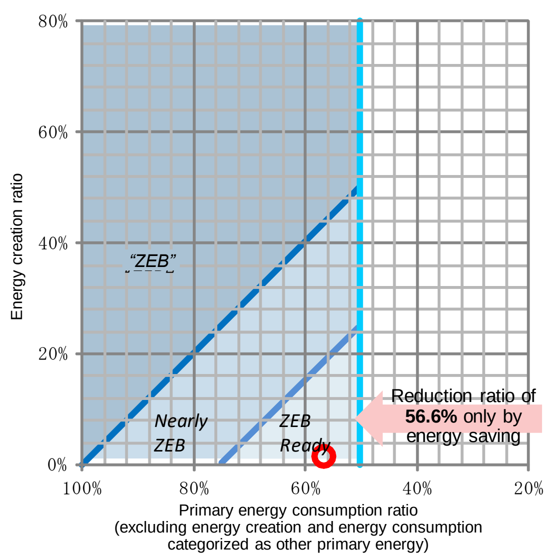
<Energy performance evaluation>

- The primary energy consumption of the building is 754 MJ/m²/year (729 MJ/m²/year including renewable energy creation) which corresponds to about 56.6% reduction from the primary energy consumption of a reference building.



Unit: MJ/m²/year

	Reference	Design	BPI/BEI
Envelope	435	342	0.79
Air condition-ing	1,324	362	0.27
Ventilation	24	24	1.00
Lighting	348	303	0.87
Hot water supply	20	39	1.92
Elevator	26	26	1.00
Total	1,742	754	0.43
Renewable energy	0	-25	-
Total	1,742	729	0.42



Example 05: Retrofitting of Existing Building for ZEB through the Enhancement of Envelope Performance and Introduction of Energy Saving Equipment

<Concept for realizing ZEB>

An existing technology research institute underwent retrofitting so as to satisfy ZEB with its primary energy consumption reduced through the introduction of the technologies for: the enhancement of envelope performance (retrofit Low-E glass, retrofit inner windows, interior side insulation, solar tracking blind control), the optimal utilization of natural ventilation, solar energy assisted air-cooled heat pump chiller, high-efficiency independent dispersed air-conditioning, external air treatment air-conditioning with cooling trench, total heat exchange ventilation, LED lighting with automatic dimming control and energy creation through photovoltaic power generation, and high-efficiency transformer.

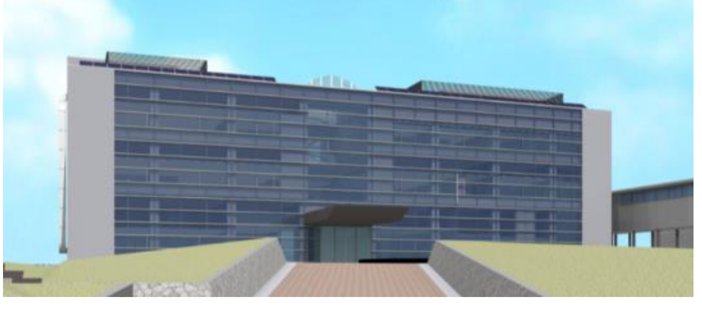
<Outline of the building>

- Location: Ibaraki Prefecture (Area 5)
- Site area: 28,180 m^2
- Building area: 1,206 m^2
- Total floor area: 3,104 m^2
- Structural type: RC
- Number of stories: 3 stories above ground
- Building use: Office and others
- Annual workdays: 239 days

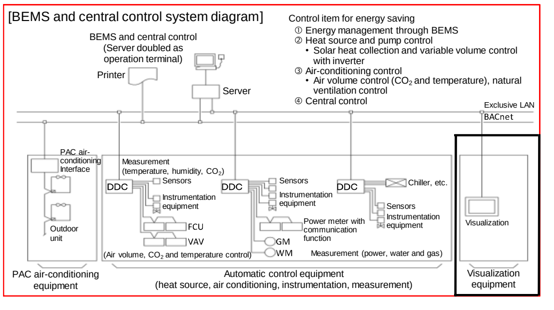
<Cost per unit floor area>

- Procurement cost for the portion of the building eligible for subsidy: 42,427 yen/m^2
- Procurement and installation costs for the portion of the building eligible for subsidy: 72,862 yen/m^2

External image of the building



BEMS and central control system diagram



<Outline of systems introduced>

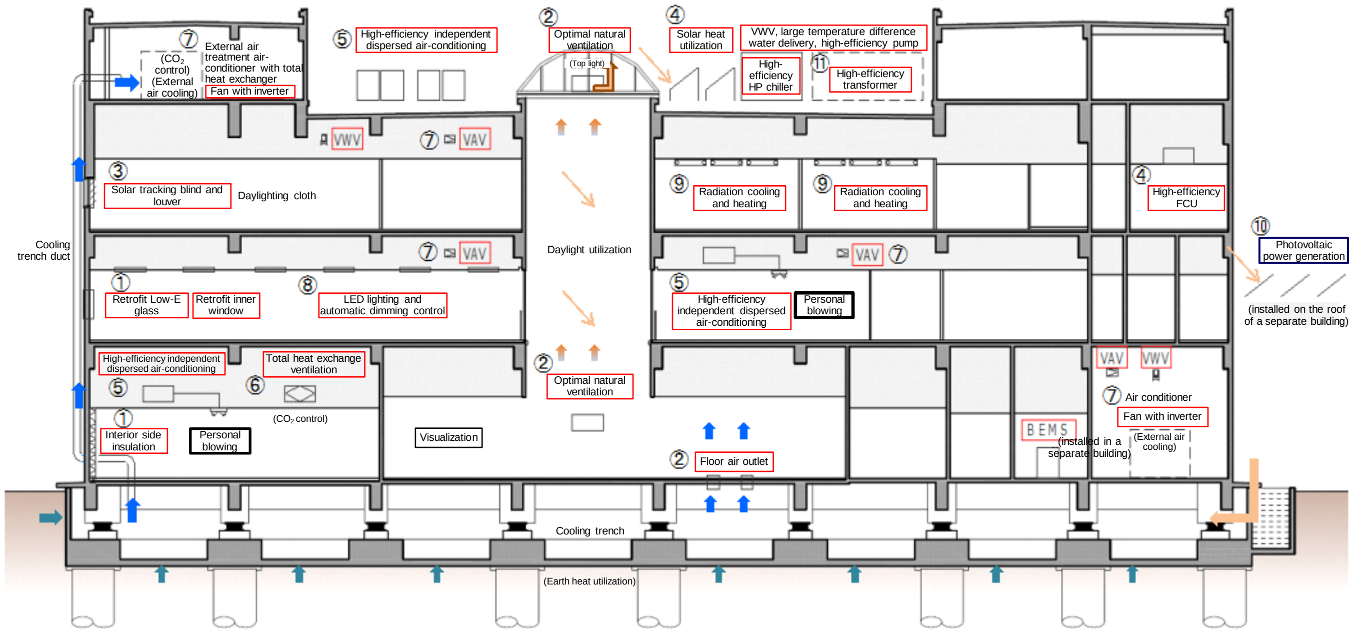
Envelope	External wall	• Hard urethane foam 15 mm
	Roof	• Extruded polystyrene foam 25 mm
	Window	• Retrofit Low-E double glass • Retrofit inner window • Blind • Louver • Top light
Air conditioning	Heat source type	• Central and independent combined
	Equipment	• Air-cooled heat pump chiller • EHP • Solar heat collection equipment
	System I	• Utilization of untapped energy★ • Quantity control • Variable volume control • Rotation control
	System II	• Total heat exchanger • Minimum external air intake control • Radiation air-conditioning★ • Task ambient air-conditioning★ • CO_2 sensor control • External air cooling • VAV • VWV • Large temperature difference water delivery system

Mechanical ventilation	Equipment	• Type 1 ventilation • Type 3 ventilation
Lighting	Equipment	• LED
	System	• Luminous detection control • Time schedule control • Motion detection control • Digital independent control • Solar tracking bling control
	Daylight utilization	• Atrium • Daylighting cloth
Hot water supply	Heat source type	• Independent
Renewable energy, etc.		• Photovoltaic power generation • Utilization of wind★ • Upgrading to high-efficiency top runner transformer
BEMS★		• Data output function • Time program control • Display and output of daily, monthly and annual reports • Display of trend graph • Equipment history management • Operation performance management • Warning data management • Visualization • Energy use calculation plan
System control, etc.		• Equipment-use linkage control system★ • Load control★ • Energy management in operation stage such as tuning★

Note: ★ means that a system or equipment cannot be quantitatively evaluated with the Energy Consumption Performance Calculation Program (Nonresidential Version) Ver. 2.4.0 (October 2017).

<Outline of systems and equipment>

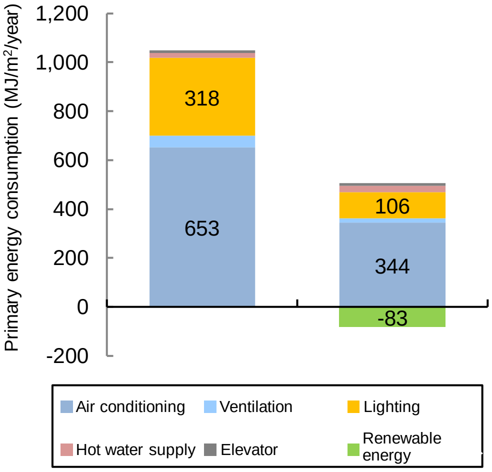
- The site is located in a category II residential area with no high-rise buildings nearby. Also, because the main building keeps sufficient distances from the property boundaries, photovoltaic power generation equipment has been installed on the roof with the expectation of long sunshine duration.
- The retrofitting plan includes: the introduction of an optimal natural ventilation utilization system as a passive technology at the entrance hall with a vaulted ceiling in the center of the building; the reinforcement of insulation and the introduction of insolation shielding system to the openings on the external glass curtain walls of air-conditioned rooms facing north and south; and the reinforcement of interior side insulation on east and west side walls mostly made of concrete in the air-conditioned rooms.
- The retrofitting plan also includes the introduction of earth thermal utilization by applying a cooling trench structure to vibration isolation pits.



① Enhancement of envelope performance
Window: Retrofit Low-E glass, retrofit inner windows, U:2.64 W/m2/K
External wall: Interior side insulation
② Optimal natural ventilation utilization
Air intake through cooling trench and exhaust through roof ventilation window
③ Solar tracking louver
Installation of solar tracking louver outside the building
④ Solar heat utilization and air-cooled heat pump chiller type heat source equipment
Utilization of solar heat as high temperature source
VWV and large temperature difference water delivery
⑤ Personal blowing type high-efficiency independent dispersion air-conditioning
⑥ Total heat exchange ventilation
CO_2 control
⑦ External air treatment air conditioner with cooling trench
Upgrading of external air treatment equipment to VAV equipment, addition of VAV unit to terminal
⑧ LED lighting and automatic dimming control
⑨ Radiation cooling and heating
⑩ Photovoltaic power generation
PV: 30 kW
⑪ High-efficiency transformer

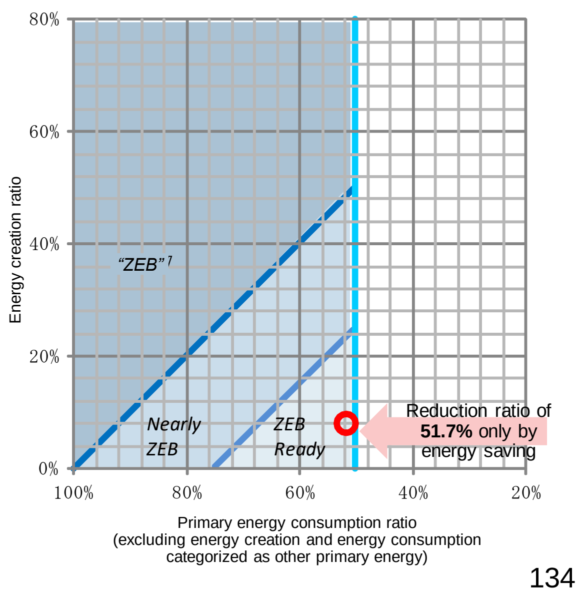
<Energy performance evaluation>

- The primary energy consumption of the building is 506 MJ/m²/year (423 MJ/m²/year including renewable energy creation) which corresponds to about 51.7% reduction from the primary energy consumption of a reference building.



Unit: MJ/m²/year

	Reference	Design	BPI/ BEI
Envelope	450	366	0.81
Air condition-ing	653	344	0.53
Ventilation	46	19	0.40
Lighting	318	106	0.33
Hot water supply	20	25	1.27
Elevator	12	12	1.00
Total	1,050	506	0.48
Renewable energy	0	-83	-
Total	1,050	423	0.40



7.2 Reference Information on the Model Building

Calculation Result of the Energy Consumption Performance Calculation Program (Nonresidential Version)

1. Calculation conditions

Date of calculation	12:45 on January 10, 2017
Person in charge of data input	
Program version	Ver. 2.2.3 (Oct. 2016)
XML ID	6c6df5d3-6ecc-431c
Re-output code	TM#R-*AEU-MJBU-#FWE

2. Outline of the building

Name	10,000 m^2, office building
Location	XX, YY-machi, Chiyoda-ku, Tokyo
Area classification	Area 6
Insolation area classification	No designation
Primary energy equivalent to heat supplied by others	No designation
Structure	Steel frame steel reinforced concrete
Number of stories	Seven stores above ground
Site area	5000 m^2
Building area	1422.9095 m^2
Total floor area	10104.51 m^2

3. Calculation result of PAL* and primary energy consumption

	Designed value	Reference value
PAL*	423	470

		Designed primary energy consumption	Reference primary energy consumption
Breakdown	Air-conditioning system	4,489.37 GJ/year (444.29 MJ/total floor area in m^2/year)	8,804.51 GJ/year (871.34 MJ/total floor area in m^2/year)
	Ventilation system	394.06 GJ/year (39.00 MJ/total floor area in m^2/year)	695.14 GJ/year (68.80 MJ/total floor area in m^2/year)
	Lighting system	1,722.06 GJ/year (170.42 MJ/total floor area in m^2/year)	4,209.25 GJ/year (416.57 MJ/total floor area in m^2/year)
	Hot water supply system	209.02 GJ/year (20.69 MJ/total floor area in m^2/year)	138.80 GJ/year (13.74 MJ/total floor area in m^2/year)
	Elevator system	204.80 GJ/year (20.27 MJ/total floor area in m^2/year)	256.00 GJ/year (25.34 MJ/total floor area in m^2/year)
	Equipment for enhancing efficiency	0.00 GJ/year (0.00 MJ/total floor area in m^2/year)	
	Others	3,677.42 GJ/year (363.94 MJ/total floor area in m^2/year)	3,677.42 GJ/year (363.94 MJ/total floor area in m^2/year)
Total		10,696.8 GJ/year (1,058.62 MJ/total floor area in m^2/year)	17,781.2 GJ/year (1,759.73 MJ/total floor area in m^2/year)
Total (excluding others)		7,019.4 GJ/year (694.68 MJ/total floor area in m^2/year)	14,103.8 GJ/year (1,395.79 MJ/total floor area in m^2/year)

This calculation result is obtained by assuming a building designed on the assumption of the above area classification and operation conditions of building equipment according to a certain operation schedule and, therefore, the calculated energy consumption is different from that of actual operation of buildings.

4. Determination result

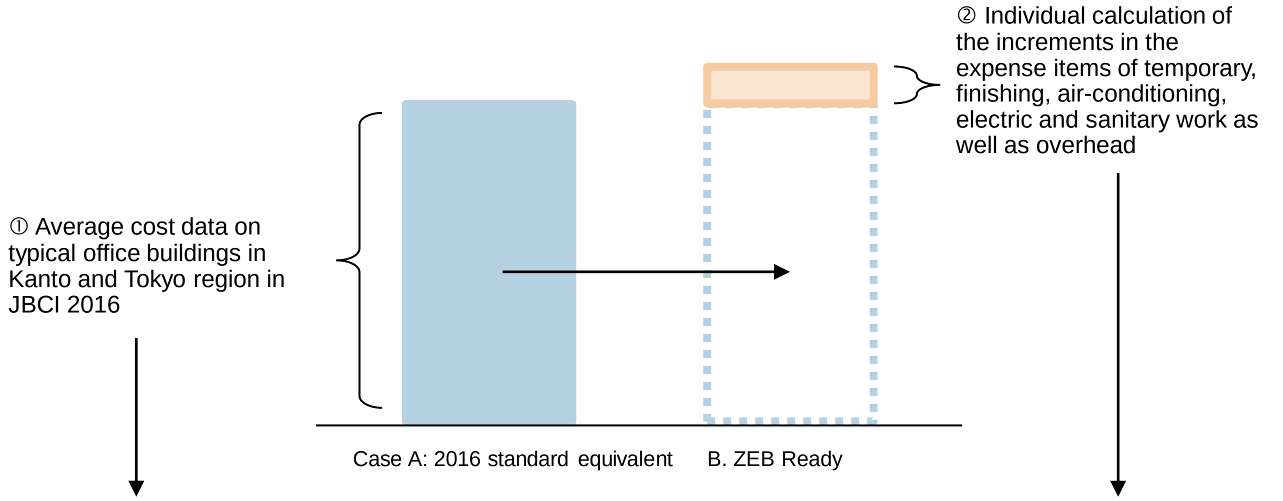
BPI	(Designed PAL* value/Reference PAL* value)	0.90
BEI	(Designed primary energy amount excluding others/ Reference primary energy amount excluding others)	0.50

			Applicable/ Not applicable	Reference primary energy consumption
Building Energy Efficiency Act	Energy consumption performance standards	New building	Applicable	17,781.2 GJ/year (1,759.73 MJ/total floor area in m^2/year)
		Existing building*	Applicable	19.191.5 GJ/year (1,899.30 MJ/total floor area in m^2/year)
	Voluntary standards	New building	Applicable	14,960.4 GJ/year (1,480.57 MJ/total floor area in m^2/year)
		Existing building*	Applicable	17,781.2 GJ/year (1,759.73 MJ/total floor area in m^2/year)
Certification system for the building plans of low-carbon buildings and new construction, etc.			Applicable	16,370.8 GJ/year (1,620.15 MJ/total floor area in m^2/year)

* The existing building means a building that already exists at the time of the enforcement of the Building Energy Efficiency Act.

Calculation Methods of Approximate Construction Costs

- What follows is the comparison of the approximate construction costs of "Case A: 2016 standard equivalent" and "Case B: ZEB Ready" estimated on the basis of the following cost estimation methods.
  - "Case A: 2016 standard equivalent": Cost estimation was made using the average cost data (cost per unit floor area) on "typical office buildings in Kanto and Tokyo region" in Japan Building Cost Information 2016 (JBCI 2016) published by the Construction Research Institute.
  - "Case B: ZEB Ready": Cost estimation was made in a manner that calculated the increments in the expense items of temporary, finishing, air-conditioning, electric and sanitary work as well as overhead for realizing the energy saving rate of 50% and added the increments to the estimated cost of "Case A: 2016 standard equivalent."
- These approximate construction costs are the estimation results on the basis of the model building used in the case study of these Guidelines and, therefore, subject to adjustment depending on price fluctuation due to the changes in economic situations and the changes in building specifications. Also, please note that, when designing a building with higher performance than ZEB Ready (energy saving rate of 50%), there is a necessity of considering the introduction of those architectural methods (such as an atrium or void to utilize natural ventilation and daylight) which can produce high energy saving effects but cause initial costs to be increased.



① Average construction cost of typical office buildings in Kanto and Tokyo region

	Average (thousand yen/m²)	Cost (million yen) * 10,000 m²	Composition ratio
Building finishing work (high-efficiency insulation, insolation shielding)	104.0	1,040	29.5%
Air-conditioning work (air conditioning + ventilation)	26.3	263	7.5%
Electric work (lighting)	33.7	337	9.6%
Sanitary work (hot water supply)	19.0	190	5.4%
Elevator work	6.9	69	2.0%
Temporary work	22.2	222	6.3%
Earth work	11.1	111	3.2%
Foundation work	14.4	144	4.1%
Structural work	74.1	741	21.0%
Overhead	40.4	404	11.5%
Total	352.1 thousand yen/m²	3,521	100.0%

② Bases of unit rates for calculating the increments in individual expense items

Item	Source of unit rate	Ratio of wholesale price to retail price
Double-glazed glass	Maker's quoted price	18.2%
Horizontal canopy	Maker's quoted price	70%
Extruded polystyrene foam insulation board	Catalog price	60%
Prefabricated double row scaffolding	Construction cost information in October 2016	100%
Absorption chiller heater	Maker's quoted price	50%
Air conditioner	Maker's quoted price	40%
Cooling tower	Maker's estimation material	40%
Fan coil	Maker's estimation material	40%
Heat source pump	Catalog price	45%
Air-cooled heat pump package	Catalog price	50%
Automatic control equipment	Maker's approximate quoted price	40%
Labor for mechanical installation	Unit design and labor costs for public works in 2016	100%
Lighting fixture (Hf fluorescent lamp)	Maker's quoted price	40%
Lighting fixture (LED fluorescent lamp)	Maker's quoted price	50%
Lighting control equipment	Maker's approximate quoted price	45%
Labor for electrical installation	Unit design and labor costs for public works in 2016	100%

* For the details of the specifications and introduced equipment in “Case A: 2016 standard equivalent” and “Case B: ZEB Ready,” refer to “2.3 Outline of the Case Study in These Guidelines.”

Comparison Result of Approximate Costs (1/5)

Building finishing work (high-efficiency insulation, insolation shielding)

Unit: million yen

Case A: 2016 standard equivalent			Case B: ZEB Ready					
Name/specification	Calculation method	Cost	Name/specification	Calculation method	Cost	Difference	Unit	Quantity
Double glazing glass Low-E: single sheet	-	-	Double glazing glass Low-E: single sheet <u>and insulation gas</u>	-	-	-	m^2	2,098
Aluminum sash	-	-	<u>Aluminum resin composite sash</u>	-	-	-	m^2	2,098
<Roof insulation> Extruded polystyrene foam insulation board Type 1, 50 mm	-	-	<Roof insulation> Extruded polystyrene foam insulation board <u>Type 3, 100 mm</u>	-	-	-	m^2	1,097
<External wall insulation> Extruded polystyrene foam insulation board Type 1, 25 mm	-	-	<External wall insulation> Extruded polystyrene foam insulation board <u>Type 3, 50 mm</u>	-	-	-	m^2	4,275
Subtotal of the increase in insulation performance	Subtotal of above items	128		Subtotal of above items	201	73		
No insolation shielding	-	-	<u>Horizontal canopy 1.4 m above window</u> <u>Aluminum, W600</u>	-	-	-	m	1,075
Subtotal of insolation shielding	Subtotal of above items	0		Subtotal of above items	47	47		
Building finishing work Total of window and insulation		128			248	120		

Note: Those specifications which differ between “Case A: 2016 standard equivalent” and “Case B: ZEB Ready” are highlighted with underlines.

Source: Calculation result of the ZEB Roadmap Follow-up Committee with the cooperation of the Building Surveyor’s Institute of Japan

* For the details of the specifications and introduced equipment in “Case A: 2016 standard equivalent” and “Case B: ZEB Ready,” refer to “2.3 Outline of the Case Study in These Guidelines.”

Comparison Result of Approximate Costs (2/5)

Air-conditioning work (air conditioning)

Unit: million yen

Case A: 2016 standard equivalent			Case B: ZEB Ready					
Name/specification	Calculation method	Cost	Name/specification	Calculation method	Cost	Difference	Unit	Quantity
Heat source Central: COP (1.10 for cooling and 0.87 for heating) Rated capacity (527 kW/unit for cooling) Rated capacity (353 kW/unit for heating)	-	-	Heat source Central: COP (1.25 for cooling and 0.88 for heating) Rated capacity (527 kW/unit for cooling) Rated capacity (353 kW/unit for heating)	-	-	-	unit	2
Cooling tower	-	-	Cooling tower	-	-	-	unit	2
Cooling water pump	-	-	Cooling water pump	-	-	-	unit	2
Automatic control	-	-	VAV 14 units/system Automatic control	-	-	-	lump sum	1
Heat source Independent: COP (4.1 for cooling and 4.7 for heating) Rated capacity (3.6 kW/unit for cooling) Rated capacity (4.0 kW/unit for heating)	-	-	Heat source Independent: COP (4.1 for cooling and 4.7 for heating) Rated capacity (3.6 kW/unit for cooling) Rated capacity (4.0 kW/unit for heating)	-	-	-	unit	4
Subtotal of high-efficiency heat source	Subtotal of above items	76		Subtotal of above items	88	19		
Water delivery Pump	-	-	Water delivery Pump	-	-		unit	4
Water delivery Constant flow rate control	-	-	Water delivery Quantity control and rotation control	-	-		lump sum	1
Subtotal of flow rate control	Subtotal of above items	9		Subtotal of above items	17	8		
Air conditioner ① Cooling capacity of 52 kW/unit and heating capacity of 29 kW/unit	-	-	Air conditioner ① Cooling capacity of 52 kW/unit and heating capacity of 29 kW/unit Mounted with total heat exchanger	-	-	-	unit	1
Air conditioner ② Cooling capacity of 41 kW/unit and heating capacity of 21 kW/unit	-	-	Air conditioner ② Cooling capacity of 41 kW/unit and heating capacity of 21 kW/unit Mounted with total heat exchanger	-	-	-	unit	1
Air conditioner ③ Cooling capacity of 87 kW/unit and heating capacity of 43 kW/unit	-	-	Air conditioner ③ Cooling capacity of 87 kW/unit and heating capacity of 43 kW/unit Mounted with total heat exchanger	-	-	-	unit	5
Air conditioner ④ Cooling capacity of 75 kW/unit and heating capacity of 36 kW/unit	-	-	Air conditioner ④ Cooling capacity of 75 kW/unit and heating capacity of 36 kW/unit Mounted with total heat exchanger	-	-	-	unit	5
Air conditioner ⑤ Cooling capacity of 95 kW/unit and heating capacity of 47 kW/unit	-	-	Air conditioner ⑤ Cooling capacity of 95 kW/unit and heating capacity of 47 kW/unit Mounted with total heat exchanger	-	-	-	unit	1
Air conditioner ⑥ Cooling capacity of 82 kW/unit and heating capacity of 39 kW/unit	-	-	Air conditioner ⑥ Cooling capacity of 82 kW/unit and heating capacity of 39 kW/unit Mounted with total heat exchanger	-	-	-	unit	1
Indoor unit 5.6 kW, pair	-	-	Indoor unit 5.6 kW, pair	-	-	-	unit	1
Indoor unit 3.6 kW, pair	-	-	Indoor unit 3.6 kW, pair	-	-	-	unit	3
FCU 7.7 kW	-	-	FCU 7.7 kW	-	-	-	unit	1
FCU 2.9 kW	-	-	FCU 2.9 kW	-	-	-	unit	7
FCU control Constant air volume control	-	-	FCU control Constant air volume control	-	-	-	set	8
Air conditioner control Constant air volume control	-	-	Air conditioner control Constant air volume control	-	-	-	unit	14
Straight sirocco fan 300 m^3/h × 2 units (Supply and exhaust)	-	-	Indoor unit control Total heat exchanger, 250 m^3/h Mounted with microcomputer (external air cut control)	-	-	-	set	1
Straight sirocco fan 150 m^3/h × 2 units (Supply and exhaust)	-	-	Indoor unit control Total heat exchanger, 150 m^3/h Mounted with microcomputer (external air cut control)	-	-	-	set	2
Straight sirocco fan 400 m^3/h × 2 units (Supply and exhaust)	-	-	Indoor unit control Total heat exchanger, 350 m^3/h Mounted with microcomputer (external air cut control)	-	-	-	set	1
Constant air volume control	-	-	Automatic control (Option for external air cooling equipment)	-	-	-	unit	4
Subtotal of air-conditioning control	Subtotal of above items	172		Subtotal of above items	295	123		
Air-conditioning work Total of air-conditioning work		257			401	150		

Note: Those specifications which differ between “Case A: 2016 standard equivalent” and “Case B: ZEB Ready” are highlighted with underlines.

Source: Calculation result of the ZEB Roadmap Follow-up Committee with the cooperation of the Building Surveyor’s Institute of Japan

* For the details of the specifications and introduced equipment in “Case A: 2016 standard equivalent” and “Case B: ZEB Ready,” refer to “2.3 Outline of the Case Study in These Guidelines.”

Comparison Result of Approximate Costs (3/5)

Air-conditioning work (ventilation)

Unit: million yen

Case A: 2016 standard equivalent			Case B: ZEB Ready					
Name/specification	Calculation method	Cost	Name/specification	Calculation method	Cost	Difference	Unit	Quantity
Toilet Sirocco, 0.2 kW JIS C4210 Standard motor	-	-	Toilet Sirocco, 0.2 kW JIS C4212 High-efficiency induction motor	-	-	-	unit	14
Warehouse 50% noise reduction, 0.15 kW JIS C4210 Standard motor	-	-	Warehouse 50% noise reduction, 0.15 kW JIS C4210 Standard motor	-	-	-	unit	7
Kettle room 50% noise reduction, 0.15 kW JIS C4210 Standard motor	-	-	Kettle room 50% noise reduction, 0.15 kW JIS C4210 Standard motor	-	-	-	unit	7
Machine room Sirocco, 0.4 kW JIS C4210 Standard motor	-	-	Machine room Sirocco, 0.4 kW JIS C4212 High-efficiency induction motor	-	-	-	unit	6
Machine room (1F ①) Sirocco, 1.5 kW JIS C4213 Premium efficiency motor	-	-	Machine room (1F ①) Sirocco, 1.5 kW JIS C4213 Premium efficiency motor	-	-	-	unit	2
Machine room (1F ②) Sirocco, 0.4 kW JIS C4210 Standard motor	-	-	Machine room (1F ②) Sirocco, 0.4 kW JIS C4212 High-efficiency induction motor	-	-	-	unit	1
Machine room (roof) Sirocco, 0.4 kW JIS C4210 Standard motor	-	-	Machine room (roof) Sirocco, 0.4 kW JIS C4212 High-efficiency induction motor	-	-	-	unit	2
Electric room Sirocco, 0.75 kW JIS C4213 Premium efficiency motor	-	-	Electric room Sirocco, 0.75 kW JIS C4213 Premium efficiency motor	-	-	-	unit	2
Resting room 50% noise reduction, 0.15 kW JIS C4210 Standard motor	-	-	Resting room 50% noise reduction, 0.15 kW JIS C4210 Standard motor	-	-	-	unit	1
Subtotal of high-efficiency motor	Subtotal of above items	5		Subtotal of above items	5	0		
No control	-	-	Automatic control	-	-	-		
Subtotal of air volume control	Subtotal of above items	0		Subtotal of above items	10	10		
Air-conditioning work Total of ventilation		5			15	10		

Note: Those specifications which differ between “Case A: 2016 standard equivalent” and “Case B: ZEB Ready” are highlighted with underlines.

Source: Calculation result of the ZEB Roadmap Follow-up Committee with the cooperation of the Building Surveyor’s Institute of Japan

* For the details of the specifications and introduced equipment in “Case A: 2016 standard equivalent” and “Case B: ZEB Ready,” refer to “2.3 Outline of the Case Study in These Guidelines.”

Comparison Result of Approximate Costs (4/5)

Electric work (lighting)

Unit: million yen

Case A: 2016 standard equivalent			Case B: ZEB Ready					
Name/specification	Calculation method	Cost	Name/specification	Calculation method	Cost	Difference	Unit	Quantity
Hallway Hf (2400 lm/35 W)	-	-	Hallway LED (2400 lm/19.2 W)	-	-	-	unit	258
Lobby Hf (5500 lm/87 W)	-	-	Lobby LED (5500 lm/19.2 W)	-	-	-	unit	24
Central control room Hf (4950 lm/48 W)	-	-	Central control room LED (4950 lm/31 W)	-	-	-	unit	10
Changingroom or warehouse Hf (4950 lm/48 W)	-	-	Changingroom or warehouse LED (4950 lm/31 W)	-	-	-	unit	25
Toilet Hf (2400 lm/35 W)	-	-	Toilet LED (2400 lm/7.4 W)	-	-	-	unit	140
Machine room Hf (4950 lm/48 W)	-	-	Machine room LED (4950 lm/31 W)	-	-	-	unit	91
Kettle room Hf (4950 lm/48 W)	-	-	Kettle room LED (4950 lm/31 W)	-	-	-	unit	7
Electric room Hf (4950 lm/48 W)	-	-	Electric room LED (4950 lm/31 W)	-	-	-	unit	5
Office Hf (4950 lm × 2/95 W) * Number of lighting fixtures: 1,239 units	-	-	Office LED (5040 lm/47 W) * Number of lighting fixtures: 1,625 units	-	-	-	unit	1,239
Subtotal of high-efficiency lighting system	Subtotal of above items	36		Subtotal of above items	82	47		
No control	-	-	Time schedule control/ Initial illuminous correction control	-	-	-	m^2	7,184
Subtotal of lighting control	Subtotal of above items	0		Subtotal of above items	9	9		
Electric work Total of lighting		36			91	56		

Sanitary Work (Hot water supply)

Unit: million yen

Case A: 2016 standard equivalent			Case B: ZEB Ready					
Name/specification	Calculation method	Cost	Name/specification	Calculation method	Cost	Difference	Unit	Quantity
Water heater Local storage type electric water heater * Rated heating capacity: 1.1 kW Heat source efficiency: 0.37	-	-	Water heater Local storage type electric water heater * Rated heating capacity: 1.1 kW Heat source efficiency: 0.37	-	-	-	unit	29
Hot water saving equipment Not applicable	-	-	Hot water saving equipment Automatic hot water faucet	-	-	-	loca-tion	48
Subtotal of energy saving hot water supply	Subtotal of above items	6		Subtotal of above items	7	1		
Sanitary work Total of hot water supply		6			7	1		

Note: Those specifications which differ between “Case A: 2016 standard equivalent” and “Case B: ZEB Ready” are highlighted with underlines.

Source: Calculation result of the ZEB Roadmap Follow-up Committee with the cooperation of the Building Surveyor’s Institute of Japan

* For the details of the specifications and introduced equipment in “Case A: 2016 standard equivalent” and “Case B: ZEB Ready,” refer to “2.3 Outline of the Case Study in These Guidelines.”

Comparison Result of Approximate Costs (5/5)

Building work (direct work, temporary work, overhead)

Unit: million yen

Case A: 2016 standard equivalent			Case B: ZEB Ready					
Name/specification	Calculation method	Cost	Name/specification	Calculation method	Cost	Difference	Unit	Quantity
Installation of canopy	-	-	Installation of canopy Prefabricated double-pole scaffold, W600	-	-	-	m^2	4,960
Building work Total of direct work	①	0		①	13	13		
Grand total of direct work (Temporary + Finishing + Electric + Sanitary + Air conditioning)	-	-	Grand total of direct work (Temporary + Finishing + Electric + Sanitary + Air conditioning)	-	-	-		
Increment Temporary work	②=(Direct cost)×(Ratio of common temporary cost to direct cost)	13	Common temporary work cost	②=(Direct cost)×(Ratio of common temporary cost to direct cost)	24	11	%	3.05%
Increment Total of net construction cost	-	-	Increment Total of net construction cost	-	-	-		
Increment Site expenses	③=(Net construction cost)×(Ratio of site expenses to net construction cost)	-	Increment Site expenses	③=(Net construction cost)×(Ratio of site expenses to net construction cost)	-	-	%	5.77%
Increment Total of construction cost	-	-	Increment Total of construction cost	-	-	-		
Increment General administrative cost, etc.	④=(Construction cost)×(Ratio of general administrative cost to construction cost)	-	Increment General administrative cost, etc.	④=(Construction cost)×(Ratio of general administrative cost to construction cost)	-	-	%	8.41%
Increment Total of overhead	③+④	64		③+④	117	53		

billion yen and 24 months respectively.

■ Summary of increments — Unit: million yen

Temporary work	①+②	24
Finishing work		120
Electric work		56
Sanitary work		1
Air-conditioning work		160
Overhead	③+④	53
Total		414

Note: Those specifications which differ between “Case A: 2016 standard equivalent” and “Case B: ZEB Ready” are highlighted with underlines.

Source: Calculation result of the ZEB Roadmap Follow-up Committee with the cooperation of the Building Surveyor’s Institute of Japan

Future Direction of Environmental Buildings

ZEB Design Guidelines

<ZEB Ready for Medium-scale Establishments>

Main edition

Separate edition for small-scale offices

Separate edition for elder care and welfare facilities

Separate edition for supermarkets/ home centers

Separate edition for hospitals

Ver. 1 April 2018
Edited and written by: ZEB Roadmap Follow-up Committee

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