Zero Energy Buildings & Technologies of

SANKEN
ENVIRONMENTAL ENGINEERING

SANKEN SETSUBI KOGYO CO., LTD.　JAPAN

ZEB
PLANNER
ZEB29P-00006-PGC

1. SANKEN ENVIRONMENTAL ENGINEERING company profile

ZEB PLANNER
ZEB29P-00006-PGC

Company Profile

Company Name	**SANKEN SETSUBI KOGYO CO., LTD.** **Established in 1946.**
Head Office	Kayabacho First Building, 17-21 Shinkawa 1-Chome, Chuo-ku, Tokyo 104-0033
Paid-in Capital	¥1,000milion
Number of Employees	**Technical Staff 958** Clerical Staff 368 **Total 1,326 (As of April 1, 2024)**
Net Sales	¥92,900 million (FY 2024)
Construction Business License	(Toku-4) No.1879 by Minister of Land, Infrastructure, Transport and Tourism
Business Lines	Plumbing Business, Architectural and Construction Business, Electrical Contracting Business, etc.
First-Class Architect Office Registration	No. 61948 by Governor of TOKYO
HOME PAGE	https://skk.jp/en

Representative projects

New Olympic Stadium for Tokyo 2020
Total area 194,000m2 B2F-5F 68,000 seats by 11/2019

Toranomon I, 2-chome redevelopment project in Tokyo
A-1 Tower 237,000 m2 B4F-49F 265 m
Medium, high-rise office, Low rise hotel, commercial facility
By 2023

2. Zero Energy Buildings & Technologies of SANKEN

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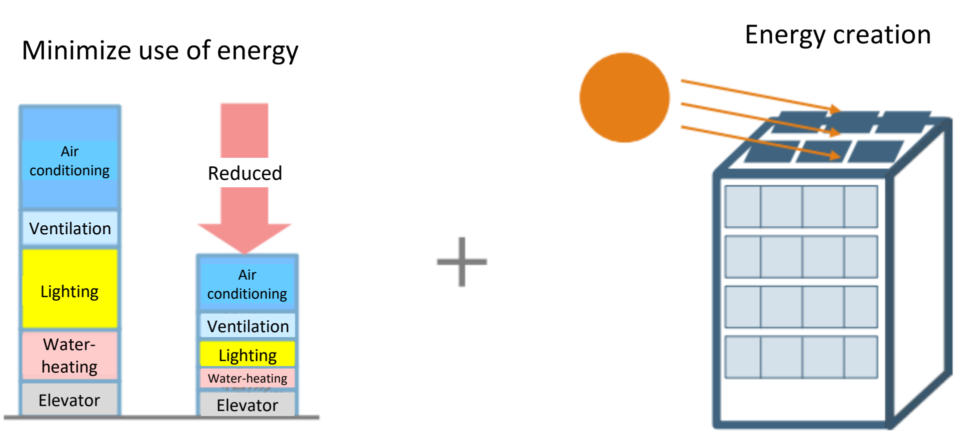
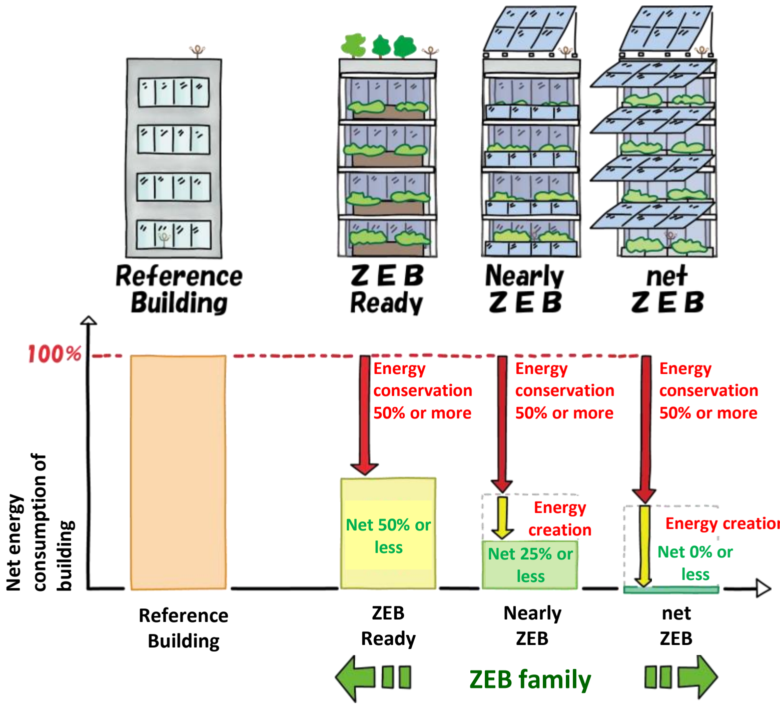
What is ZEB (Zero Energy Building) ?

ZEB is a building in which the annual building energy consumption is significantly reduced through energy saving efforts to the greatest extent possible by means of high heat insulation, solar shading, use of natural energy, and highly efficient equipment, while maintaining a comfortable indoor environment, and by generating energy through solar power generation, etc.

Greatly reducing annual energy consumption of the building





* Source: Ministry of Economy, Trade and Industry "Definition of ZEB and Future Measures at ZEB Roadmap Study Committee"

Achieve ZEB

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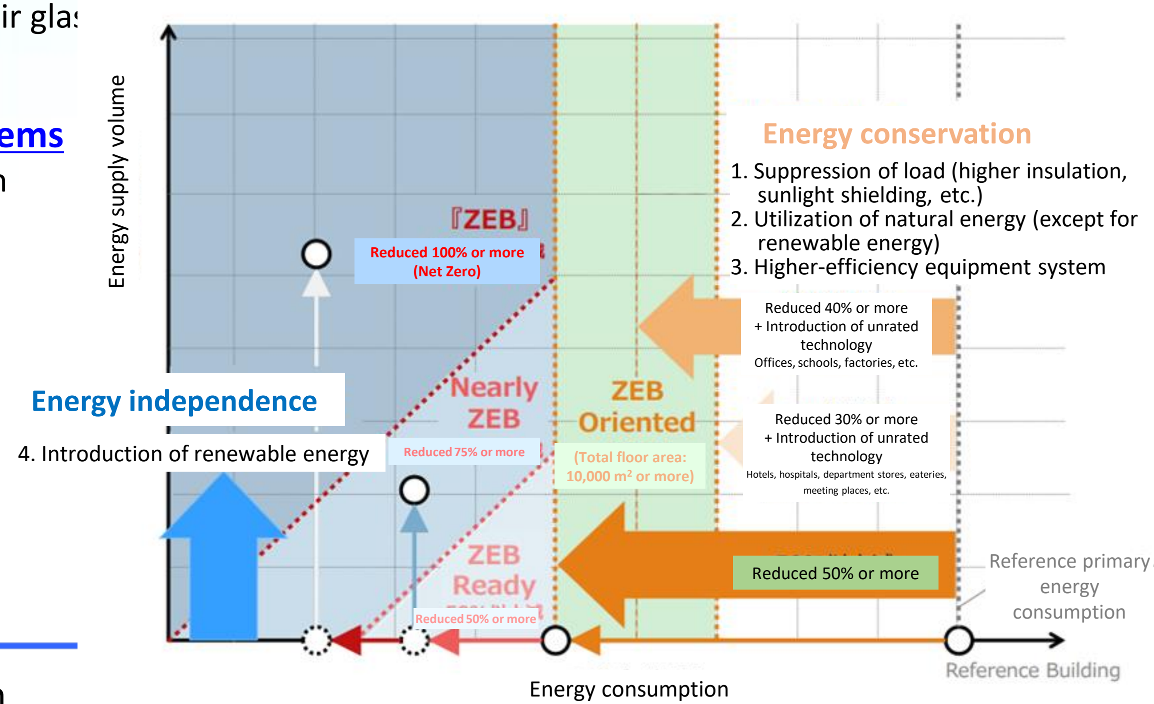
1. **Minimize the load**
   Enhancing the heat-insulation, Low-e pair glas
   Control of internal heat generation
2. **Introducing high-efficiency systems**
   Sensible heat and Latent heat separation air-conditioning system & LED lighting
3. **Utilizing renewable energy**
   PV, Geo-heat, Solar thermal, Natural ventilation, Daylight

Achieve net ZEB

Energy Consumption

Solar Power Generation



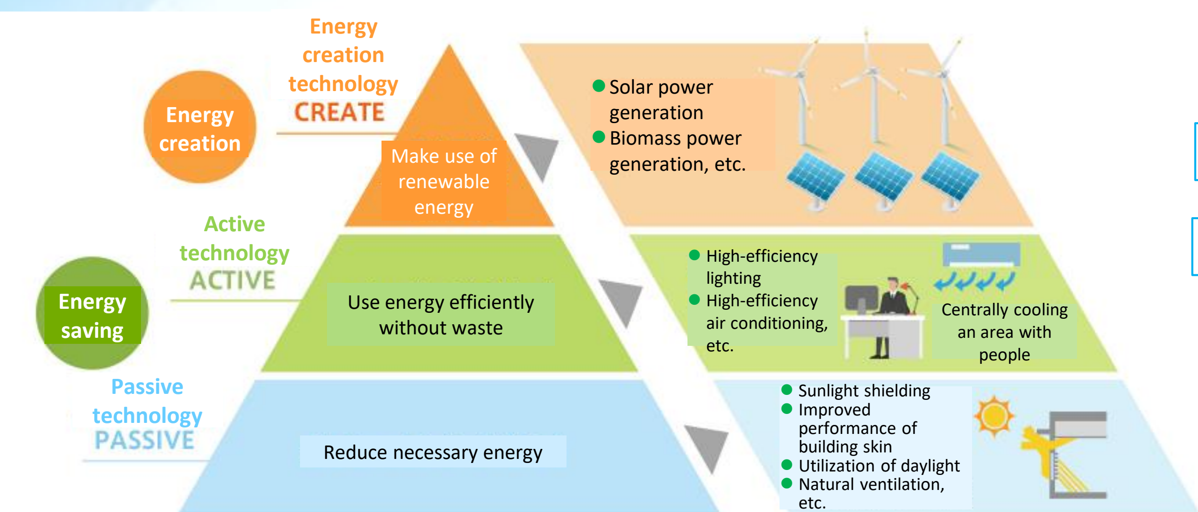
* Source: Documents of "ZEB Roadmap Follow-up Committee"

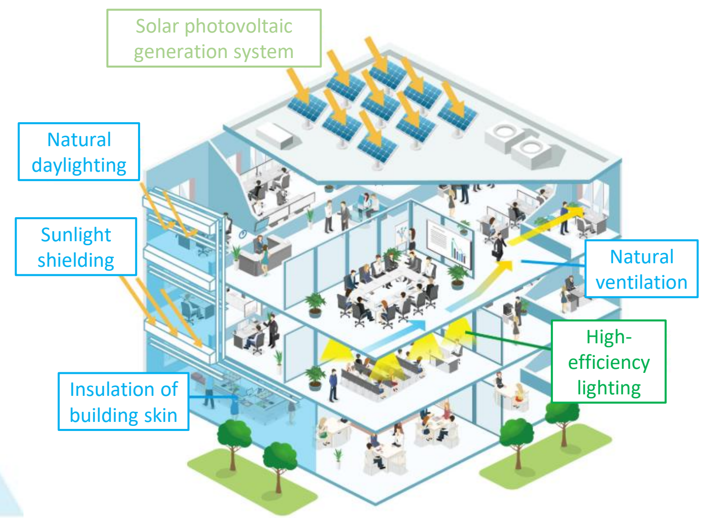
ZEB has a vital role in reducing Climate Change as well as realizing Low-Carbon Society.

Approach to ZEB

ZEB design processes

Design	Design	Operation
Passive design process	Active design process	Management process
Suppression of load Utilization of natural energy	Introduction of high-efficiency equipment System optimization Introduction of renewable energy	Energy management Commissioning
Optimized outdoor/indoor environment	Consideration for reduction of other resources, construction materials and waste	Commissioning





* Source: Ministry of Environment, Website “ZEB PORTAL”

Technologies Adopted for ZEB

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	Energy conservation technology contributive to ZEB	Total: 27 cases	Offices: 8 cases	Public offices: 1 case	Hotels: 1 case	Hospitals: 4 cases	Nursing homes, welfare facilities: 7 cases	Department stores: 3 cases	Supermarket: 2 cases	Gymnasiums etc.: 1 case
Energy conservation technologies for construction (Passive)	• Building layout plan	1	1							
	• Improved performance of building skin (PAL x Reduction rate ≥ 10%)	26	8	1	1	4	7	2	2	1
	• Insulation of building skin	26	8	1	1	4	6	3	2	1
	Glass wool insulating material	14	6		1		1	3	2	1
	Rock wool insulating material	2	1					1		
	Polystyrene form heat retaining board	12	4	1		2	4	1		
	Urethane form heat retaining material	12	3	1	1	3	3	1		
	• Low-E multi-layer glass	22	7	1	1	4	6	2		1
	Dry air	18	6	1	1	3	4	2		1
	Insulating gas	3	1				2			
	Vacuum	3				1	2			
	• Metal-resin compound sash	4	1				3			
	• Addition of inner window sash									
	• Sunlight shielding	9	4	1		1	3			
	Eaves	6	2	1		1	2			
	Blind (sunlight tracking type) * Horizontal type only	1					1			
	Gradation blind									
	Louver (sunlight tracking type)	2	2							
	Wall surface greening	1	1							
	Heat-shielding film									
	• Natural ventilation	8	4	1			2	1		
	Utilization of wind pressure	1	1							
	Utilization of temperature difference (chimney effect)	7	3	1			2	1		
	Hybrid type (combined with mechanical ventilation)									
	• Natural daylighting	7	4		1			2		
	Light shelf									
	Atrium	1	1							
	Daylighting cloth	5	2		1			2		
	Daylighting window film/panel	4	1		1			2		
	Top light	4	2					2		
	Light duct	4	2					2		
	Chromatic light blind	1	1							
Energy conservation technologies for equipment (Active) – Air conditioning	• High-performance air conditioners (individual distribution type)	27	8	1	1	4	7	3	2	1
	Room air conditioner	2				1	1			
	Packaged air conditioner (multi-system for building, EHP)	26	7	1	1	4	7	3	2	1
	Packaged air conditioner (multi-system for building, GHP)	1	1							
	• High-performance heat source machines (central type)	3	1			1	1			
	Chilling unit (air-cooled)	2	1				1			
	Absorption water cooler/heater	1				1				
	• Auxiliary heat source utilization systems	8	5			1	2			
	Underground heat utilization system (HP)	2	2							
	Underground heat utilization (cooling/heating tube)	3	1				2			
	Well water heat utilization system	2	2							
	Solar heat utilization	1	1							
	Cogeneration exhaust heat utilization (fuel cells included)	1				1				
	• Outdoor air utilization and control systems	22	7	1	1	3	7	1	1	1
	Total heat exchanger system	22	7	1	1	3	7	1	1	1
	Total heat exchanger bypass control system	9		1		2	5			1
	Outdoor air cooling system	10	3	1	1	2	2	1		
	Nighttime purge system	9	2		1	2	3	1		
	Minimum outdoor air inlet volume control system (CO_2 control)	11	5				4	1		1
	• Variable flow rate systems	6	2	1		2	1			
	VAV air-conditioning system (INV)	3	1			2				
	VWV air-conditioning system (INV)	3	2				1			
	Large temperature difference water feed system	2	1	1						
	• Other air-conditioning systems	6	3			1	1		1	
	Panel cooling and heating system	1	1							
	Desiccant air-conditioning system	2	1			1				
	Ice heat storage system	1							1	
	Underfloor air-conditioning system	2	1				1			
	Task/ambient air-conditioning system	1	1							
	Pellet stove									

	Energy conservation technology contributive to ZEB	Total: 27 cases	Offices: 8 cases	Public offices: 1 case	Hotels: 1 case	Hospitals: 4 cases	Nursing homes, welfare facilities: 7 cases	Department stores: 3 cases	Supermarket: 2 cases	Gymnasiums etc.: 1 case
Energy conservation technologies for equipment (Active) – Air conditioning	• Other air-conditioning equipment	4	3					1		
	HP desiccant outdoor unit	3	3							
	Desiccant total heat exchanger	1	1							
	Evaporative cooler	1						1		
	High-sensible heat multi air conditioner for building	1	1							
	• Air-conditioning control systems	14	3	1	1	2	4	2		1
	Presence detection control system	6	1			1	4			
	Presence detection (camera) control system	1					1			
	Amenity index (PMV) control system	1				1				
	Radiation temperature control system	10	1	1	1	2	3	2		
	Time schedule control system	6	1	1	1			2		1
	Heat source integration control system	3	1	1		1				
Mechanical ventilation	• High-efficiency electric motors (JIS C4212, 4213)									
	• DC motors	2				1	1			
	• Air flow control	7	2	1		1	3			
	CO_2 concentration	3	1	1			1			
	Temperature	2	1				1			
	Enthalpy									
	Presence detection	3		1		1	1			
	Gas consumption									
	Electric consumption									
	Miscellaneous gas detection	1				1				
Lighting	• LED lights	27	8	1	1	4	7	3	2	1
	• Task/ambient lighting	3	3							
	• Lighting control	27	8	1	1	4	7	3	2	1
	Brightness detection control system	25	8	1	1	4	6	2	2	1
	Presence detection control system	23	8	1	1	2	5	3	2	1
	Time schedule control system	9	3			1	2	2	1	
	Initial luminosity correction	3	2				1			
	Digital individual control system	3	1			1				1
Water heating	• High-efficiency water heaters	19	3		1	4	7	1	2	1
	Heat pump water heater	12	3			2	4		2	1
	Latent heat recovery water heater	7			1	1	3	1		1
	• Auxiliary heat source utilization systems	6			1	1	3			1
	Solar heat utilization system	2					1			1
	Geothermal heat utilization system									
	Well water heat utilization system	1	1							
	Cogeneration exhaust heat utilization system	4			1	1	2			
	PV panel heat utilization system									
Elevators	• VVVF control, electric power regeneration control, etc.	3	2			1				
Power reception/transformation	• Second top runner transformers	14	4		1	2	3	2	1	1
	• Cogeneration equipment	4			1	1	2			
	Fuel cells									
	• Storage battery equipment (creation-storage linkage)	5	4				1			
Renewable energy	• Power generation equipment	17	6			2	5	3		1
	Solar photovoltaic generation system	17	6			2	5	3		1
	Wind power generation system									
Energy management	• Inter-equipment integration control system	7	1			1	2	2	1	
	• Equipment-user linkage control system	10	3		1	1	4			1
	• Load control	14	6	1		2	3		1	1
	• Inter-building integration control system									
	• Development to operation such as tuning	26	8	1	1	4	6	3	2	1

(light green): Technology introduced by 50% or more

(green): Technology introduced by 80% or more

Technologies frequently adopted for ZEB in Japan

<Passive technologies (Construction)>

- Low-e multi-layer glasses
- Sunlight shielding (eaves)
- Insulation

<Active technologies (Equipment)>

- Air conditioners (individual distribution)
- Total heat exchanger system
- Inverter control
- LED lighting + control
- High-efficiency water heater
- Solar photovoltaic generation

→ ZEB Ready can be realized by introducing these technologies.

(Many buildings have similar specifications.)

* Excerpted from documents of Sustainable Open Innovation Initiative (Sii), 2018 ZEB Demonstration Project Survey Presentation

ISO:TS23764 Technical Specifications

SANKEN ENVIRONMENTAL ENGINEERING

Title: Methodology for achieving of ZEB for non-residential buildings

Background and Purpose

Since the adoption of the Paris Agreement at the 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC), all parties (including emerging countries) have been required to set targets for reducing greenhouse gas emissions from 2020 onwards. In all countries, reducing energy consumption can be said to be the most effective means of reducing greenhouse gas emissions.

The buildings sector accounts for a 30% share of global energy consumption, and this share appears to be increasing more and more [from IEA World Energy Outlook 2020]. Reducing greenhouse gas emissions from this sector is therefore a key issue worldwide, and eventually we need to achieve (net) ZEB by reducing the energy expenditure of buildings and balancing with renewable energy.

While the ultimate goal of achieving ZEB is clearly understood, its realization has been constrained by practical barriers such as high initial investment. However, due to the long life cycle of buildings, designing and constructing more energy-saving buildings is seen as a current rather than a future attempt to reduce greenhouse gases. The challenge is therefore to accelerate the move towards ZEB.

From this point of view, TS23764 is advocating a step-by-step approach towards realizing (net) ZEB. The aim is to embody practical ways of realizing ZEB in order to accelerate the movement towards ZEB. In other words, this specification proposes a practical ZEB approach. It outlines the items that should be basically examined in the whole process of ZEB implementation, from the designing stage to the operation and maintenance stage.

Outline of ISO:TS23764 Technical Specifications

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TECHNICAL SPECIFICATION

ISO/TS 23764

First edition
2021-09

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

ISO

Reference number
ISO/TS 23764:2021(E)

Standard
ISO/TS 23764:2021
Methodology for achieving non-residential zero-energy buildings (ZEBs)

Published on 2021-09 [Edition 1, 37 Pages]

The guidance also contributes to making many of the United Nations Sustainable Development Goals (SDG) a reality. These include the Goals addressing affordable and clean energy (SDG 7), sustainable cities and communities (SDG 11) and climate action (SDG 13).

ISO/TS 23764 was developed by ISO technical committee ISO/TC 205, *Building environment design*, whose secretariat is held by ANSI, ISO's member for the USA. It can be purchased from your national ISO member or the ISO Store.

Related information

SDG 7
Affordable and Clean Energy
Ensure access to affordable, reliable, sustainable and modern energy for all

SDG 11
Sustainable Cities and Communities
Make cities and human settlements inclusive, safe, resilient and sustainable

SDG 13
Climate Action
Take urgent action to combat climate change and its impacts

Standards

ISO/TS 23764:2021
Methodology for achieving non-residential zero-energy buildings (ZEBs)

Committees

ISO/TC 205
Building environment design

Outline of ISO:TS23764 Technical Specifications

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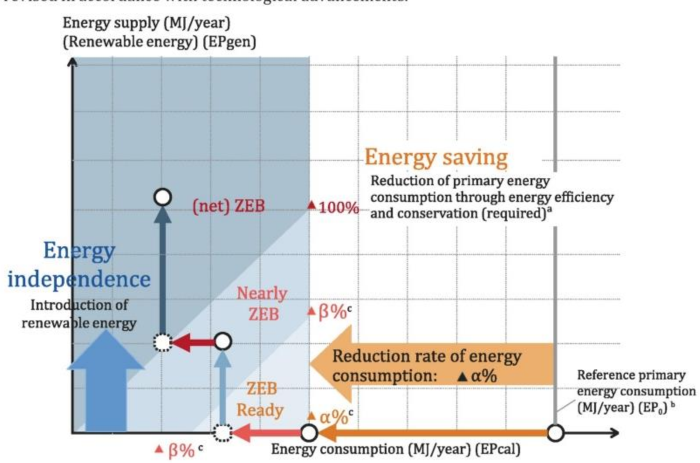
3.1
ZEB-ready
building that prospectively achieves *(net) ZEB* (3.3) through enhanced insulation suited to building use and climate, exterior surface and shading for suppressing the load, high-efficiency energy-conservation equipment and optimization of energy consumption by data integration and verification

3.2
nearly ZEB
building that almost achieves *(net) ZEB* (3.3), with an annual primary energy consumption of almost zero using renewable energy while meeting the criteria of *ZEB-ready* (3.1)

3.3
(net) ZEB
building with zero or negative net annual primary energy consumption while meeting the criteria of *ZEB-ready* (3.1)

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

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



Key

a The target of the energy consumption reduction from the reference primary energy consumption is set in accordance with regional circumstances and adopted as a standard.

b A reference building may be determined in accordance with regional circumstances and its energy consumption is defined as the reference energy consumption.

c Reduction rate targets, α% and β% to be set by individual countries.

Figure 3 — Energy supply versus energy consumption

Six core elements of ISO/TS 23764

1	**At planning stage,** to have a clear policy to achieve ZEB by the three steps: ZEB Ready → Nearly ZEB → (net) ZEB, but not to achieve it by only one step to (Net) Zero Energy Building.
2	**At the design stage**, to identify appropriate passive and active design strategies and select proper materials and equipment, which are in accordance with a national or international standard, as far as possible.
3	**During construction,** to install the selected materials and equipment correctly according to the drawings and specifications.
4	**After completion of building,** to realize the energy consumption targeted at the design stage.
5	**After the start-up of the operation,** to inspect actual energy consumption continuously (suitable times per year) to monitor whether there is any difference of energy consumption between the targeted at design stage and the measurment during actual operation.
6	**After the start-up of the operation,** to calculate the primary energy consumption periodically by using simulation software, if possible.

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

4.2 Planning phase

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

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

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

Zero Energy Buildings of SANKEN

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FUKUI City, FUKUI Pre

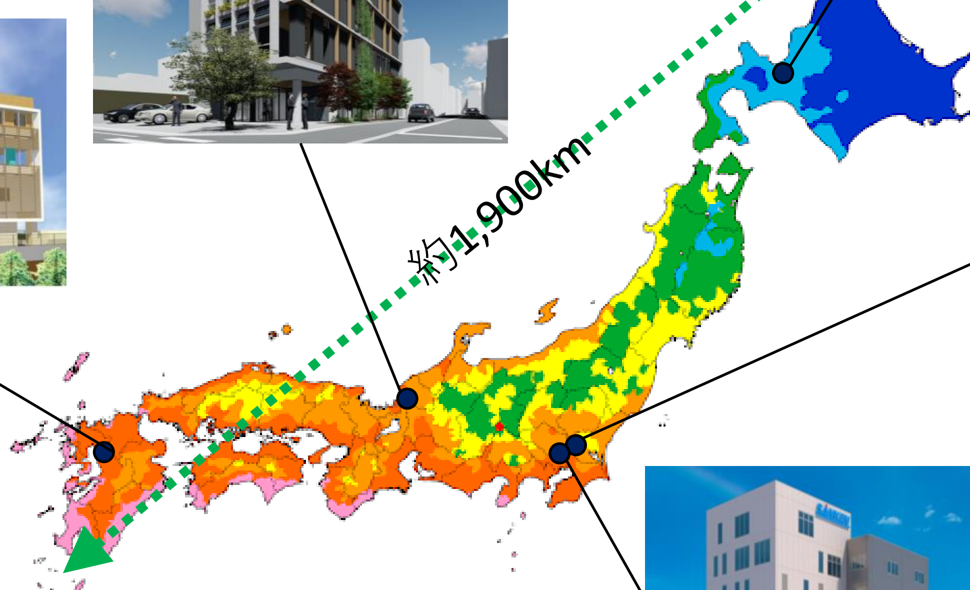
福井市（福井県）
Nearly ZEB
2021年8月竣工

Omuta City, FUKUOKA Pre

大牟田市（福岡県）
ZEB Ready
2014年11月竣工

SAPPORO City, HOKKAIDO

札幌市（北海道）
nearlyZEB
2018年10月竣工



省エネ基準地域区分

- 1 地域
- 2 地域
- 3 地域
- 4 地域
- 5 地域
- 6 地域
- 7 地域
- 8 地域

Energy conservation standard area classification

TSUKUBAMIRAI City, IBARAKI Pre

つくばみらい市（茨城県）
Net ZEB
2009年~改修開始
2014年達成

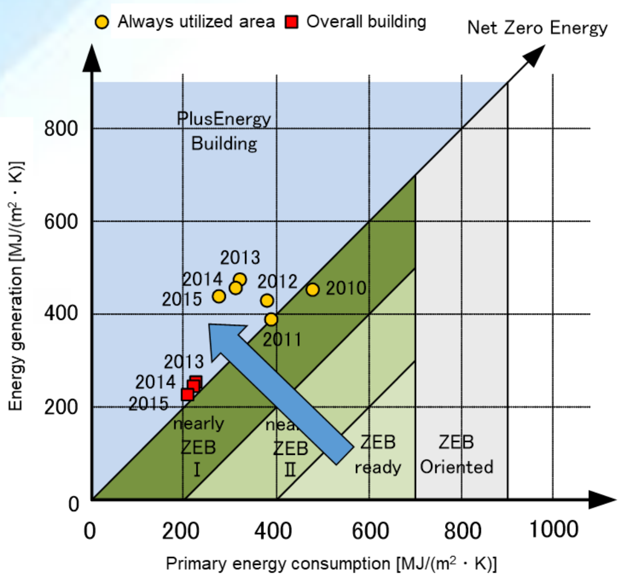
SAITAMA City, SAITAMA Pre

さいたま市（埼玉県）
ZEB Ready
2022年3月竣工

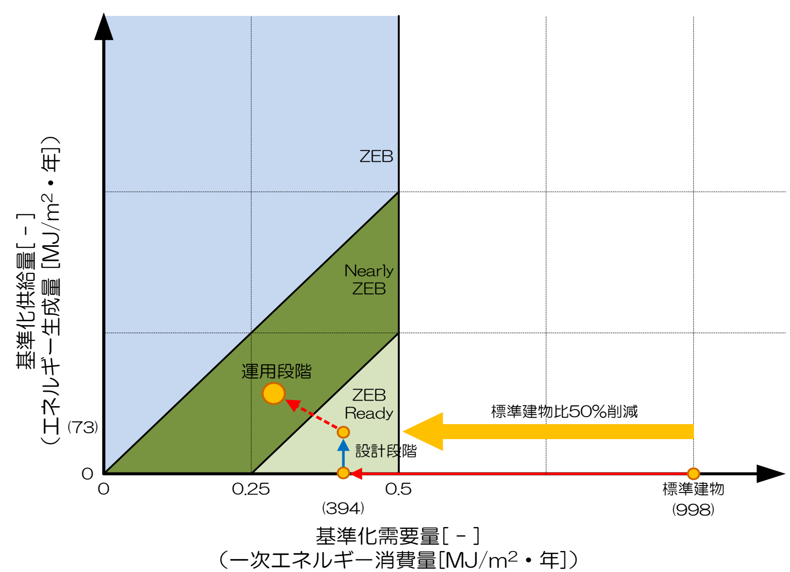
Zero Energy Buildings of SANEKN

Tsukuba-mirai Technical Center (TTC)

Sapporo Branch

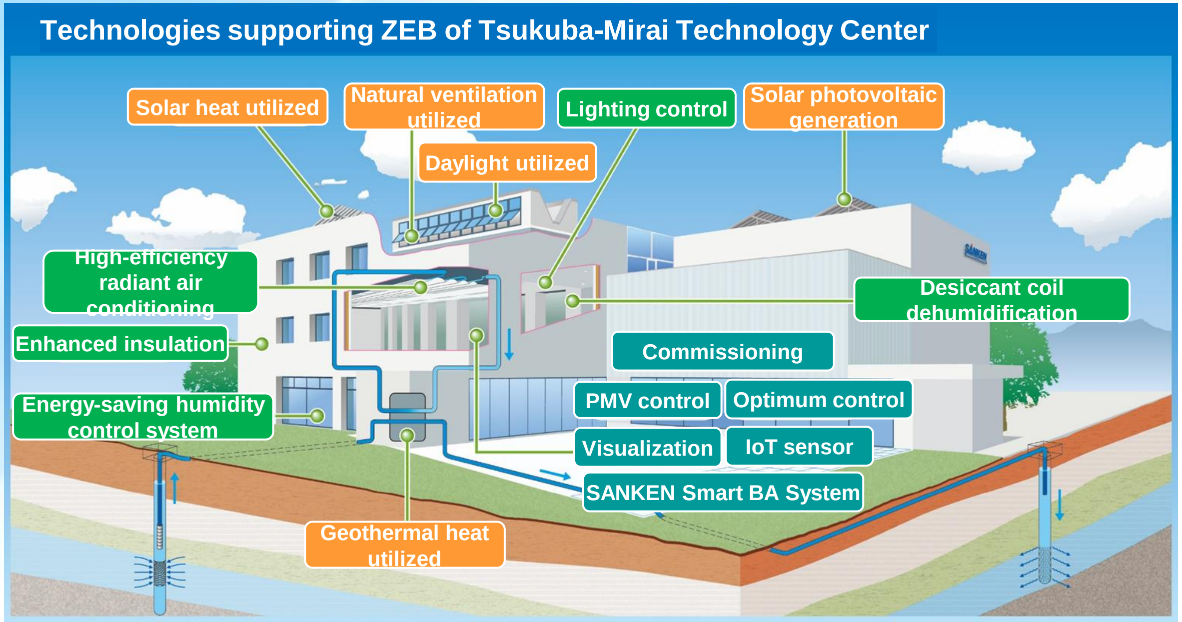


* Energy generation quantity in the always utilized areas is evaluated based on power generation of 10-kW solar battery.



Tsukuba-mirai Technical Center (TTC)

Name: Tsukuba-Mirai Technology Center, SANKEN SETSUBI KOGYO
Location: Tsukuba-Mirai, Ibaragi prefecture
Site area: 4,123 m^2 Building area: 1,101 m^2
Total floor area: 2,258 m^2 Reinforced concrete construction with 3 stories



Improved energy conservation performance	Minimized load, higher-efficiency equipment
Renewable energy	Effective use based on characteristics
Optimized system	Open visualized optimum control making energy consumption compatible with amenity

[Award-receiving history]

- Society of Heating, Air-Conditioning and Sanitary Engineers of Japan's special award; "Renewal Award"
- Global warming prevention activity; "Minister of Environment Award"
- Japanese Association of Building Mechanical and Electrical Engineers; "Carbon Neutral Award"
- Sustainable building award; "Review Committee Encouragement Award"

TSUKUBA-MIRAI TECHNICAL CENTER

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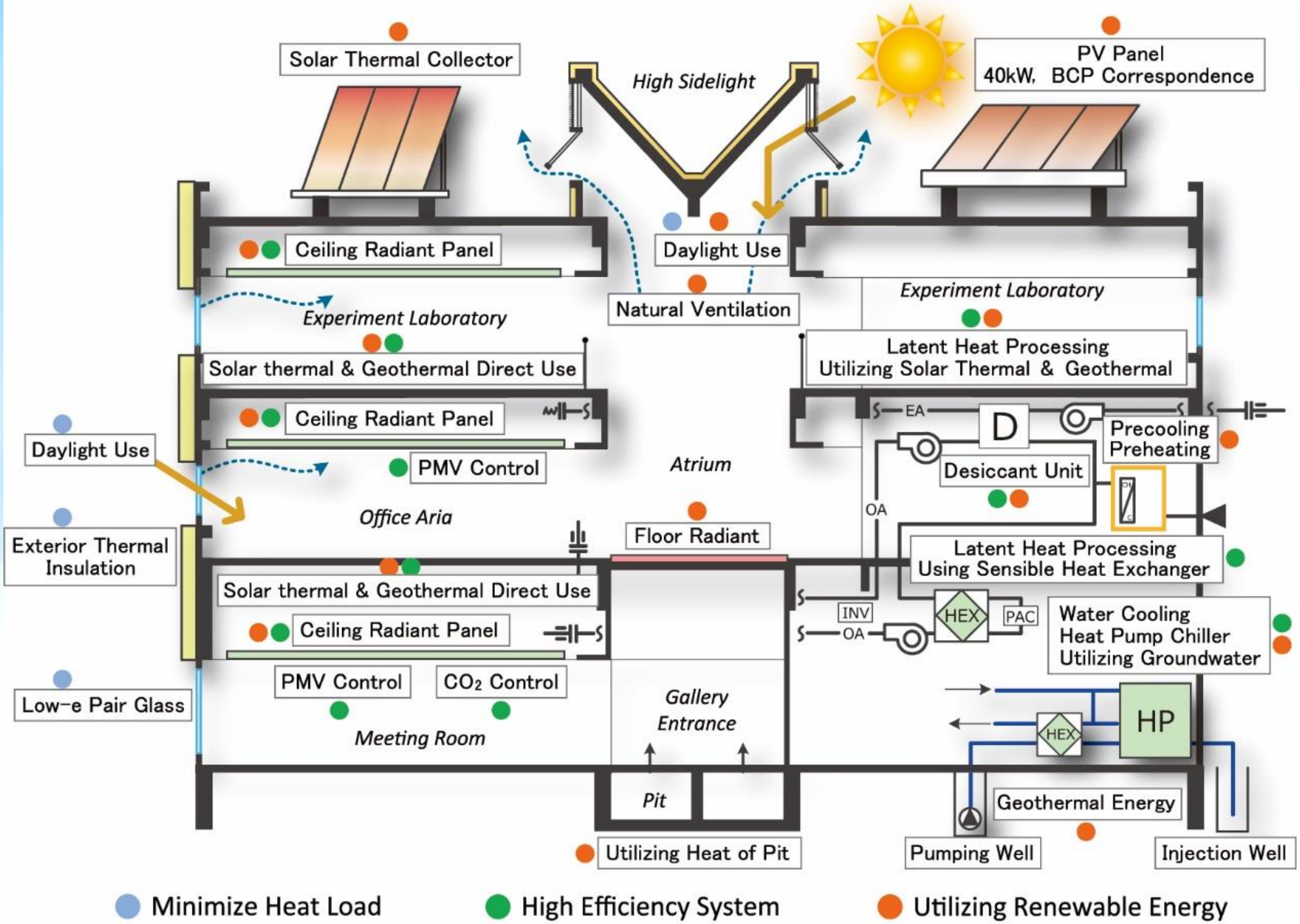

導入技術の概要
Outline of the Innovated Technologies in the Building

Elemental Technologies

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1. Architectual

① Exterior thermal insulation
② Low-e pair glass
③ Natural Ventilation

2. Air-conditioning system

① **Latent heat and Sensible heat decoupled**
Ceiling radiant panel, Latent heat treating system
② **Direct use of renewable energies**
Geo-heat, Solar thermal, Natural ventilation

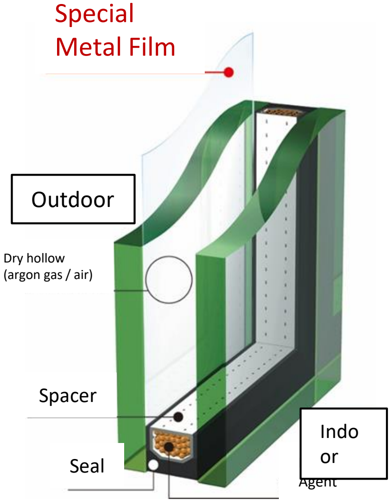
3. Electric equipment and lighting system

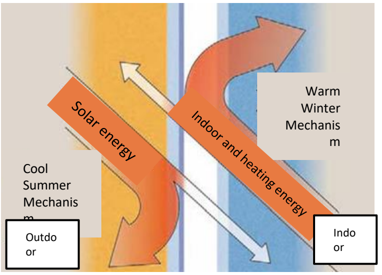
① High efficiency lighting （LED)
② Daylight control and zone control of lighting
③ High efficiency transformer

Heat Load Reduction with High Insulation

External insulation

Low-e pair glass





・70mm thick external insulation is added to the RC. (wet method)

Overall Heat Transfer Coefficient

Before： 2.4 W/㎡・K

After ：0.56W/㎡・K

・Replace with heat-shield double glazing

Overall Heat Transfer Coefficient

Before： 4.8W/㎡・K

After ： 2.5W/㎡・K

Approximately 31% reduction in heat load annually

Decoupled Sensible Heat and Latent Heat Air-conditioning System Utilizing Renewable Energies (Cooling)

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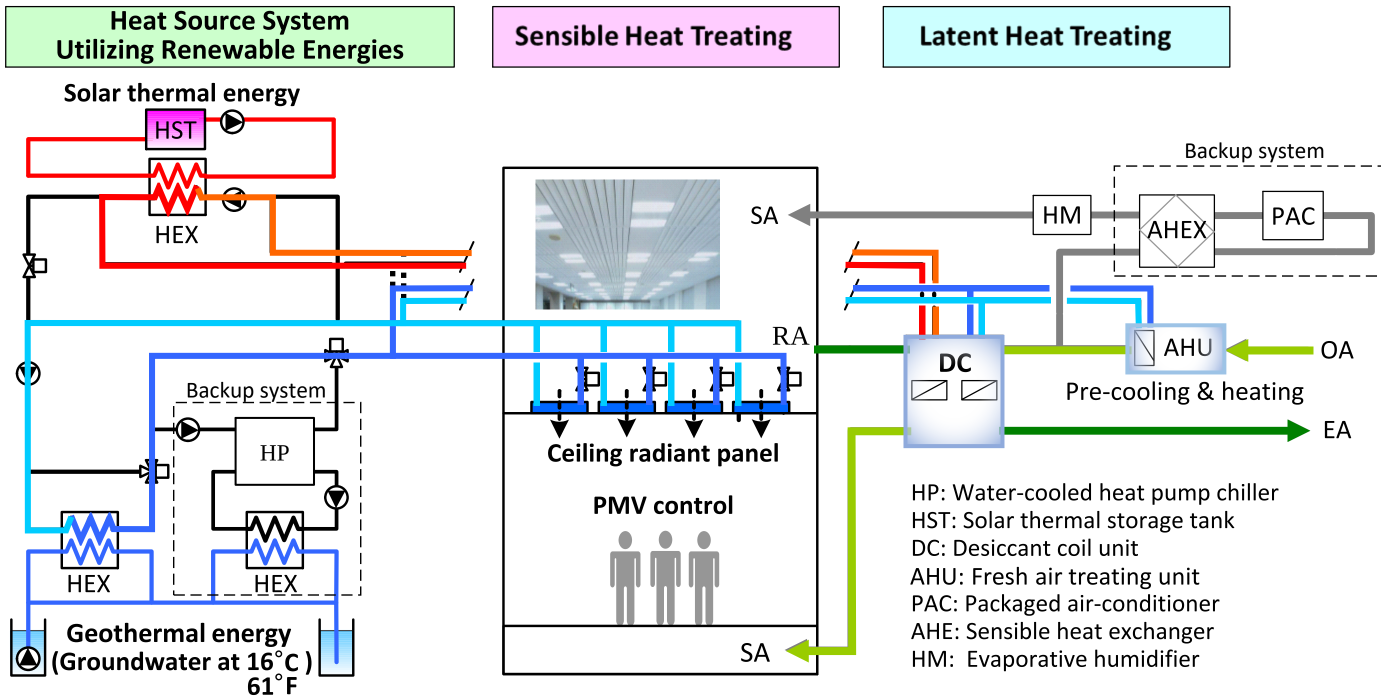

Main heat source for the air-conditioning system

Cooling: Direct utilization of geo-thermal energy and solar thermal energy
(Solar thermal energy for regeneration process of desiccant coil unit)

Heating: Direct utilization of solar thermal energy

Utilizing Renewable Energies (Cooling)

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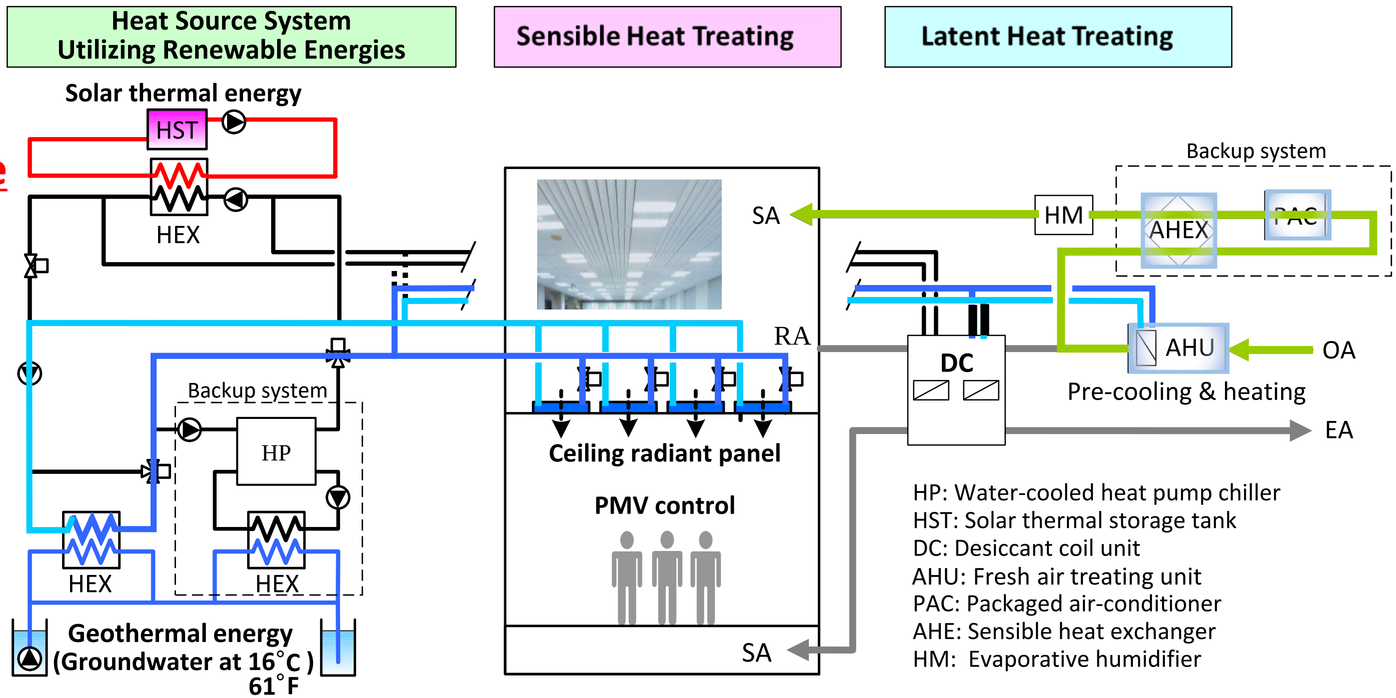
low temperature <50℃



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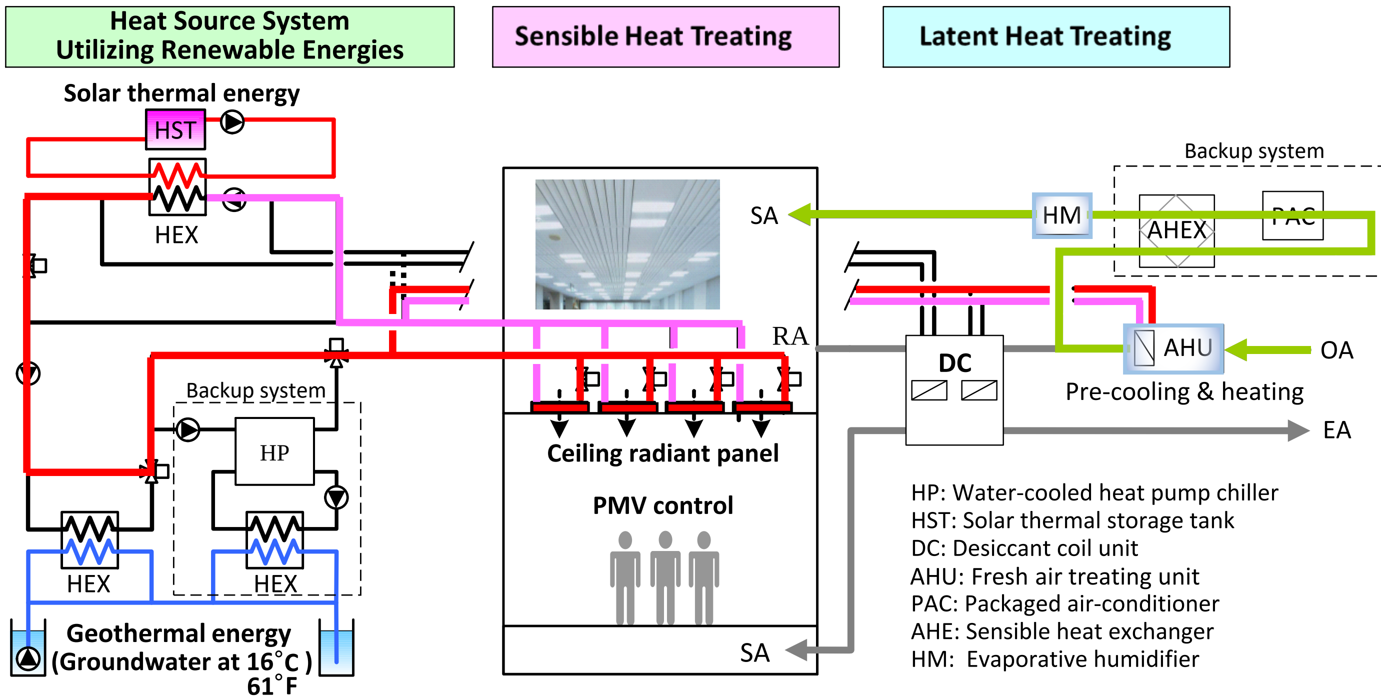
Decoupled Sensible Heat and Latent Heat Air-conditioning System Utilizing Renewable Energies (Heating)



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(Solar thermal energy for regeneration process of desiccant coil unit)

Heating: Direct utilization of solar thermal energy

Decoupled Sensible Heat and Latent Heat Air-conditioning System
Utilizing Renewable Energies (Heating)

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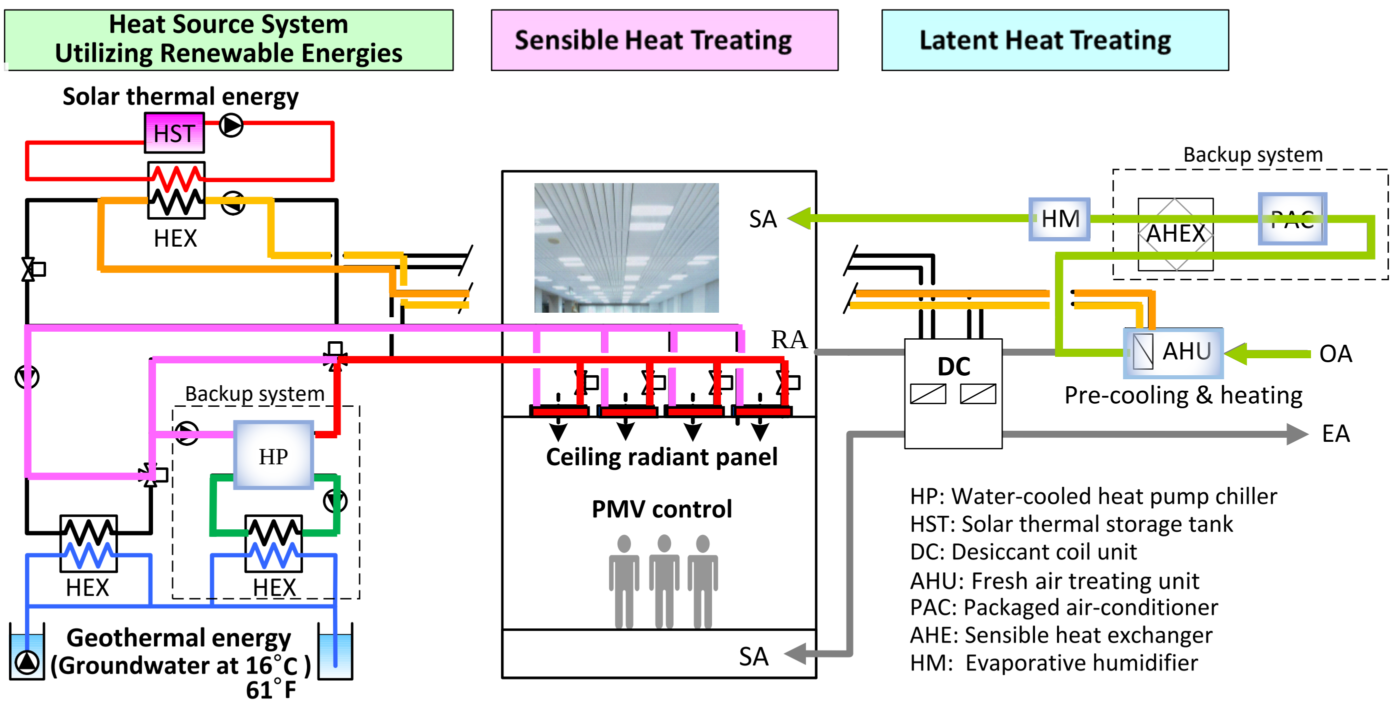
low temperature <24℃



Main heat source for the air-conditioning system

Cooling: Direct utilization of geo-thermal energy and solar thermal energy

(Solar thermal energy for regeneration process of desiccant coil unit)

Heating: Direct utilization of solar thermal energy

Desiccant Coil

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Desiccant Coil Specifications

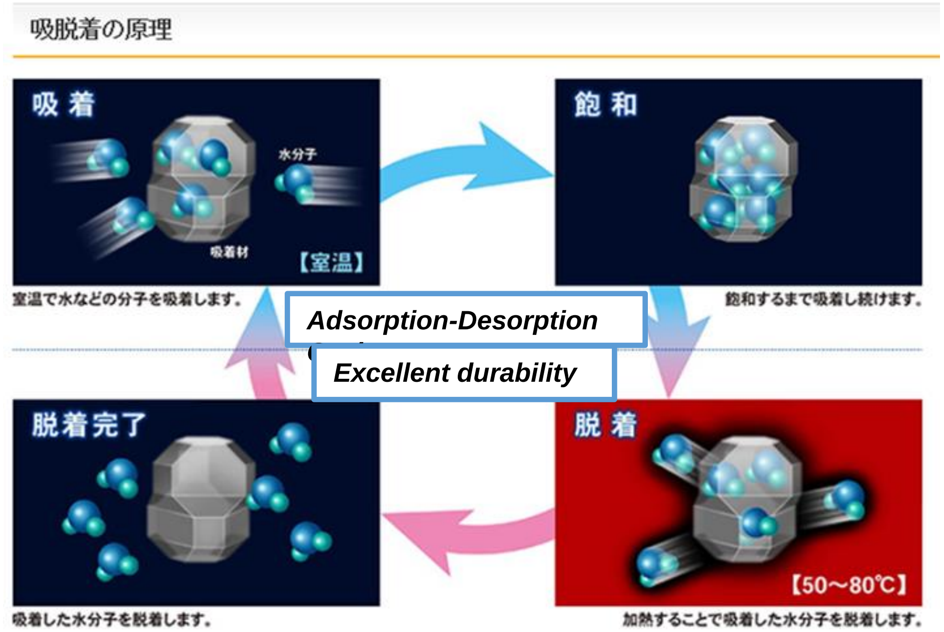
Heat Exchanger	Fin Tube Type
External Dimension	264mm x 600 mm x 102mmD
Fin Pitch	1.8mm
Material	Fin: Al, Tube: Cu
Adsorbent	Zeolite Adsorbent
	Adsorption Heat 54kJ/mol
	Specific Heat 0.764kJ/kg K
Application Amount	3 kg

Adsorption-Desorption Cycle

18℃-Groundwater thermal

Adsorption

Saturation



Desorption completed

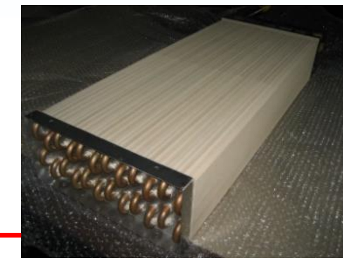
Desorption

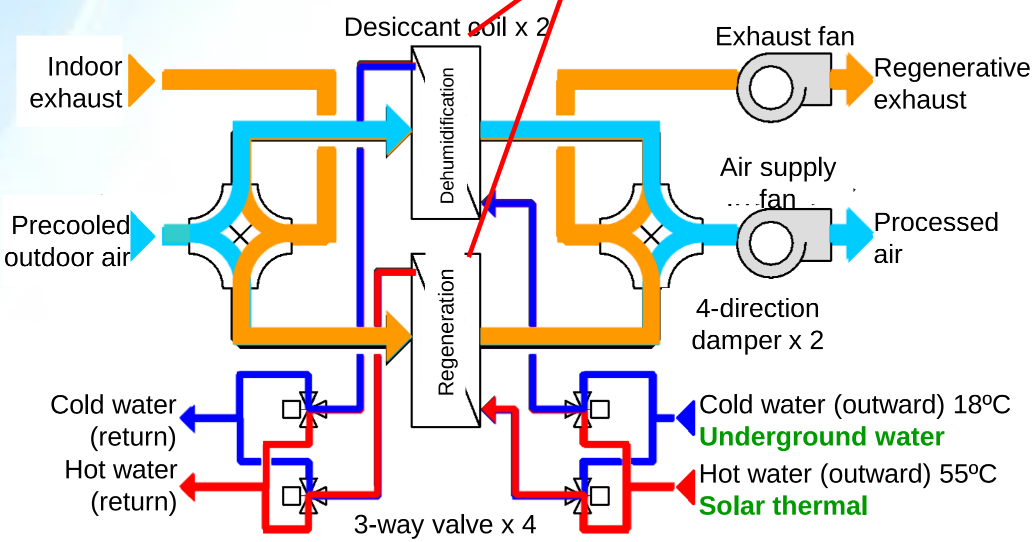
55℃-Solar thermal

Air conditioning (Solar Heat and Well Water Heat Utilized)

Expanded utilization of ***Renewable energy*** heat source

- Introduce a desiccant coil system for outdoor air processing (dehumidification) in summer.
- Reduce energy consumption by compressor-free air conditioning.





<Only renewable energy used as heat source>

Processing system: Batch system by 2 desiccant coils

Operation Data of Desiccant Coil Unit

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- The ability to maintain indoor humidity bars (10.6g/kg) by treating the latent heat load of 20 people in the room when necessary outside air is 25m3/h/persons against the outside air of 500m3/h.

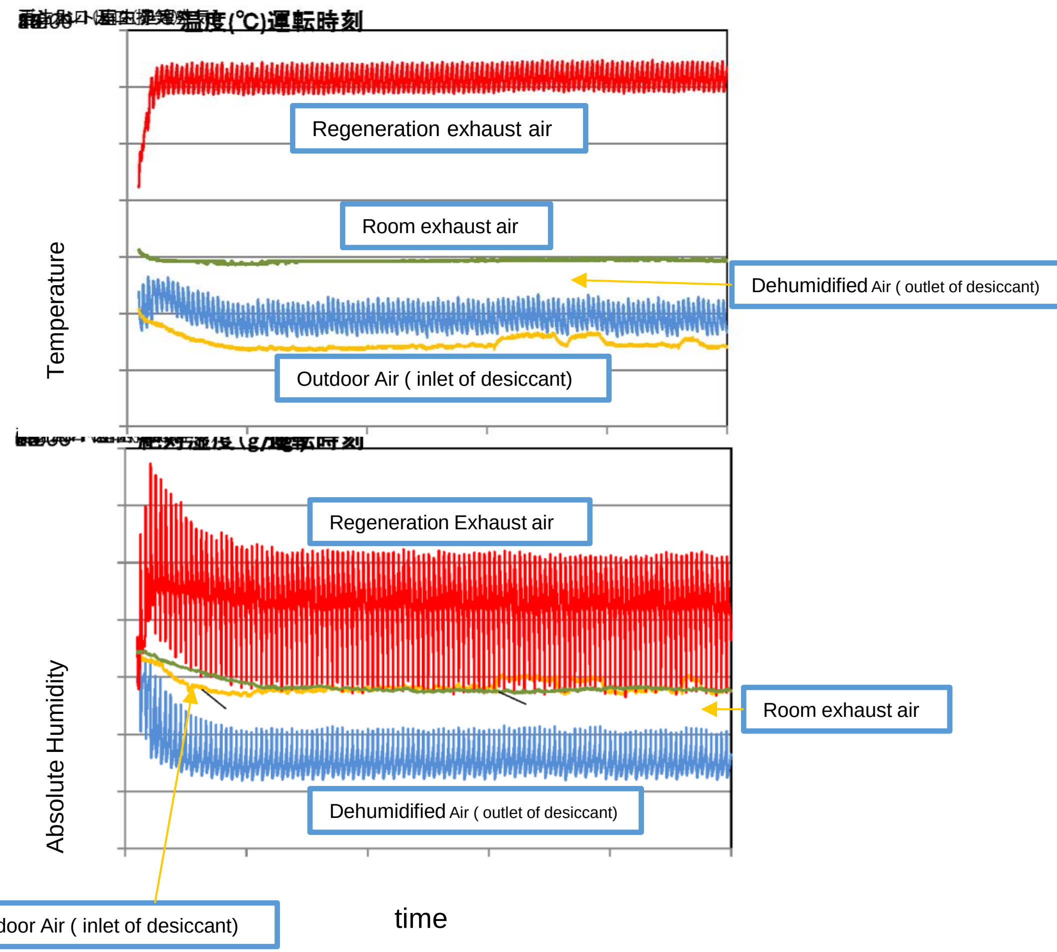
Operation data on 29/08/2013

- Batch Interval ： 5min
- Chilled Water Temperature : 17.9℃ (Groundwater)
  Flow rate : 22.6L/min.
- Hot Water Temperature : 55.2℃ (Solar thermal)
  Flow rate : 21.2L/min.

Average Temperature: 24.8℃

Average Absolute Humidity: 7.7g/kg'

- Chilled water temperature of pre-cool coil : 17.9℃(Groundwater)



Desiccant latent heat treatment system

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A system that effectively uses hot water (50-60 ℃) in summer

To utilize low exergy heat source water for an outdoor-air dehumidification system using general-purpose desiccant coil.

Construction of the dehumidification system with using renewable energy only

- Heat source : Solar heat 50-60 ℃
- Cold source : Ground water 18~20℃

It's possible to construct a compressor-less dehumidification system in ASEAN and utilization of waste heat from generators is effective.

Flat Type Solar Collector

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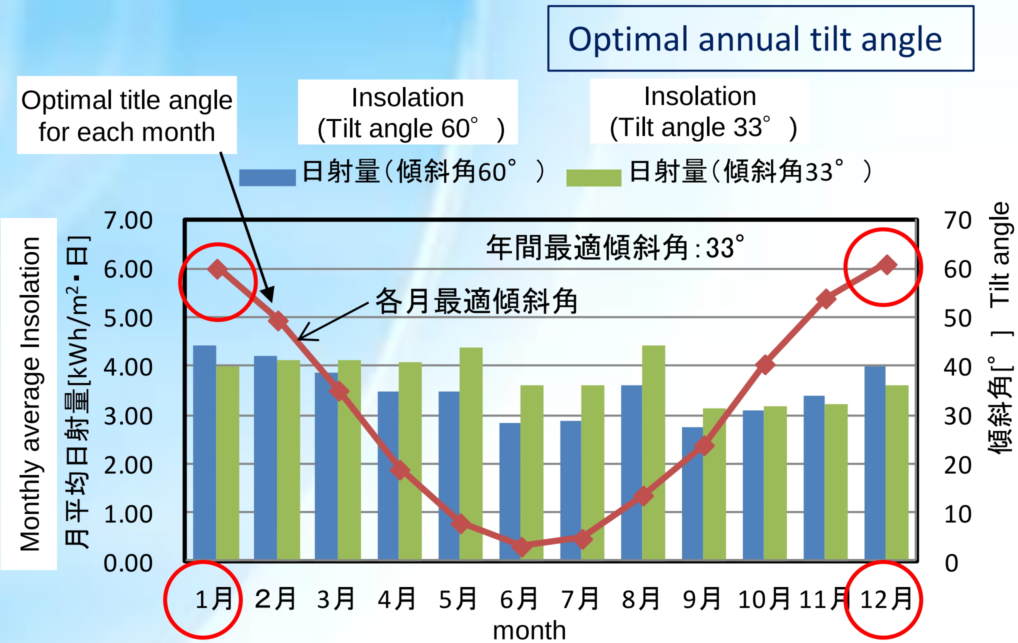

●集熱温度：45℃

Heat collection temperature: 45℃

●集熱器：低温集熱に適した平板型集熱器を採用。

Heat collector: Uses a flat-plate type heat collector suitable for low-temperature heat collection.

●暖房ピーク月の12月や1月に集熱を最大とする事を最優先で計画
⇒ 傾斜角は，年間集熱に最適の33° ではなく、60° を採用し設置面積を削減

The plan prioritizes maximizing heat collection during the peak heating months of December and January
⇒ The tilt angle is 60° instead of 33° , which is optimal for year-round heat collection, reducing the installation area.

水平面日射量：12.6MJ/m²・d
Horizontal insolation
集熱温度：45～30°C
Heat collection temperature
日中外気平均温度：5°C
Average daytime outdoor temperature
Heating Load 659MJ/ d (183kWh/ d)
→Heat collector 2㎡ x 28nos,Total 56㎡

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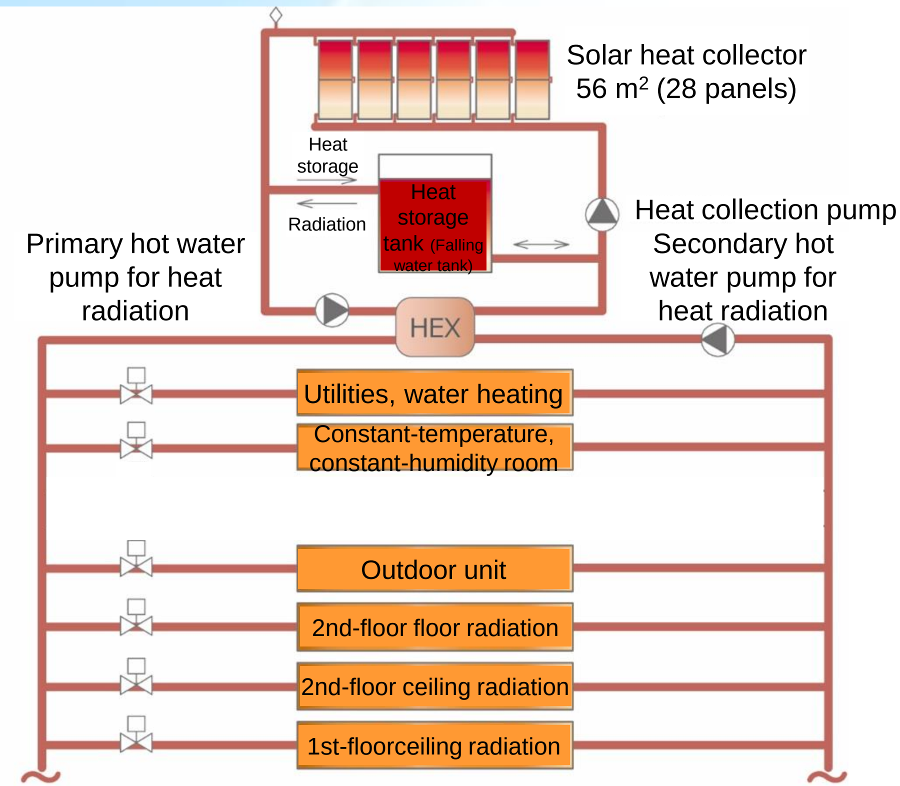
Operational improvement of renewable energy heat source

Change the utilization scope and supply temperature of hot water, depending on the heat storage temperature.
□ Increase a heat radiation amount. (Higher utilization rate of heat collection)
Expand the utilization scope from winter to summer.
□ Regenerative heat for desiccant air-conditioning and reheating source for experiment.



Category	Heat radiating operation mode	Heat storage tank evaluation temperature	Utilized for heating			Utilized for water heating
			Outdoor unit	Ceiling radiation	Floor radiation	
Winter	I	45ºC or more	42℃	27ºC to 42ºC	42℃	Supply temperature in each mode
	II	29ºC to 44ºC	27ºC to 38ºC	27ºC to 38ºC	Floor radiation HP	
	III	29ºC or more	27℃	Water-cooled chiller		
	IV	25ºC or more	22℃			
	Halt	Less than 25ºC	Water-cooled chiller			–
	Skelton heat storage	After fully stored up to upper limit on holiday	–	42℃	42℃	–

Natural Ventilation

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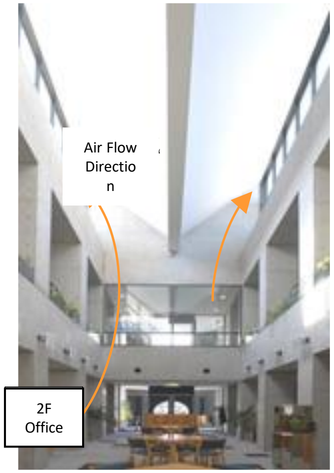
Operational improvement of air conditioning

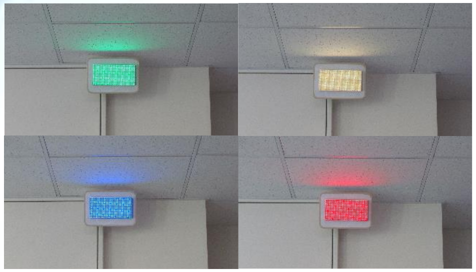
When natural ventilation is enabled, air conditioning (outdoor unit included) is halted to reduce air-conditioning energy consumption.
In summer, heat pools and heat storage are eliminated at the start of air conditioning.

- A sign(notice lamp) is installed in the office. (2014)
  → Opening and closing of the window
  (upper high-side light, tilt-and-turn(drehkipp) window)

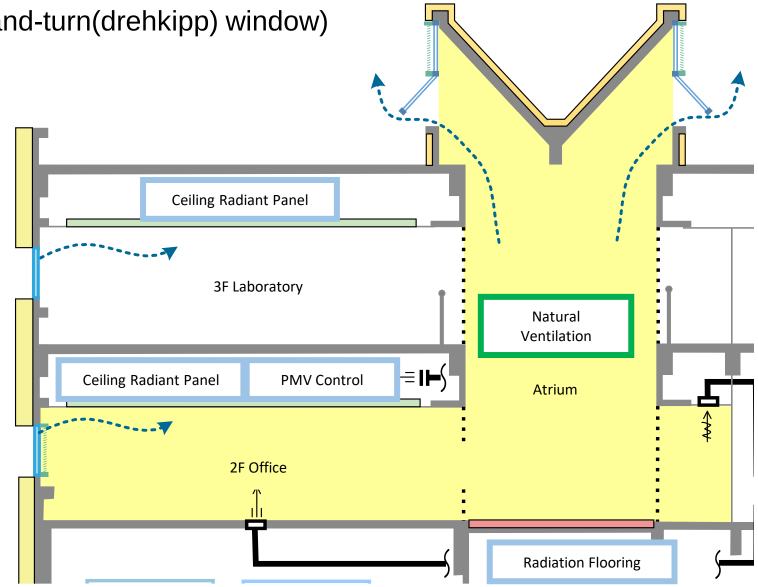
Drehkipp Flugel



Atrium



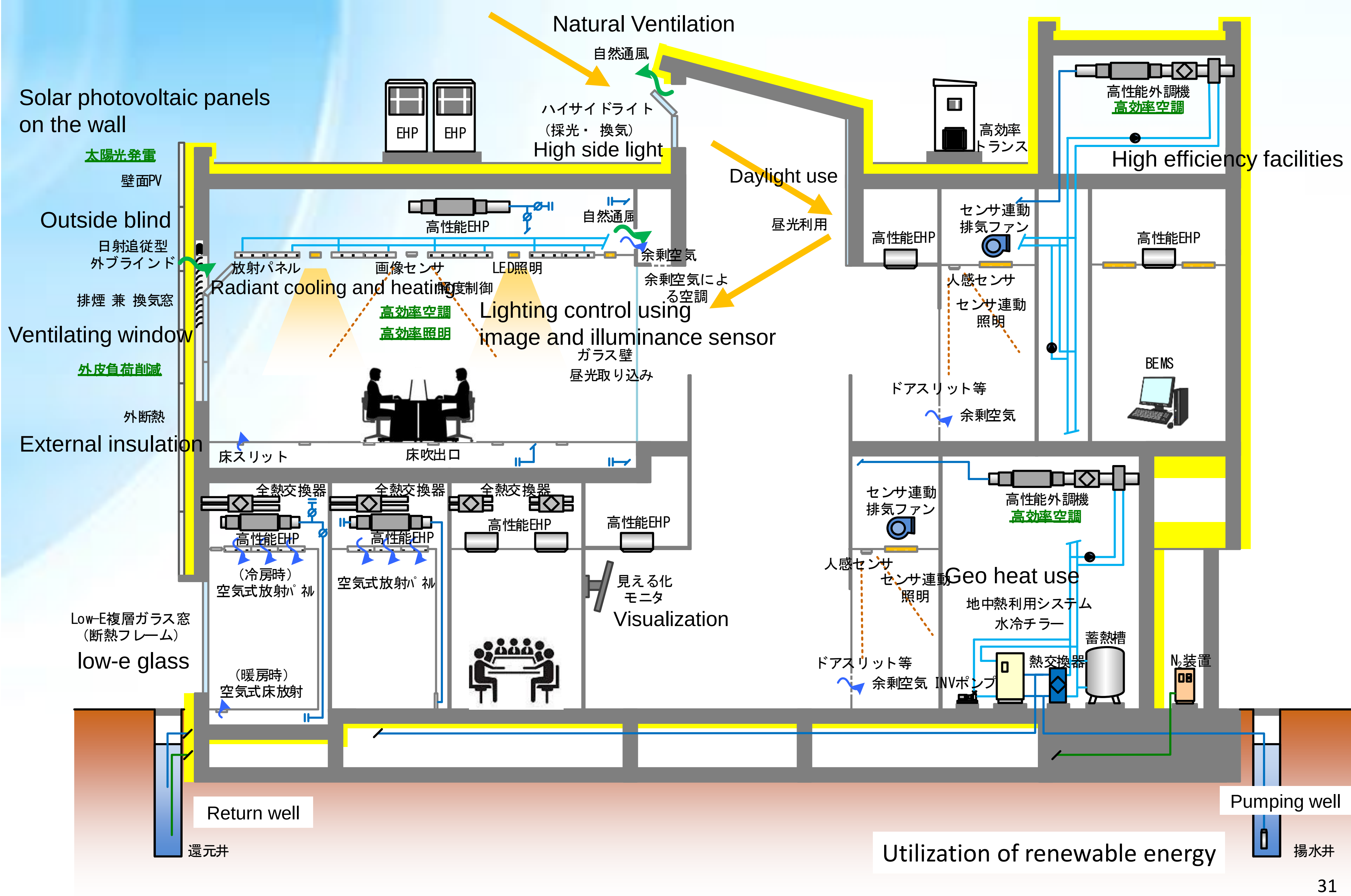
Natural Ventilation Sign



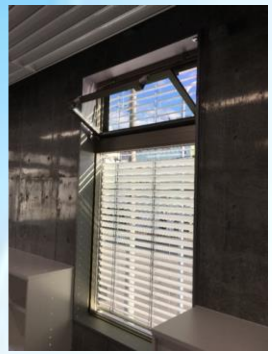
Sapporo SB Building

所在地 Location	北海道札幌市 Sapporo,Hokkaido	建築面積 Building area	972m^2
用途 Use	事務所 Office	延床面積 Total floor area	1,950m^2
構造 Structure	鉄筋コンクリート造 RC	建物高さ Height	9.1m
階数 Floor levels	地上2階 2 levels	設計・施工 Design, Construction	三建設備工業(株) SANKEN SETSUBI KOGYO CO.,LTD

Element technology for Sapporo SB

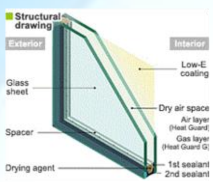


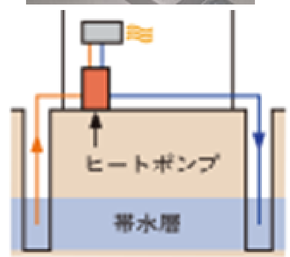
Sapporo SB Building



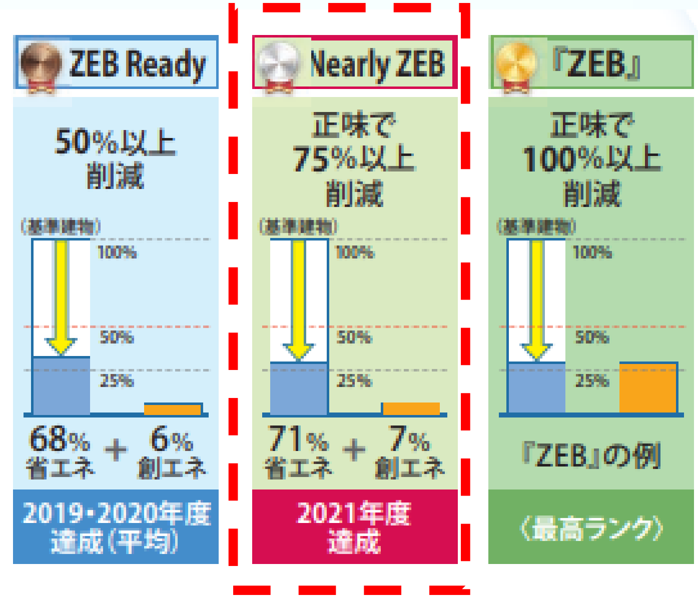
Wall Solar Panels and Low-e glasses windows

External Auto-adjusting blinds



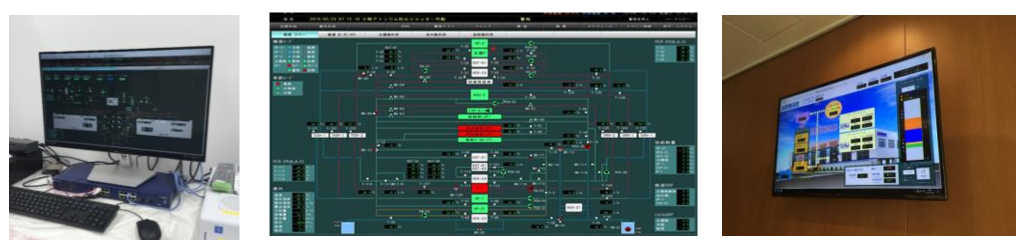


Heat pump utilizing underground heat



Achieved Nearly ZEB

High exterior thermal insulation



Smart energy monitoring system and visualization

Zero Energy Buildings & Technologies

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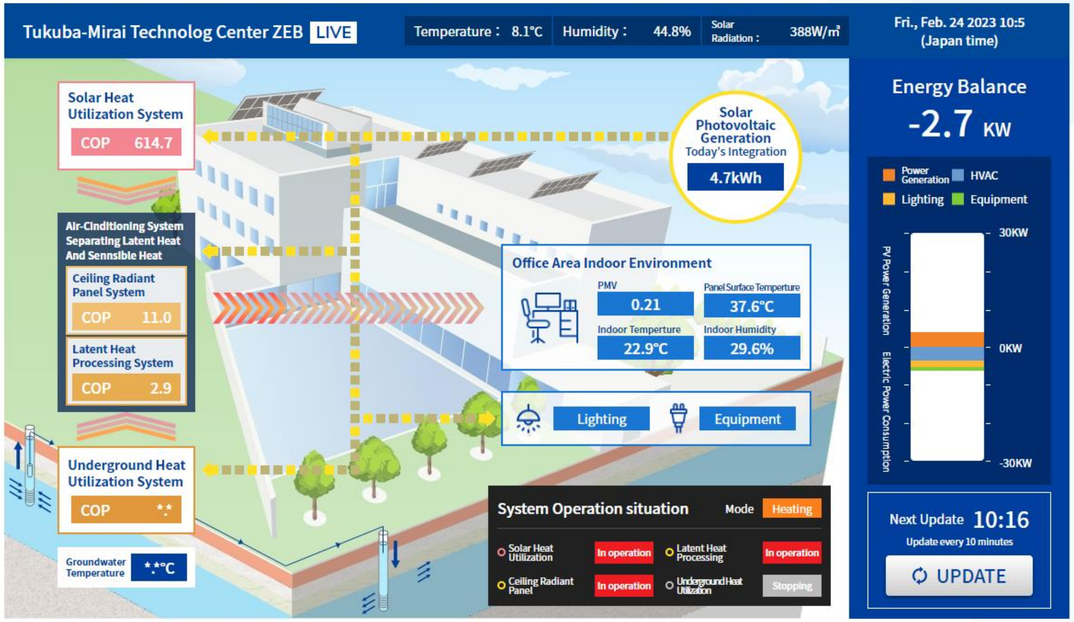
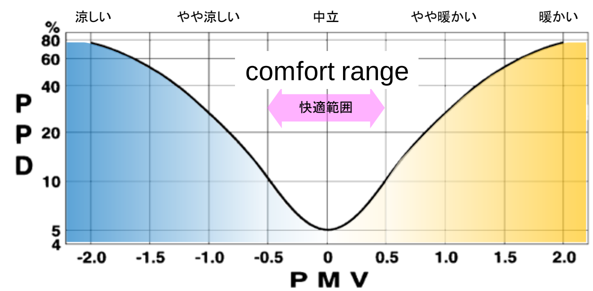
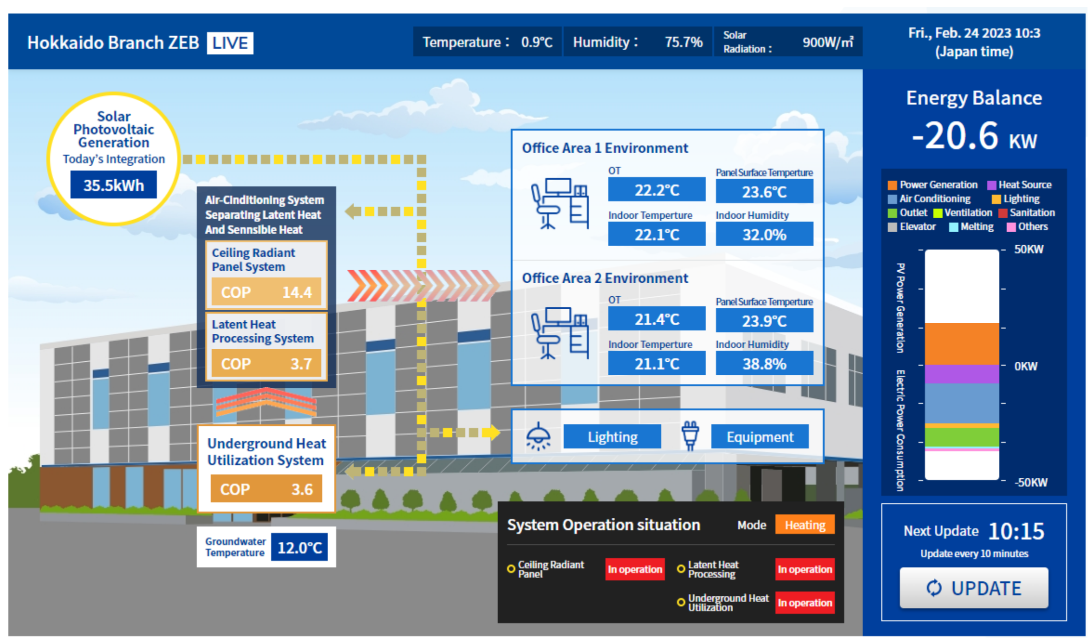


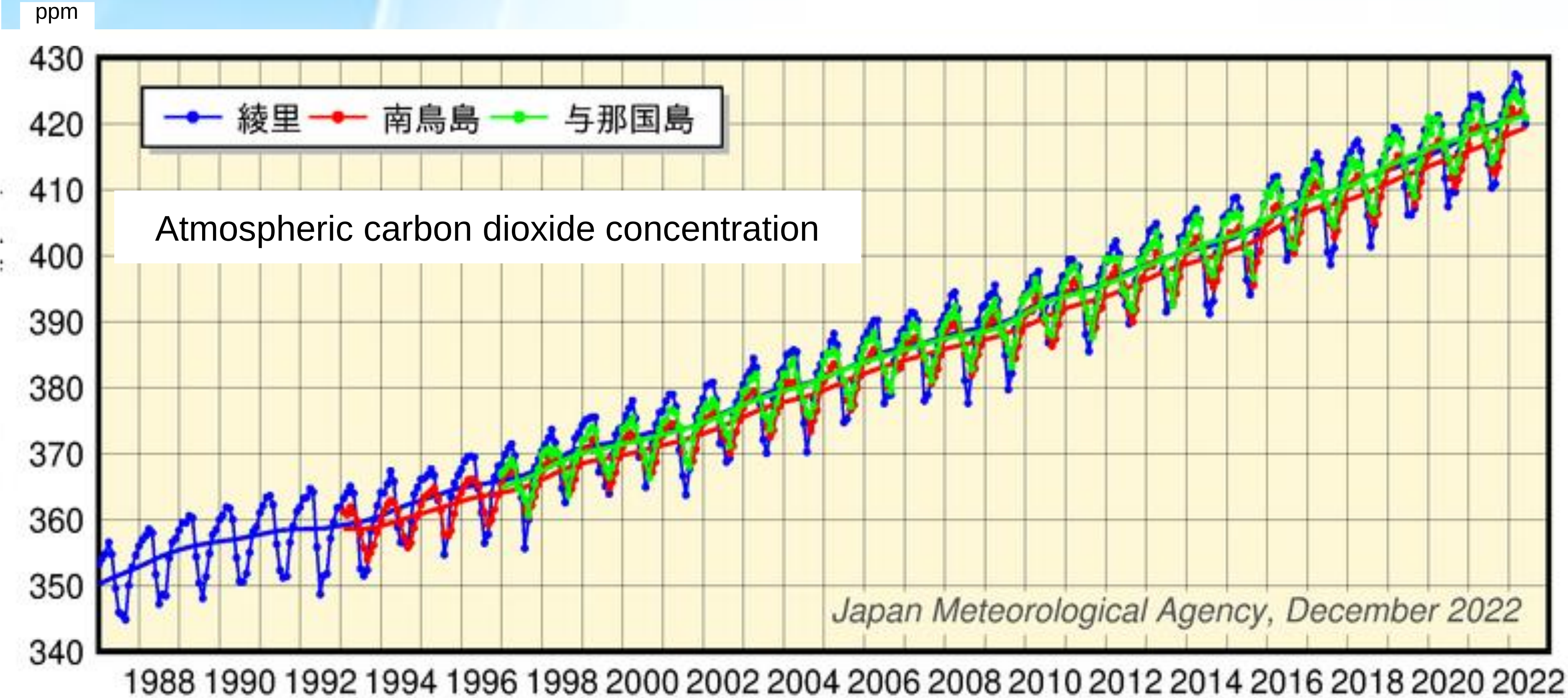
Scope of application of PMV		7 stage evaluation of PMV	
PMV	-2＜PMV＜+2	+3	Hot
Metabolic equivalent	0.8～4met	+2	Worm
Amount of clothing	0～2clo	+1	Slightly warm
Air temperature	10～30℃	0	Neutral
Mean Radiant Temp	10～40℃	-1	Slightly cool
Mean air velocity	0～1m/s	-2	Cool
Relative humidity	30～70%	-3	Cold





PMV（Predicted Mean Vote）
PPD（Predicted Percentage of Dissatisfied) ISO7730（1994）
OT（operative temperature)

ZEB promotion



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ENVIRONMENTAL ENGINEERING

Спасибо за внимание.

https://skk.jp/en/

ZEB
PLANNER
ZEB29P-00006-PGC

PIC: : Mail
Mr. SAEKI : k-saeki@skk.jp : +81-90-2230-0598 (personal) : +81-3-6280-2571 (Office)