Retrofit for an existing building with effective use of renewable energy: Targeting a Zero-Energy Building (ZEB)

Mr. Manabu Narimatsu
Manager, Technical Planning Group
Sanken Setsubi Kogyo

2:20 p.m.

Retrofit for an existing building with effective use of renewable energy;

Targeting a Zero-Energy Building (ZEB)

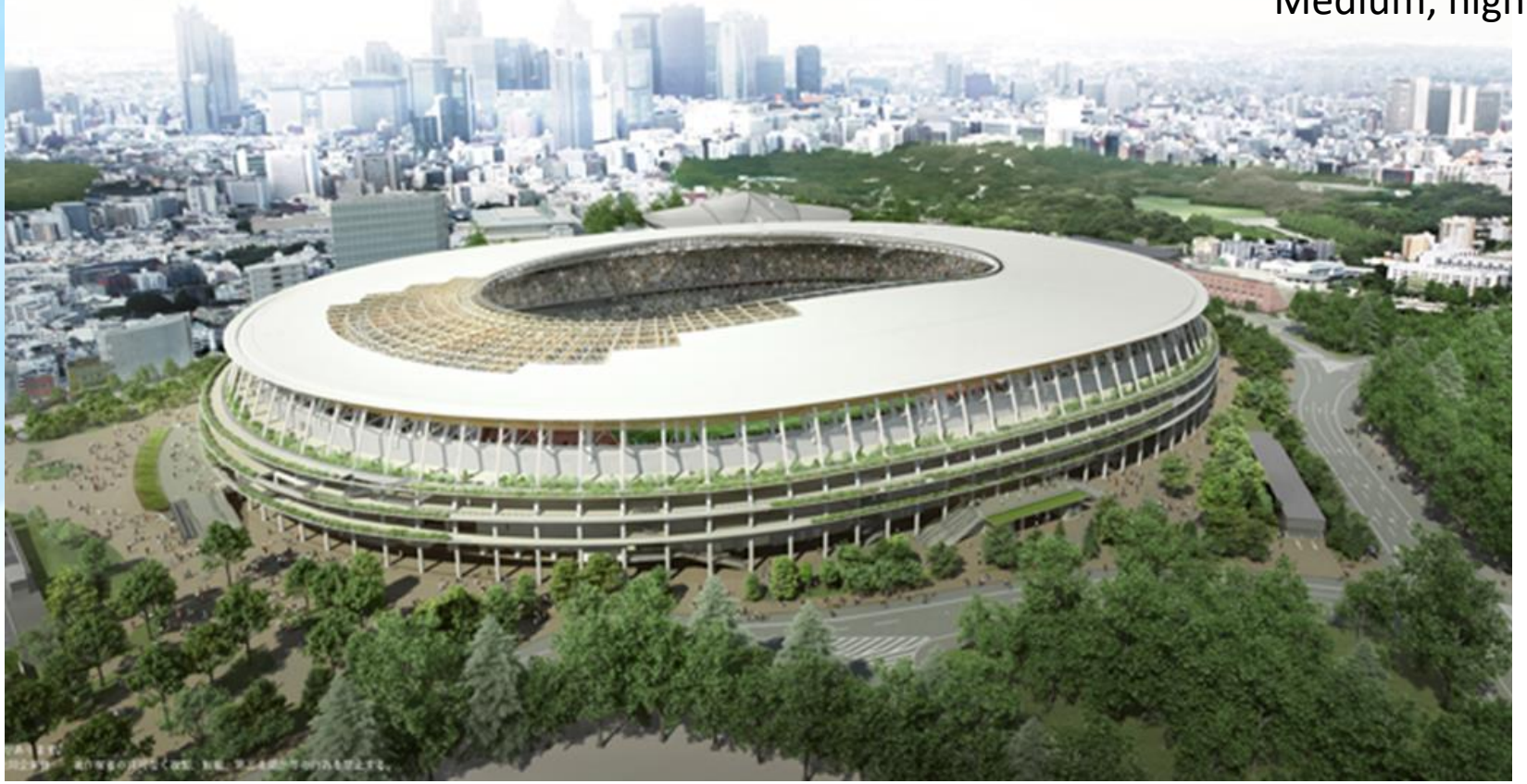
SANKEN SETSUBI KOGYO CO., LTD. JAPAN

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	¥1,000 million
Number of Employees	**Technical Staff 954** Clerical Staff 343 **Total 1,297 (As of April 1, 2023)**
Net Sales	¥75,000 million (FY 2022)
Construction Business License	(Toku-29) 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
	https://skk.jp/en

Representative projects

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



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

What is a ZEB (Zero Energy Building) ?

SANKEN ENVIRONMENTAL ENGINEERING

・ZEB is a building that utilizes high-efficiency air-conditioning systems, natural daylight and enhancing the heat-insulation to save energy usage as much as possible while maintaining comfortable indoor environments and creates electricity energy by photovoltaic and wind power generation on the site.

・ZEB can minimize power consumption derived from fossil fuels.

ZEB is necessary to keep climate change and to realize a decarbonized society.

Procedure for Achieving ZEB

1. Minimize the load

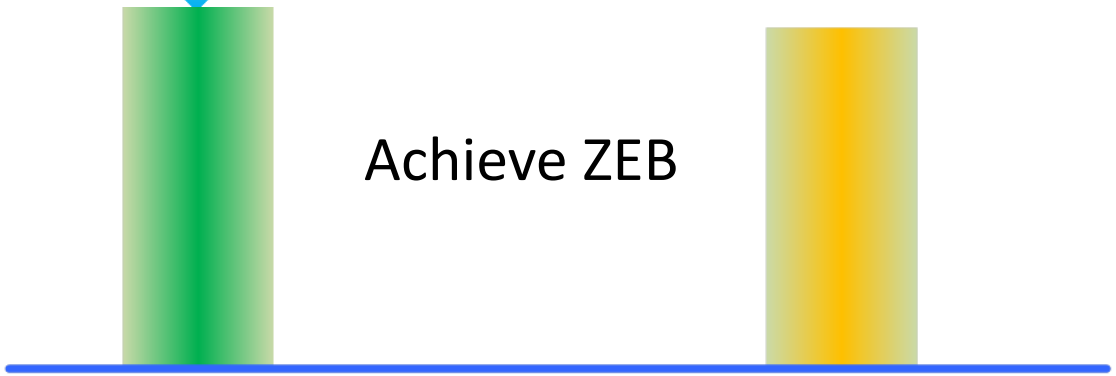
Enhancing the heat-insulation
Control of internal heat generation

2. Introducing high-efficiency systems

Sensible heat and Latent heat decoupled air-conditioning system

3. Utilizing renewable energy

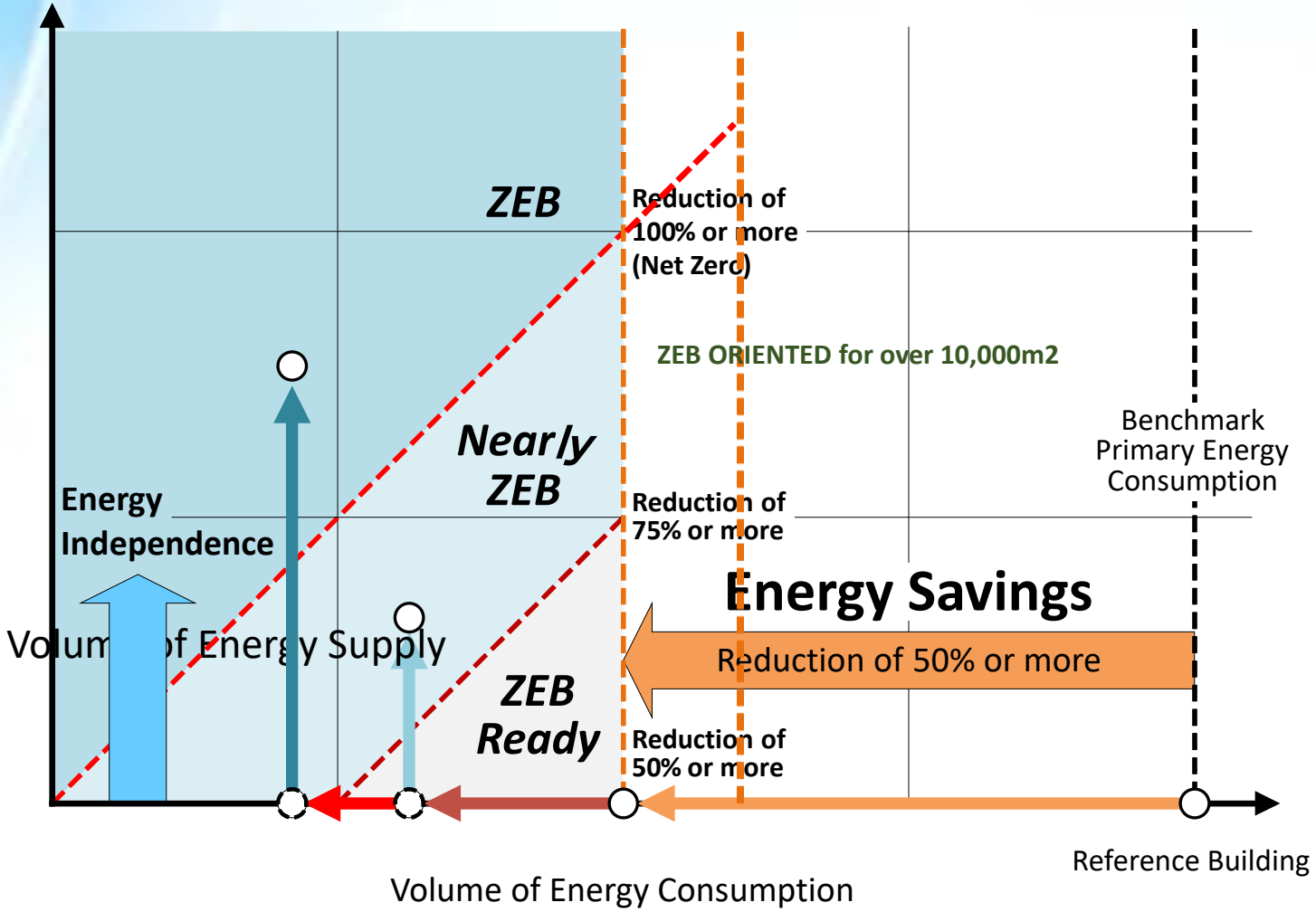
PV, Geo-heat, Solar thermal, Natural ventilation



Achieve ZEB

Energy Consumption Photovoltaic Power Generation

Image of ZEB Definition of Japan



A prerequisite for ZEB is to reduce energy consumption of 50% or more

Outline of Innovated Technologies for ZEB of SANKEN

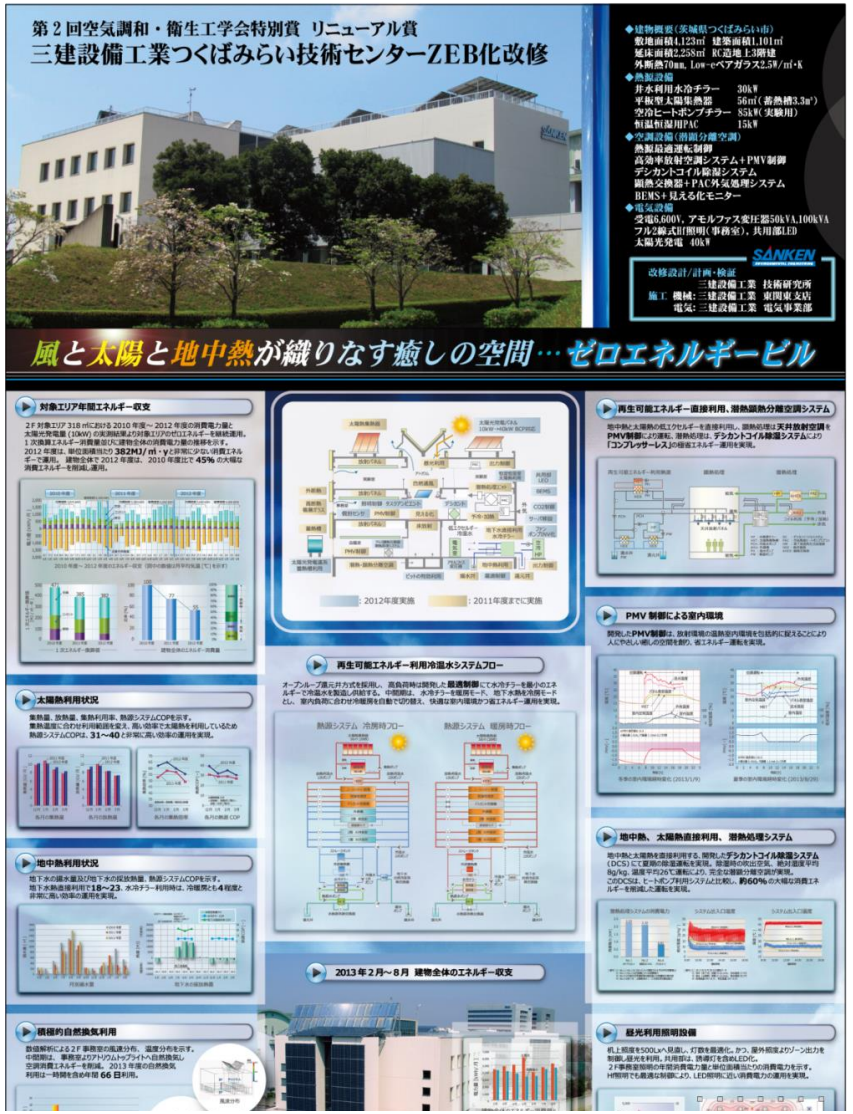
Outline of the Building (TTC)

Location: Tsukubamirai-city, Ibaraki-pref.
40km (25miles) northeast from Tokyo
Site Area: 4,123m^2 (44,380ft^2)
Floor Area: 2,258m^2 (24,305ft^2)
Reinforced-Concrete structure
Floor Number: Three stories
Completion date: Oct, 1992

SANKEN
ENVIRONMENTAL ENGINEERING

TSUKUBA TECHNICAL CENTER IN JAPAN

Title: Renewal of TTC toward Zero Energy Building



A prize of Renewal Award from SHASE in 2014

SHASE: Society of Heating, Air-Conditioning and Sanitary Engineers of Japan

Title: The ZEB is interwoven with Wind, Sun and Geothermal heat.

Minister of the Environment Award

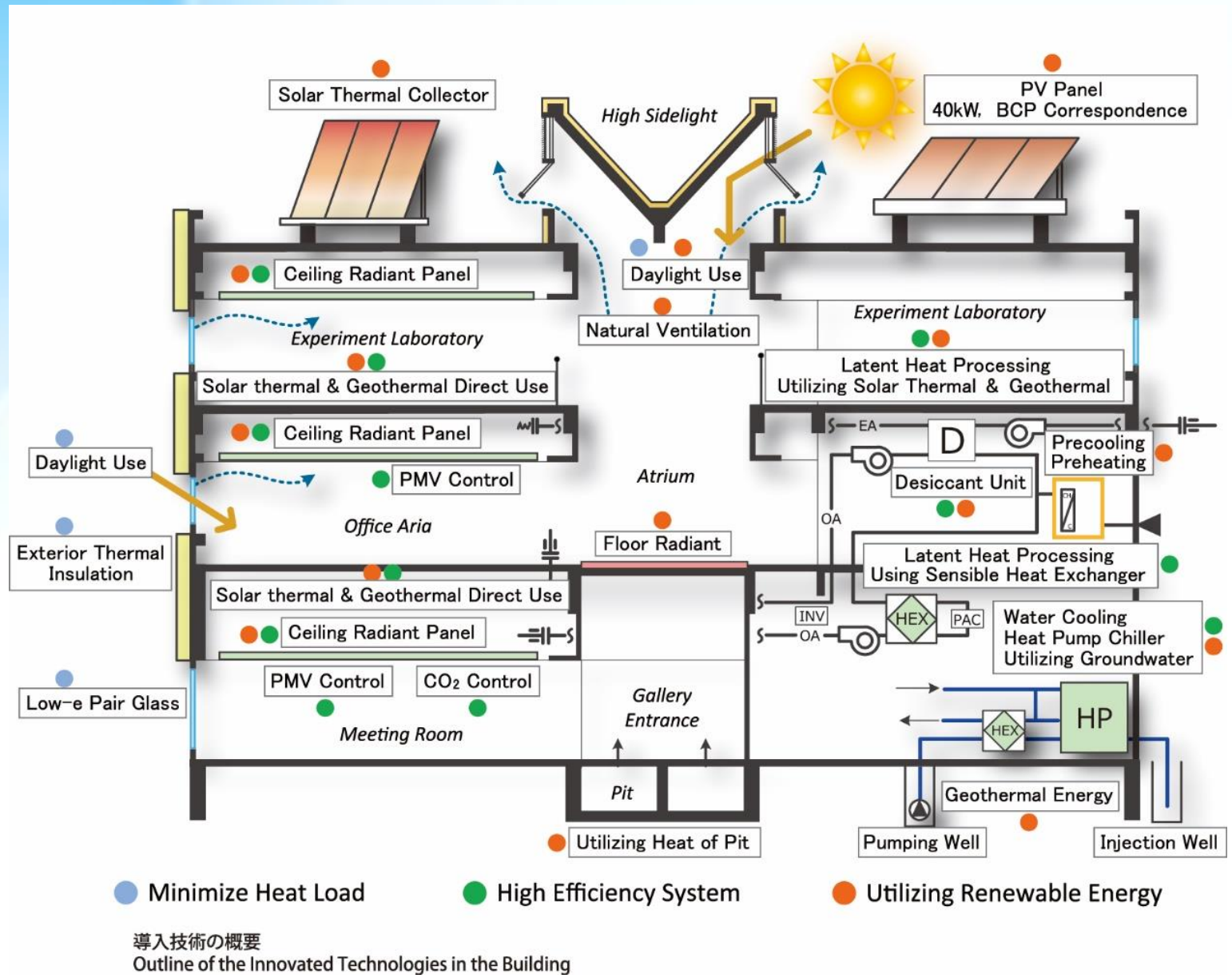
at the countermeasure technology advanced introduction department of global warming prevention activities in 2014.

Introduced Technologies

TSUKUBA TECHNICAL CENTER IN JAPAN

SANKEN ENVIRONMENTAL ENGINEERING

TSUKUBA TECHNICAL CENTER IN JAPAN



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

Innovated Technologies

Elemental Technologies

1. Architectural

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

2. Air-conditioning system

① **Decoupled Latent heat and Sensible heat**
Ceiling radiant panel, Latent heat treatment 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

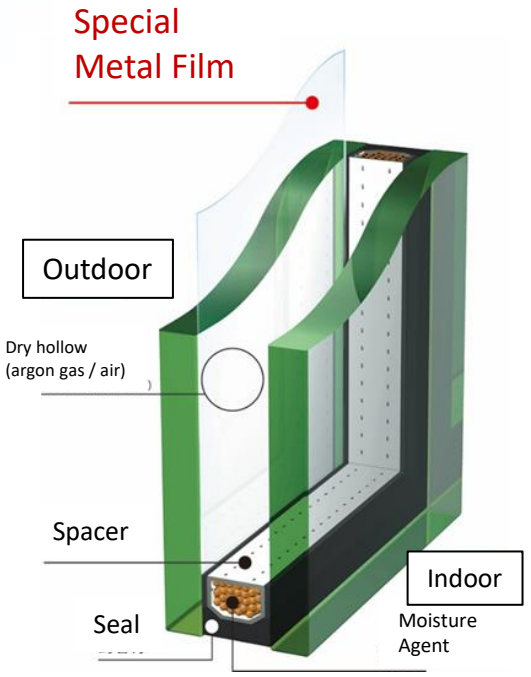
・70mm thick external insulation is added to the RC. (wet method)

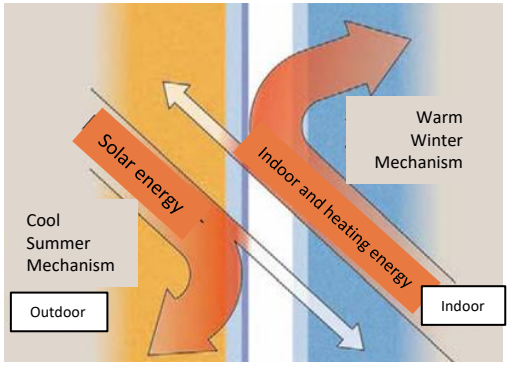
Overall Heat Transfer Coefficient

Before : 2.4 W/㎡・K

After : 0.56W/㎡・K

Low-e pair glass





・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

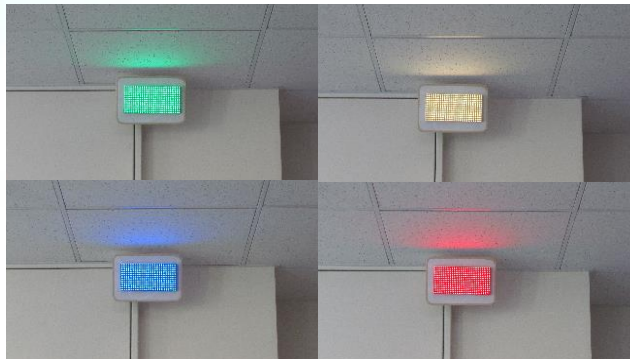
Natural Ventilation

Operational improvement of air conditioning

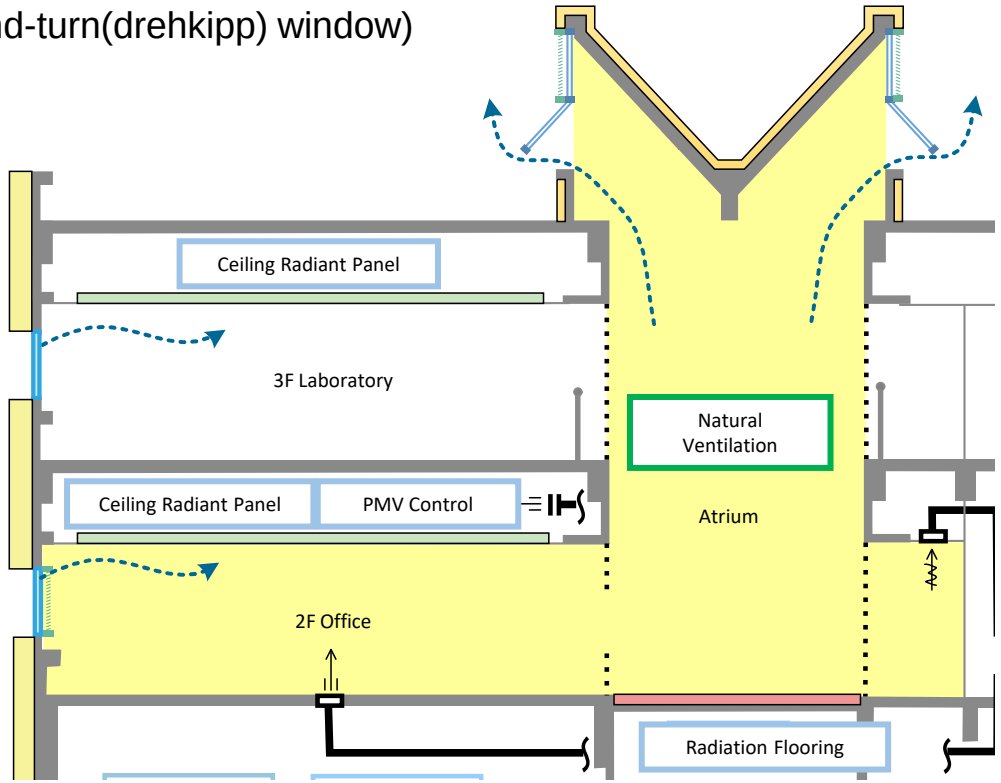
When natural ventilation is enabled, air conditioning (outdoor unit included) is halted to reduce air-conditioning energy consumption.
In summer, heat pools and heat storage are eliminated at the start of air conditioning.

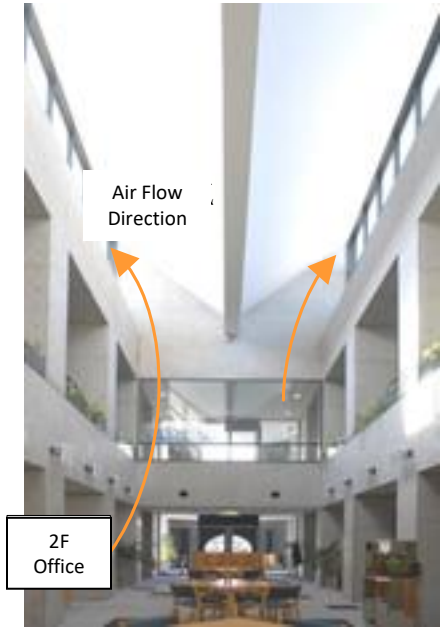
- A sign(notice lamp) is installed in the office. (2014)
  → Opening and closing of the window
  (upper high-side light, tilt-and-turn(drehkipp) window)

Drehkipp Flugel



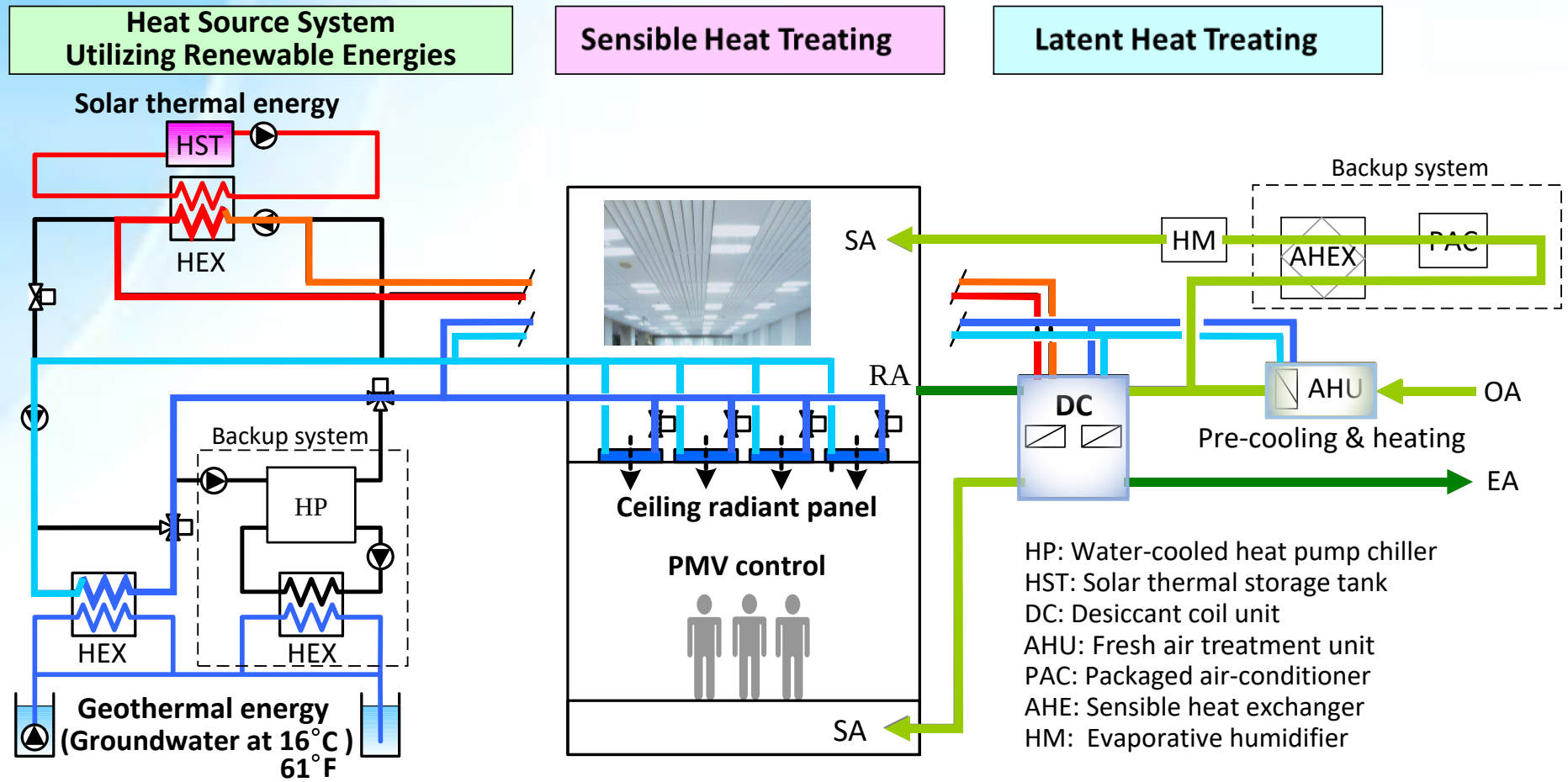
Natural Ventilation Sign





Atrium

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



Main heat source for the air-conditioning system

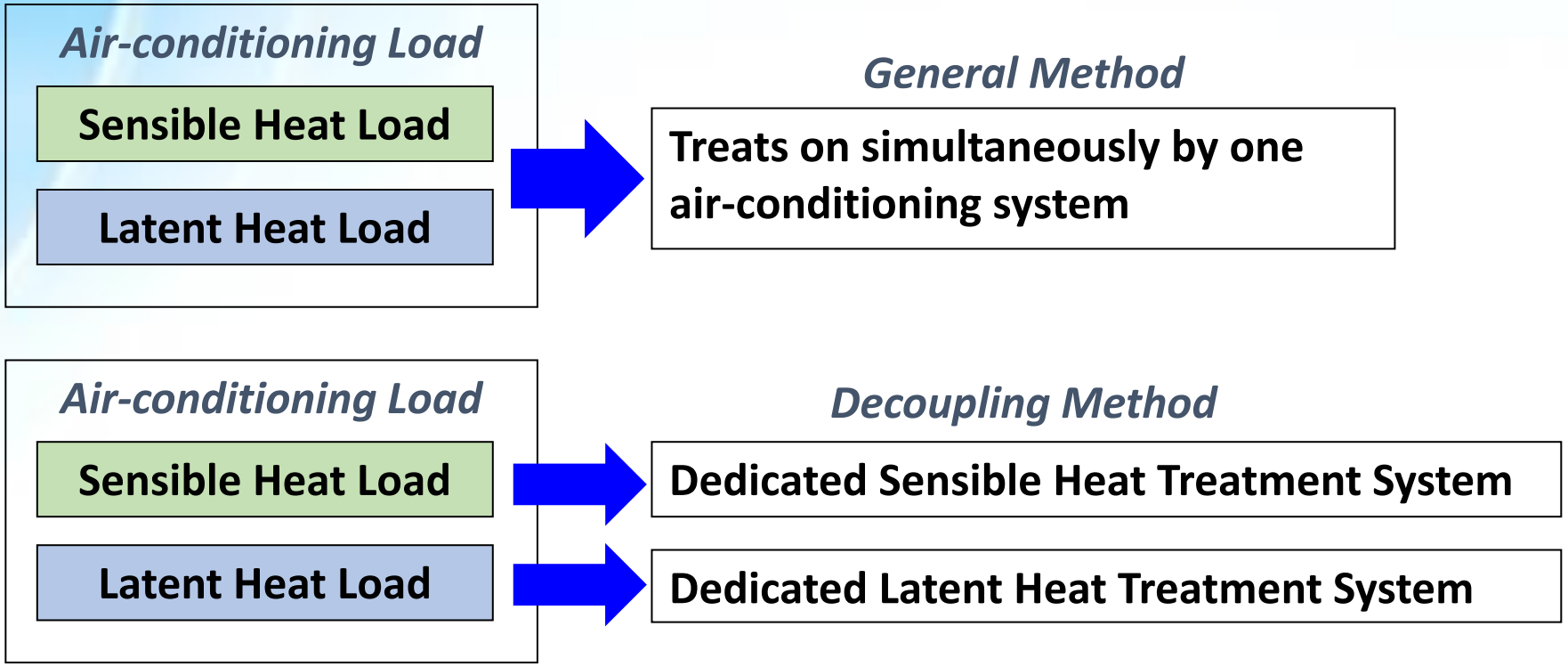
Cooling: Direct utilization of geo-thermal energy and solar thermal energy
(Solar thermal energy for regeneration process of desiccant coil unit)

Heating: Direct utilization of solar thermal energy

Air-conditioning systems that decouple and treat sensible heat load and latent heat load

Concept of Energy-Saving Effect

Decoupled Sensible and Latent Air-conditioning System

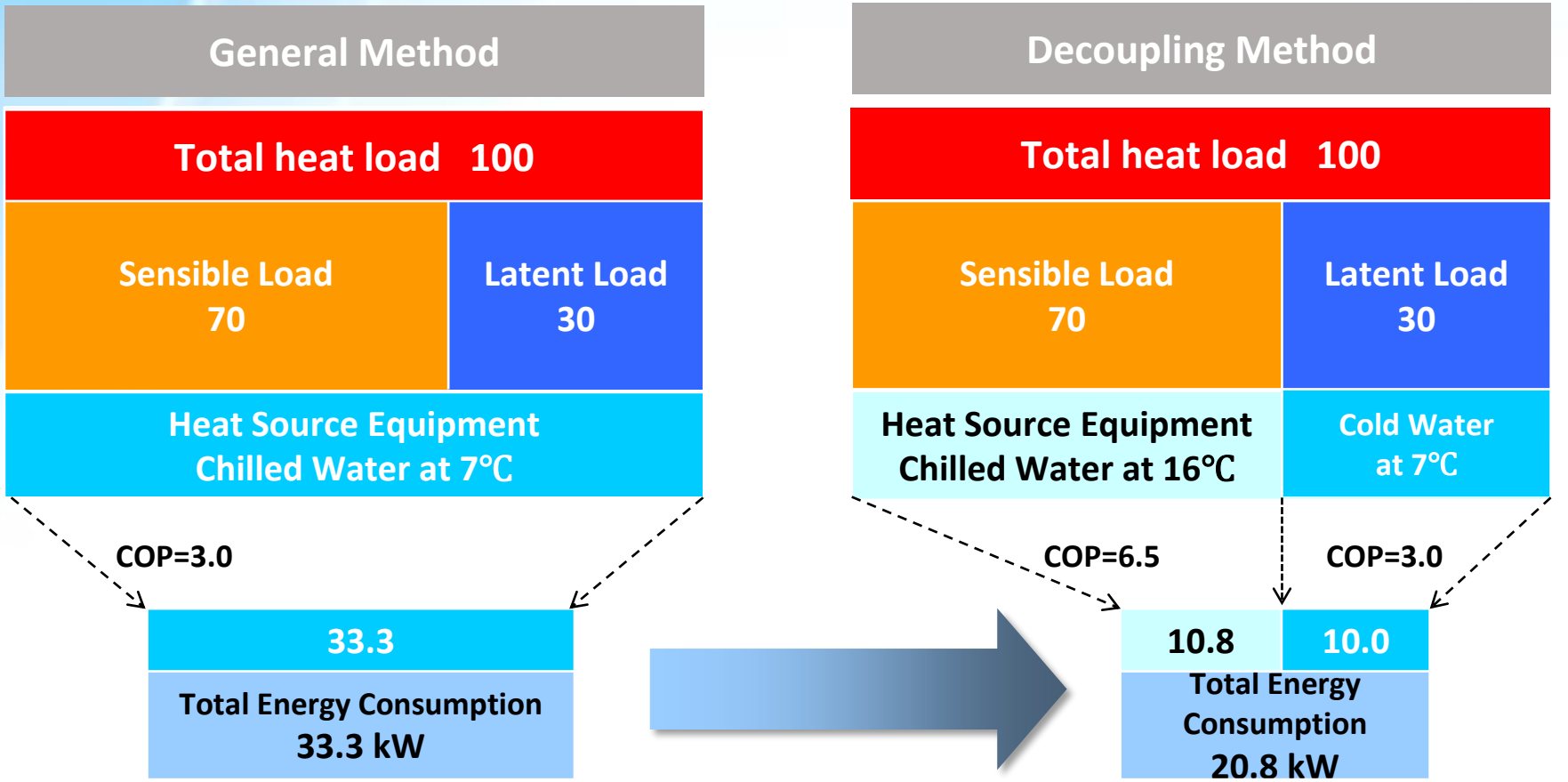


SANKEN's decoupled Sensible and Latent Air-conditioning System

Sensible Heat Treatment System: ***Ceiling radiant panel***

Latent Heat Treatment System : ***Dehumidifying unit*** and ***Desiccant coil unit for Outdoor air system***

Concept of Energy-Saving Effect
of Decoupled Sensitive and Latent



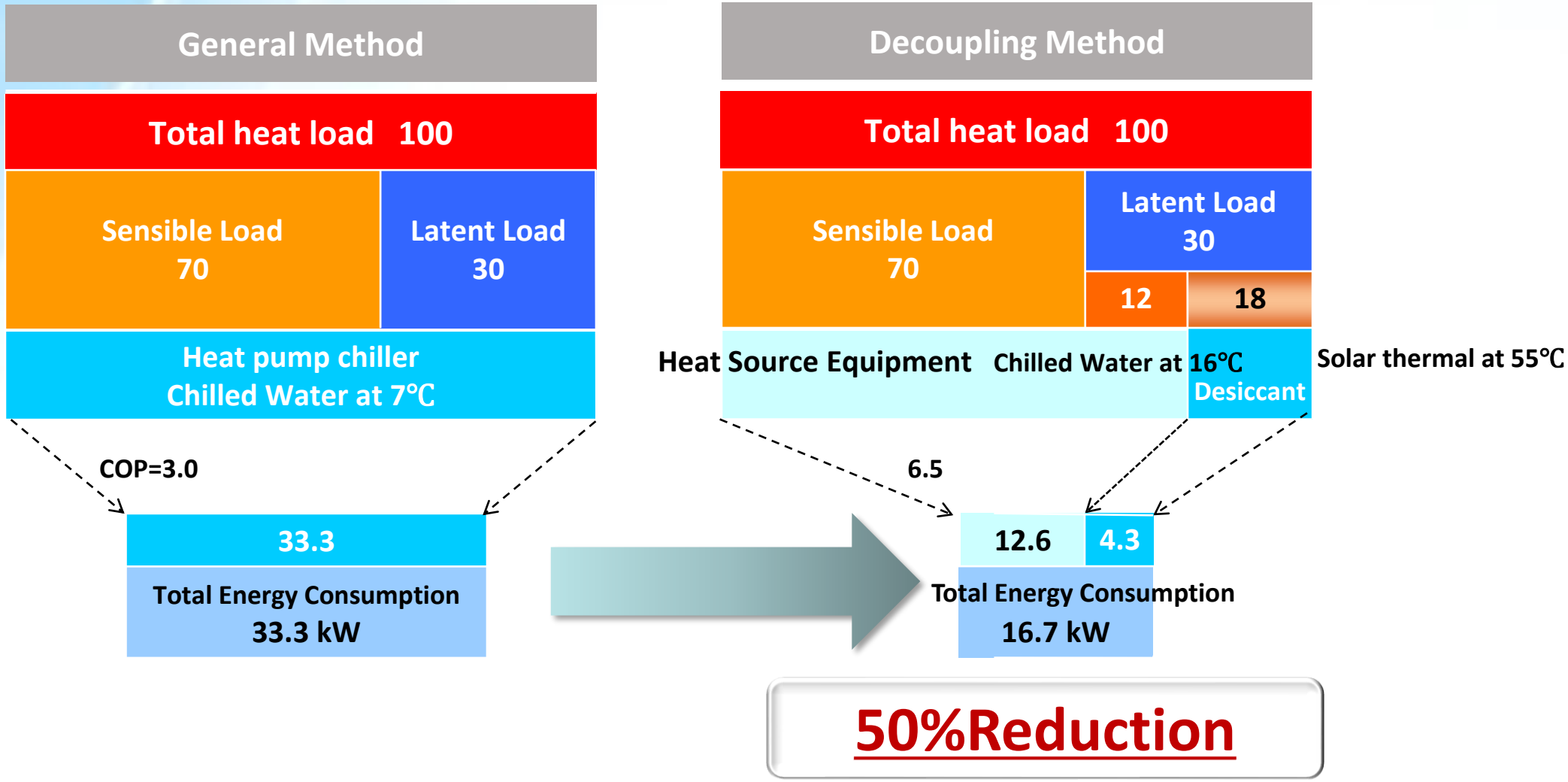
38% Reduction

COP:（Coefficient Of Performance）

Energy Saving Effects (Renewable Energy)

of an air-conditioning system separating latent and sensible heat

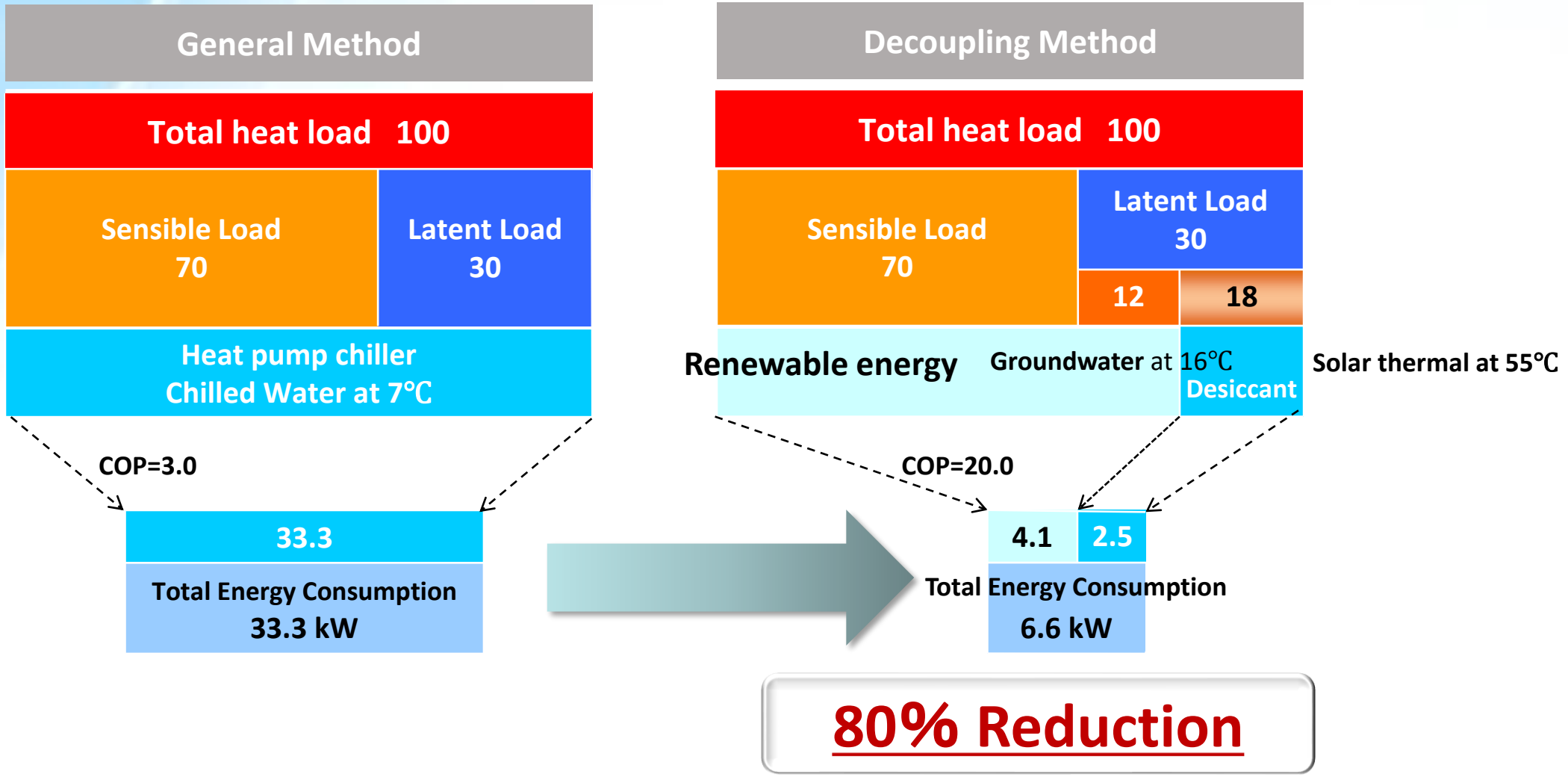
Utilization of groundwater and solar thermal to Desiccant System



Energy Saving Effects (Renewable Energy)

of an air-conditioning system separating latent and sensible heat

Utilization of groundwater and solar thermal to Desiccant System

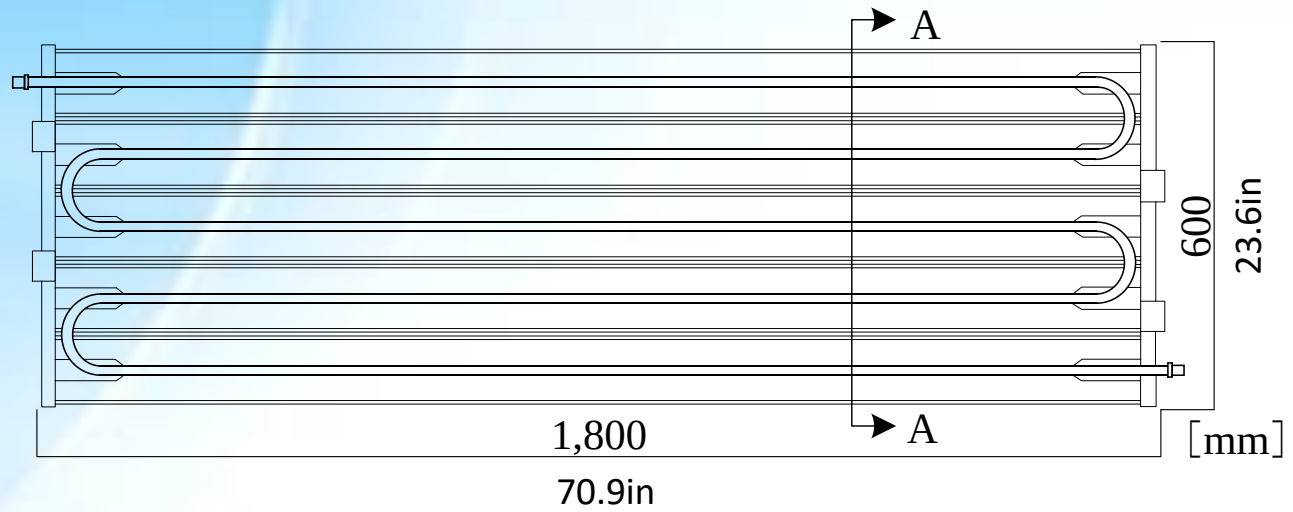


80% Reduction

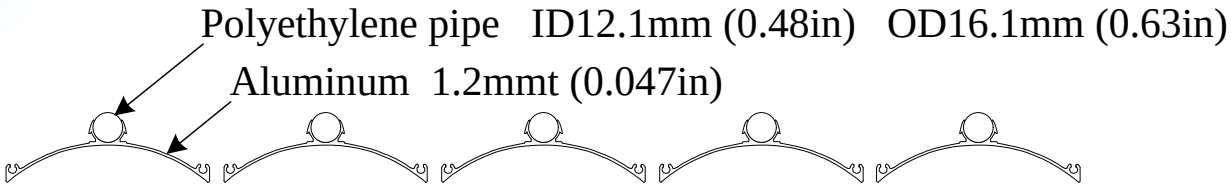
Decoupled Sensible Heat and Latent Heat Air-conditioning System

Sensible Heat Load Treatment (Ceiling Radiant Panel)

Appearance of Radiant Ceiling Panel



Plan View



A-A Cross-section

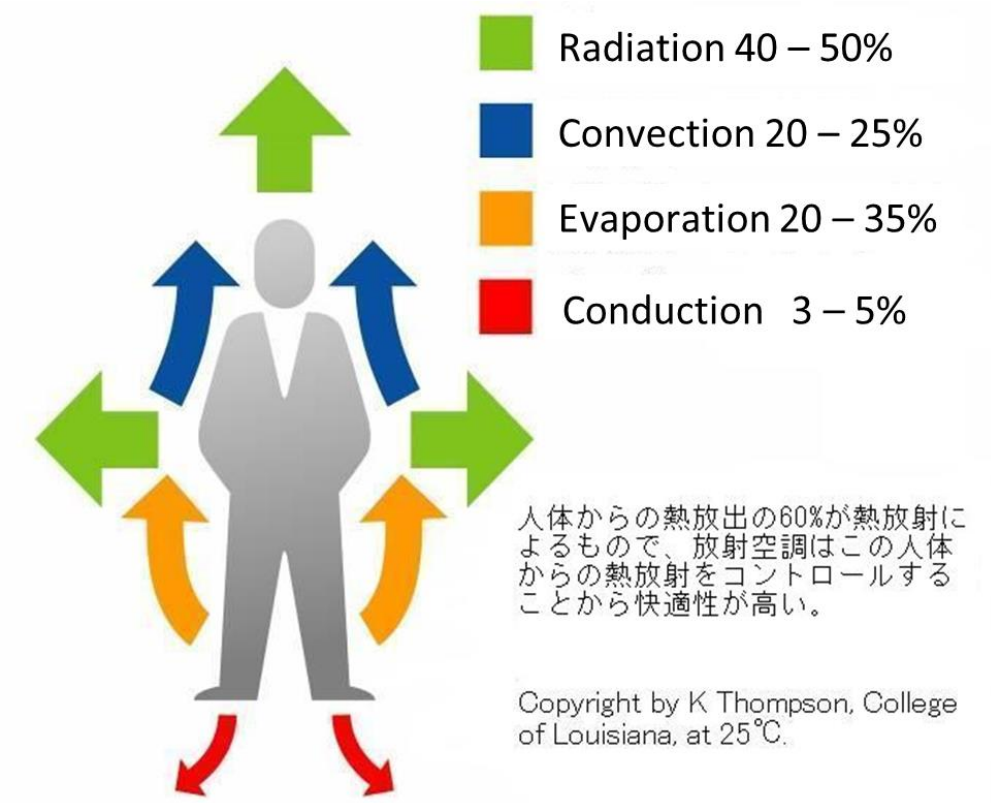
A panel made of aluminum → Good heat conductance, Lightweight

Slit between the panel → Natural convection effect

Positive Points of Radiant Air-Conditioning

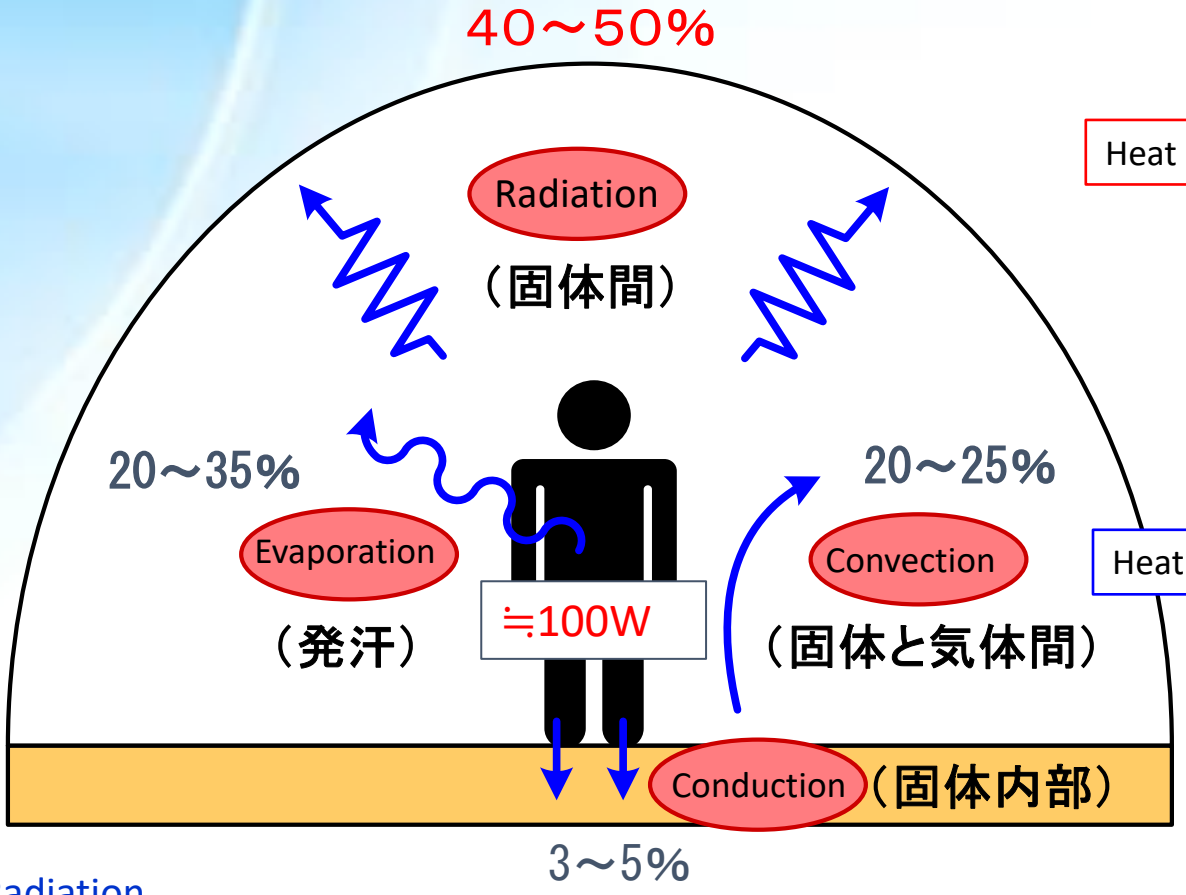
Comfort of Radiant Air-Conditioning

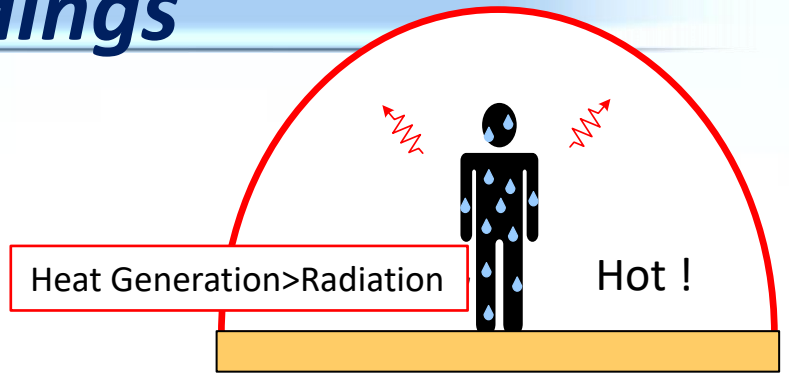
- Heat radiation is the biggest heat quantity of heat released by a human body.
- The temperature distribution of the room is even because there are few drafts.

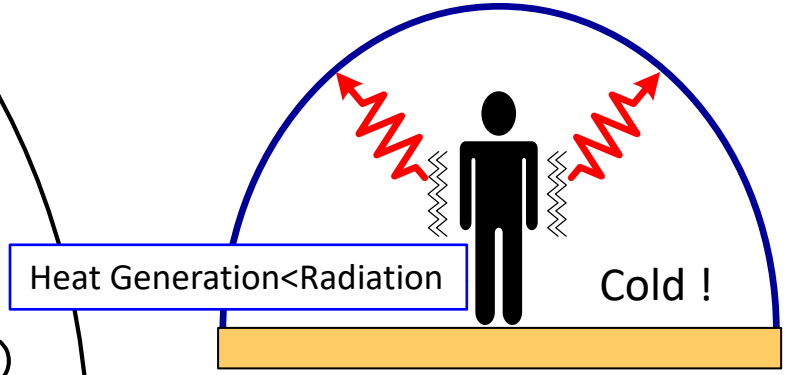


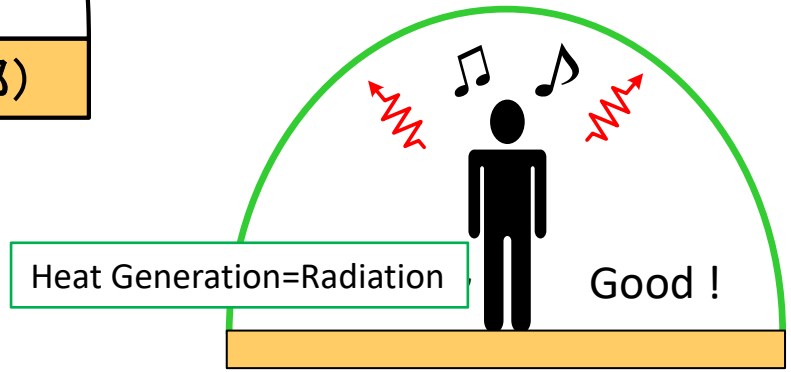
Heat Transfer Classification Between Human and its Surroundings

Heat transfer between people and surroundings









Radiation

All the objects emit far-infrared rays corresponding to the temperature and thermally move from the high-temperature object to the low-temperature object.

Energy Saving of Radiant Air-Conditioning

・The Cooling is possible by sending cold water to the ceiling metal panel at 18℃, and the efficiency of the heat source COP is improved by a factor of 2 or more.

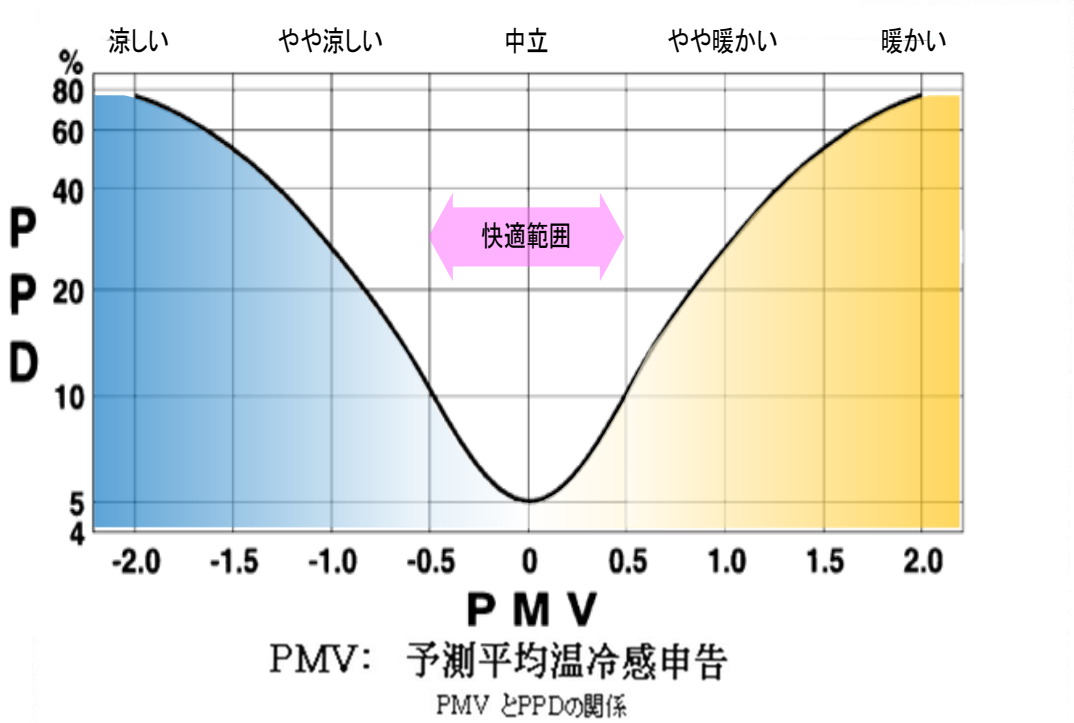
・Further, since water having a specific heat of 1 Cal/g･K is used as the cooling refrigerant, the conveying electrical power is about 30% of that of air.

PMV Controller

SANKEN developed a PMV controller of the Radiant A/C system controls the PMV which is the theoretical comfort index in the room.

:PMV（Predicted Mean Vote）and PPD（Predicted Percentage of Dissatisfied) ISO7730（1994））

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： 予測平均温冷感申告

PMV とPPDの関係

Decoupled Sensible Heat and Latent Heat Air-conditioning System

Latent heat treatment (Desiccant Coil Unit and Dehumidifying unit)

Desiccant Coil

Desiccant Coil Specifications

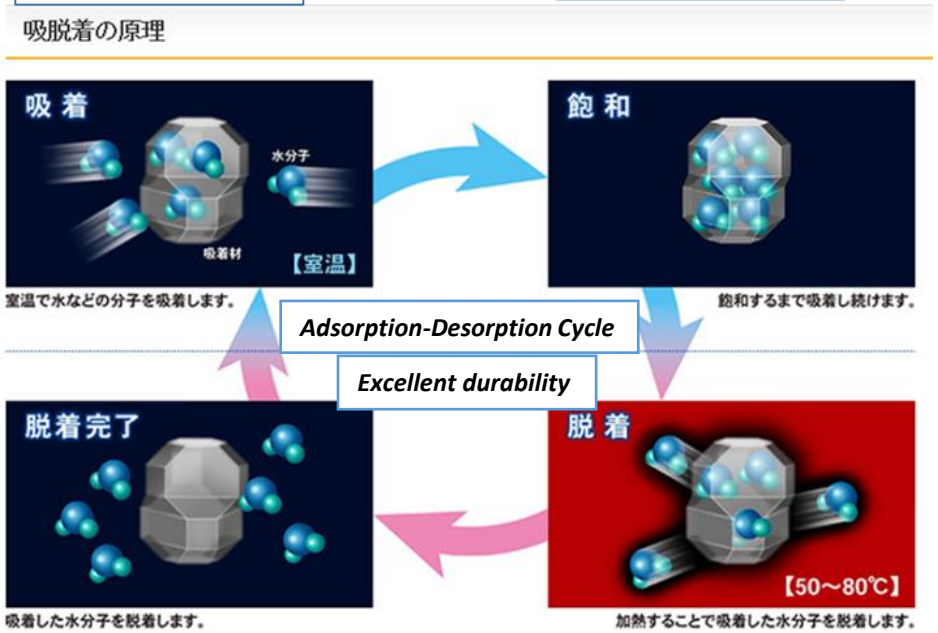
Heat Exchanger	Fin Tube Type
External Dimension	264mm x 600 mm x 102mmD
Fin Pitch	1.8mm
Material	Fin: Al, Tube: Cu
Adsorbent	Zeolite Adsorbent
	Adsorption Heat 54kJ/mol
	Specific Heat 0.764kJ/kg K
Application Amount	3 kg

Adsorption-Desorption Cycle

18℃-Groundwater thermal

Adsorption

Saturation



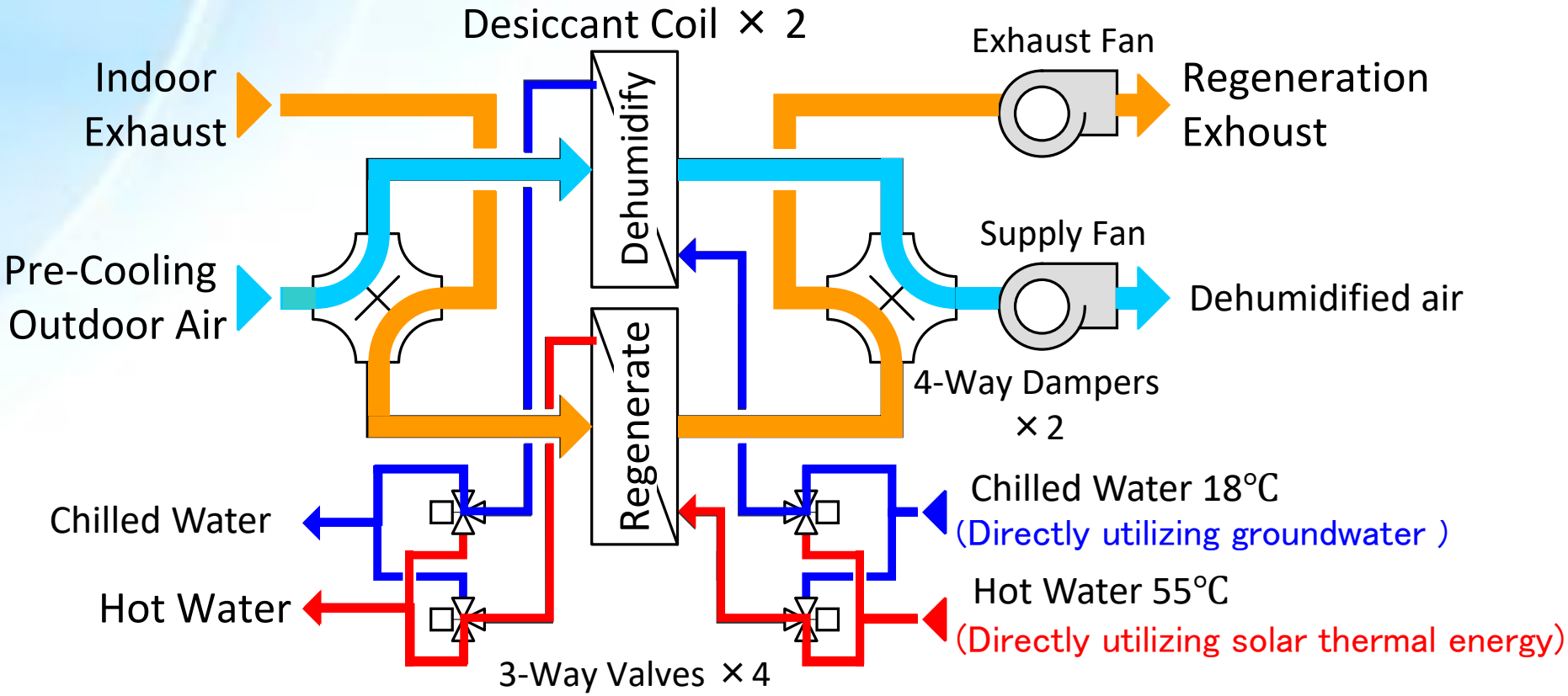
Desorption completed

Desorption

55℃-Solar thermal

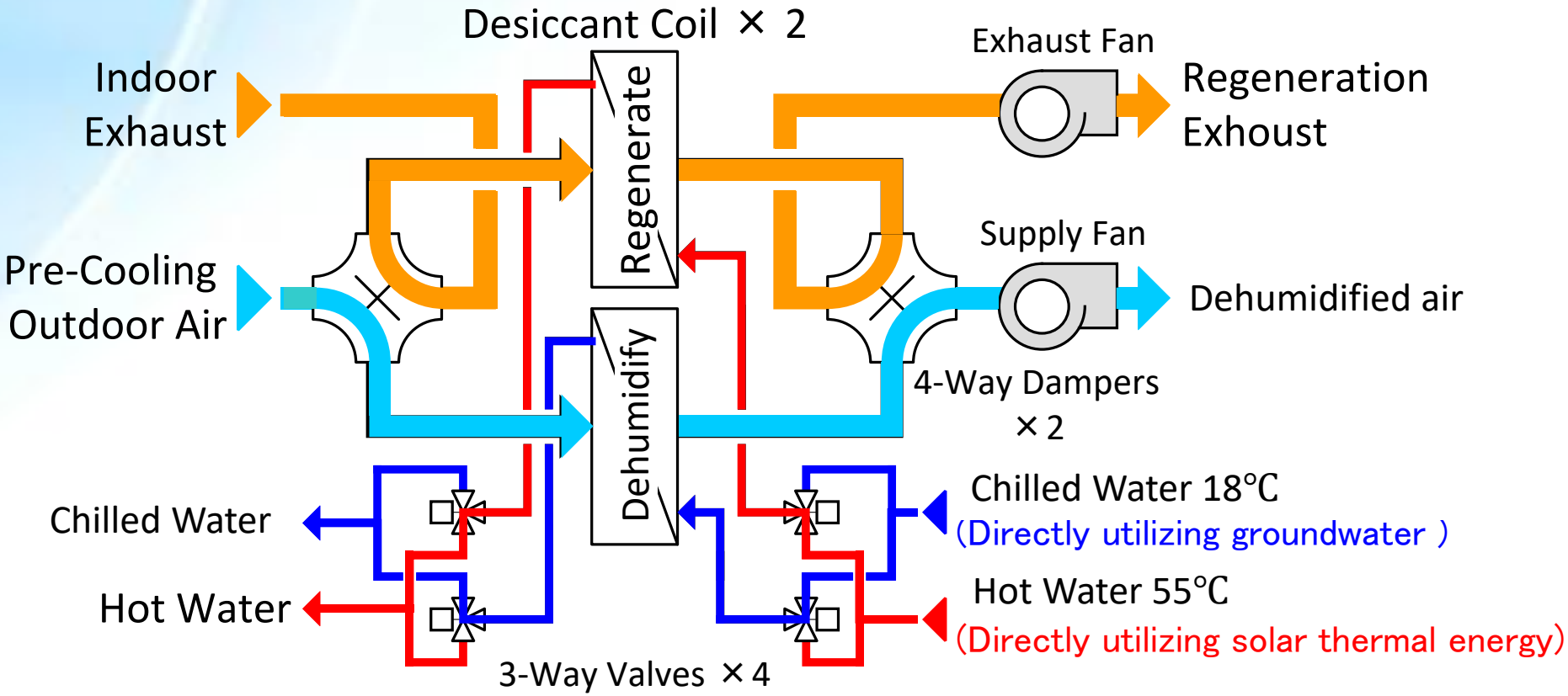
Desiccant Coil Unit

Batch Process System composed by two desiccant coils

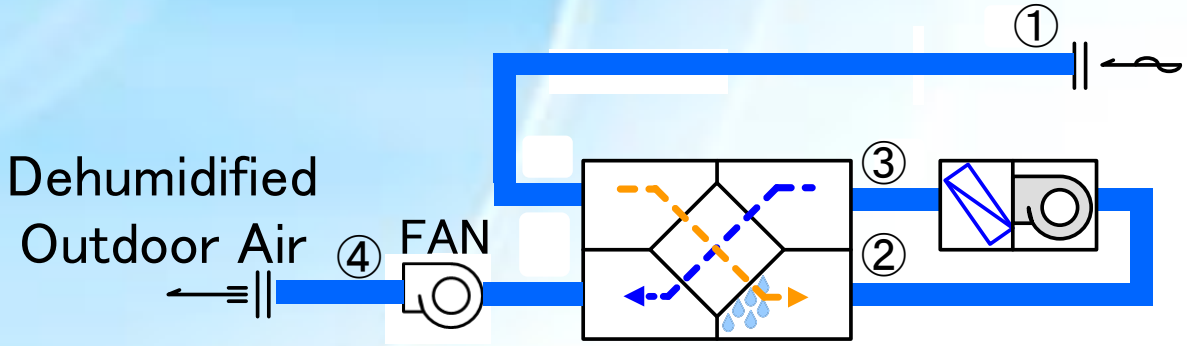


Desiccant Coil Unit

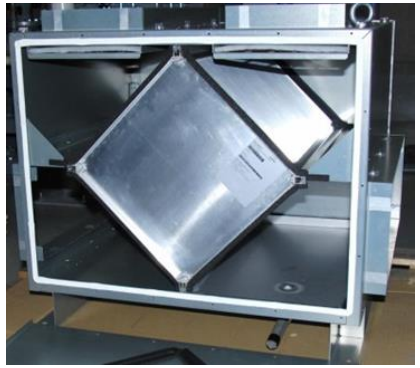
Batch Process System composed by two desiccant coils



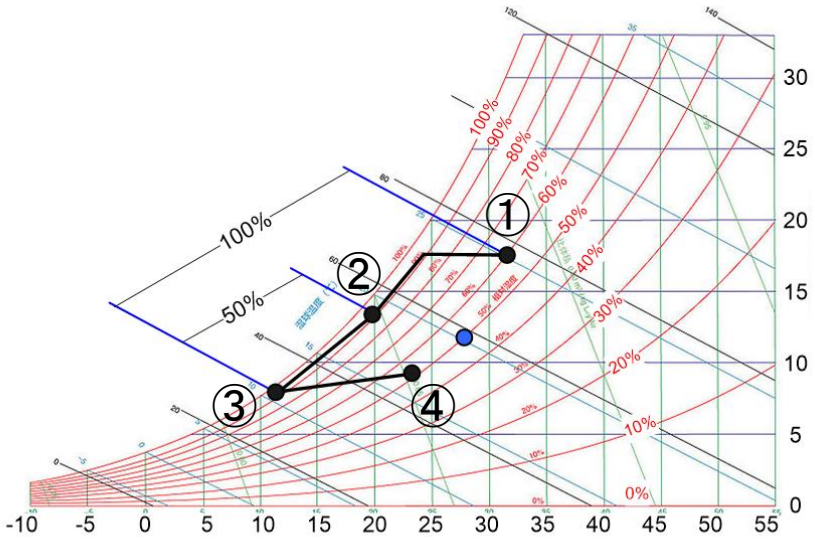
Outdoor Air Dehumidifying Unit



Heat Exchanger



Air-conditioner



We have also developed a unit(product name: ECOSALA) in Japan that incorporates the equipment into a single enclosure, as shown below right.

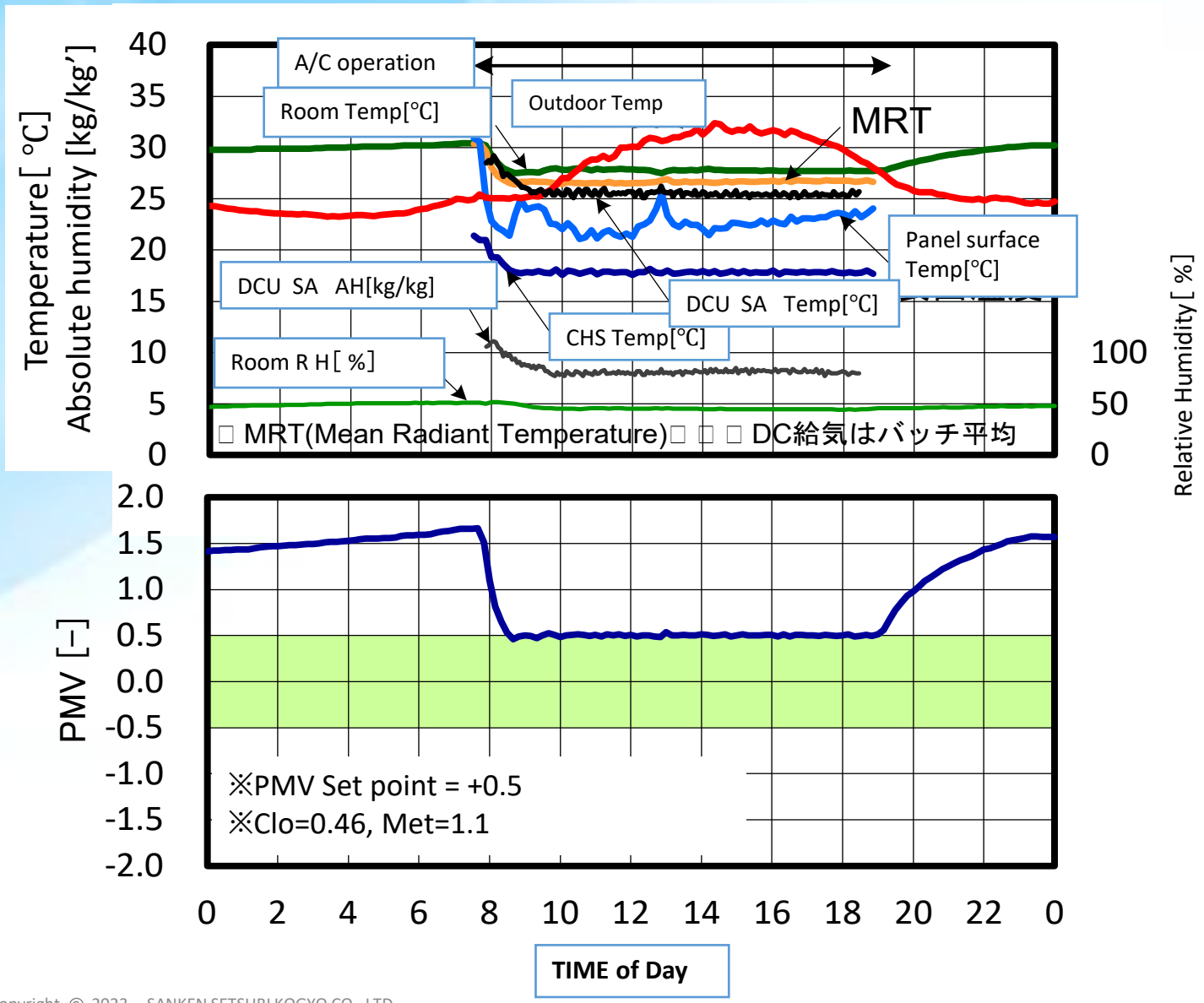
【特許登録番号6608343】

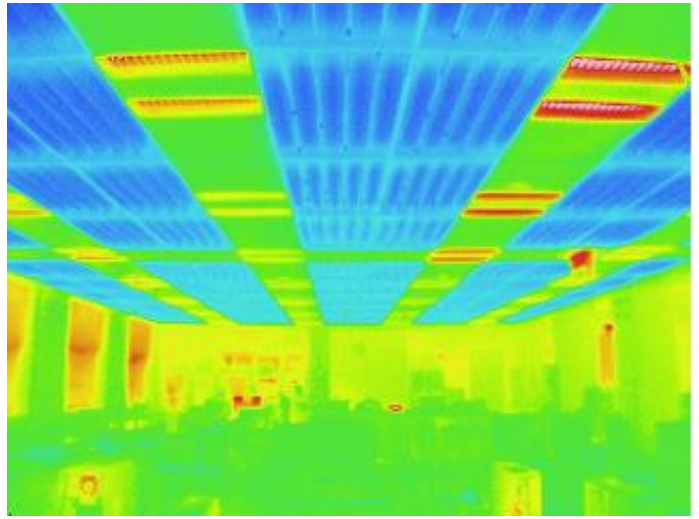
2021年度
省エネ大賞
(製品・ビジネスモデル部門)

「ゼロエネ予冷・再熱」の
除湿給気ユニットによる
省エネ空調ソリューション

ECOSALA: Ecological Sanken Latent-Heat System

Operating Condition by PMV control



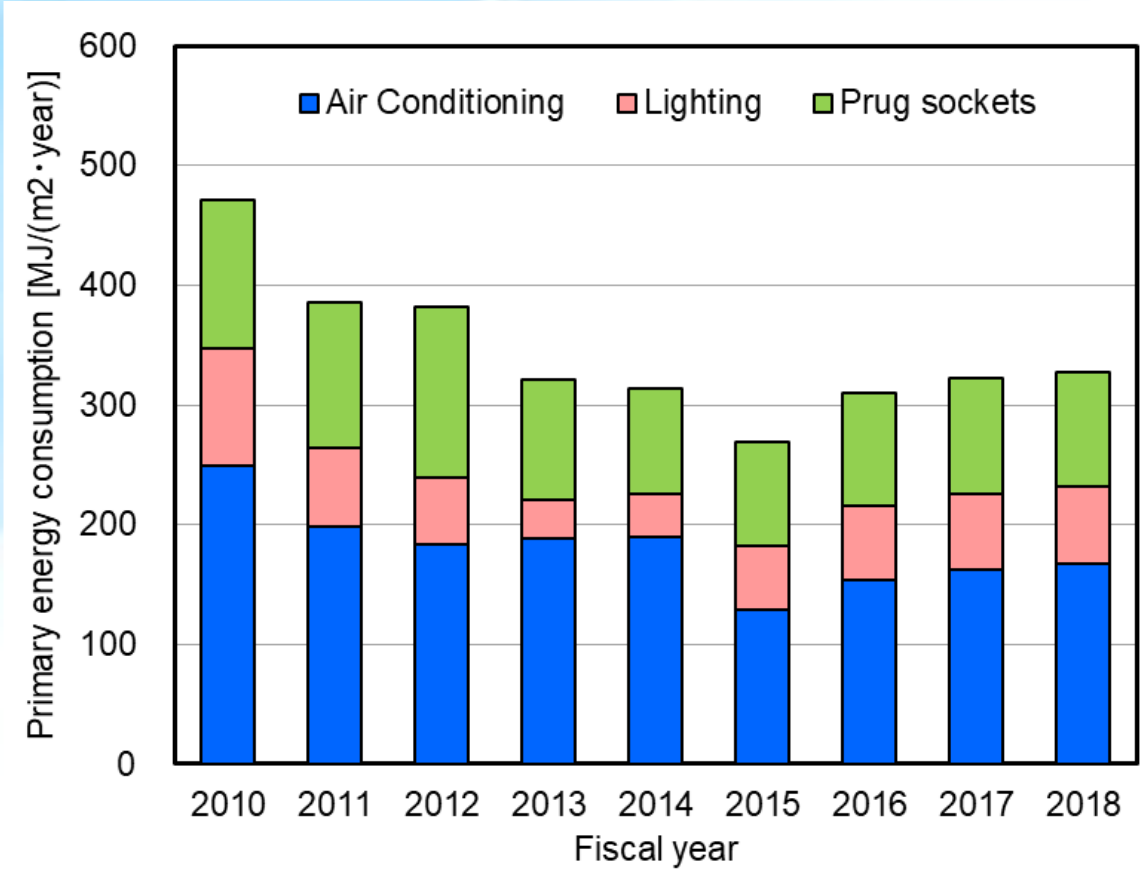


Operation Date : 28/July/2015

Energy Consumption and Energy Balance

https://skk.jp/en/zeb/

Primary Energy Consumption
in the Office Area

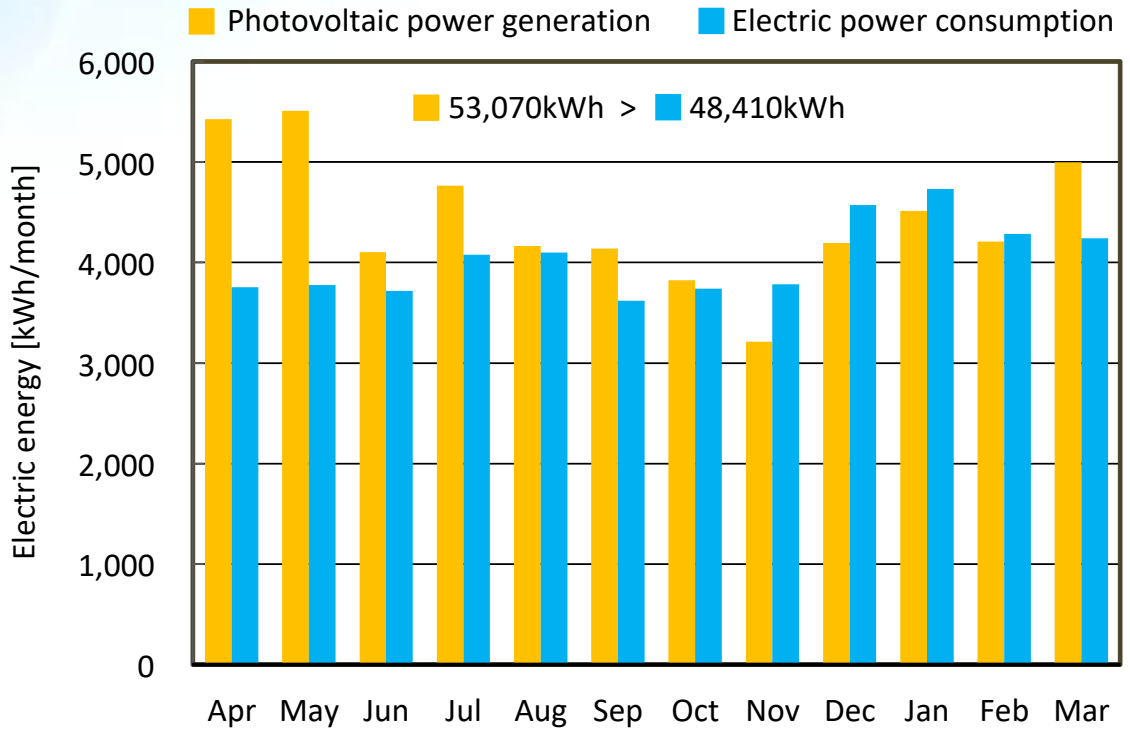


- We have been operating the renovation system since 2010.
- We have continued introducing new technologies and improving energy conservation.
- We have achieved the ZEB since 2013.

- **Primary energy consumption of the office area in 2014 was 313 MJ/m^2/year.**
- **Primary energy consumption of the reference office building is approximately 1200～1400 MJ/m^2/year.**

Electric Energy Balance

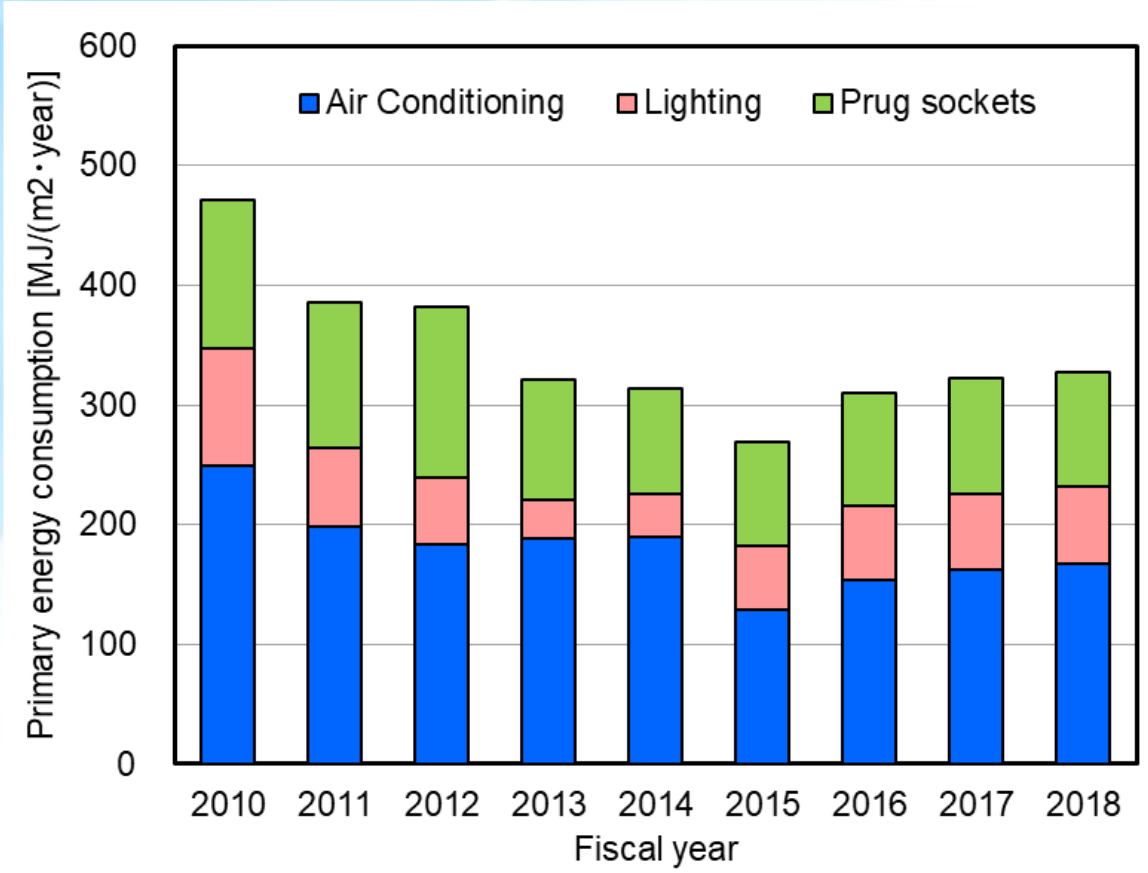
The Photovoltaic Power Generation and the Electric Power Consumption of the Whole Building in 2013

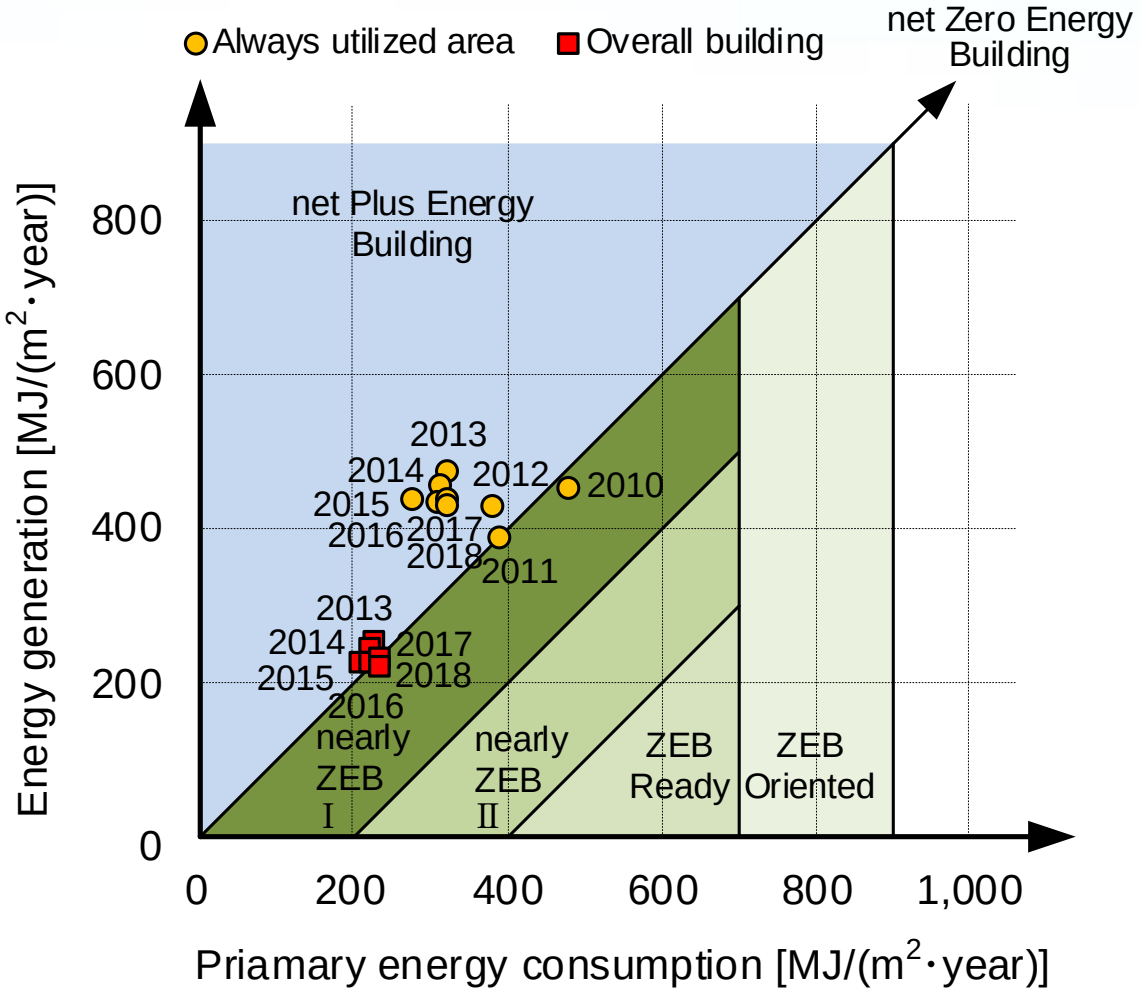


Annual electric power consumption was less than annual photovoltaic power generation.

We achieved net ZEB

Rating of TTC in ZEB Evaluation Chart





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

Conclusions

- We have achieved a ***ZEB*** of the ***existing building by renovation works.***
- The ZEB has been accomplished by mainly ***high-efficiency systems*** that make effective use of renewable energy and ***load minimizations***, and does not rely on a large amount of photovoltaic generation.
- To achieve ZEB, it is very important to reduce energy consumption for air conditioning which accounts for a large percentage of energy consumption in a building.
- The ***decoupled sensible heat and latent heat air-conditioning system*** is very important elemental technology of ZEB in Asian countries.
- By directly using renewable energy, it is possible to operate without a heat source, which greatly contributes to the realization of ZEB.

SANKEN's Actions in Asian Countries

- ***SANKEN*** would like to emphasize that ***ZEB*** is necessary to stop climate change and to realize a sustainable society where the global environment is preserved and each individual can experience happiness.

- ***SANKEN*** will continue to cooperate with the spread of **ZEB,** which will improve **health** and **productivity** of the people in various countries with **minimized energy consumption**.

Thank you for your attention.