

Introduction and utilizing of natural energy in Net ZEB practice

- Takenaka Corporation Higashi-kanto Branch Office



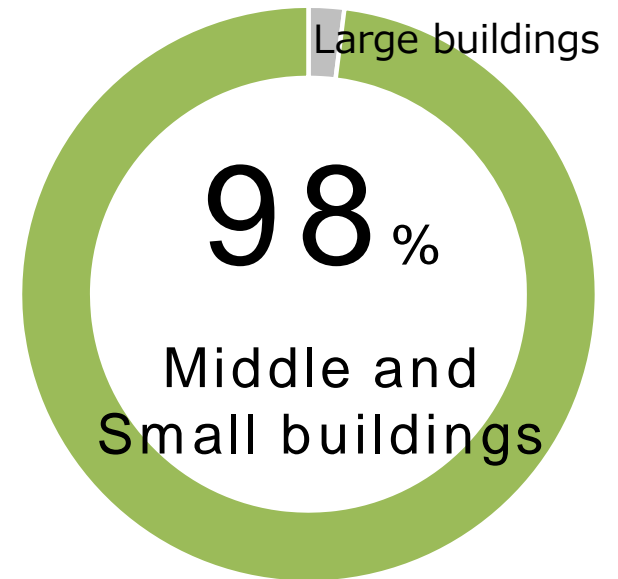
2018.10.5

Renewable Energy Institute / Green Building Symposium

Background

Promotion of
“Energy saving Renovation of Existing
middle and small stock buildings”

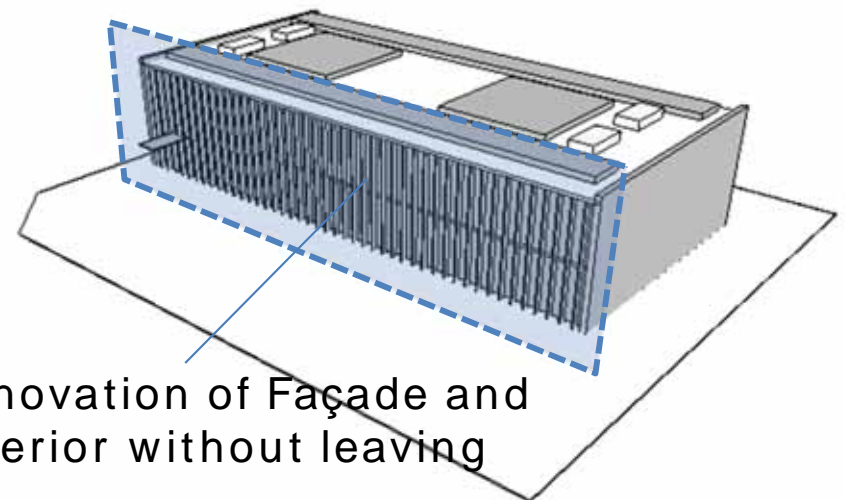
- Offices with 10,000 m² or less occupy 98% in Japan.
- Middle and small stock buildings renovation for energy saving is effective to save energy.



Proportion of existing
building in Japan

Feature of existing small buildings

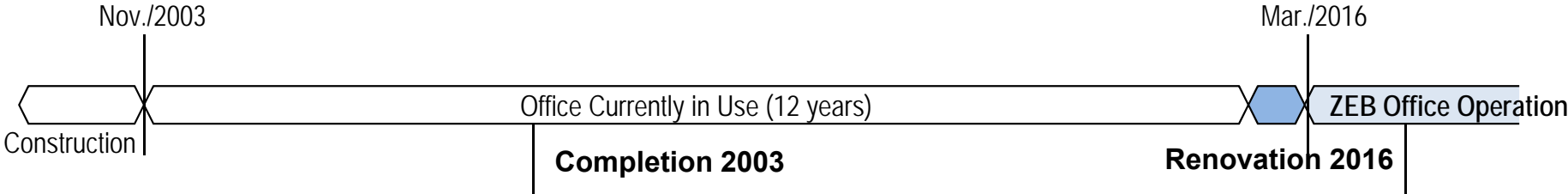
- Minimization of perimeter load is essential for energy saving.
- Renovation without leaving is important for occupants.
- Comfort is also important.



Renovation of this office

Small office, Location is Chiba City in Japan, gross floor area 1,318 m²
Completion in 2003, and Renovation completion in 2016.

*1,318 m² = 14,187 ft²



Before



After





Interior of the building after renovation

Building outline

Feature : Net-ZEB first renovation project in Japan
(Actually used, and renovation while occupying)

Building type	Office
Location	Chiba City (Near from Tokyo)
Site area	1,432.02 m ²
Structure, size	RC·S, 2 stories
Height	8.1m
Building area	679.52 m ²
Gross floor area	1,318.11 m ²
Completion	2003
Completion of Renovation	2016
Design & Built	Takenaka Corporation

Concepts of this office ZEB renovation



Change the theory of comfort

- **Maximum use of daylighting, natural vent. & control**
- **Temperature control by radiant cooling & heating**
- **Humidity control by desiccant air conditioning**
- **Airflow control by personal diffuser**



Create super energy-saving building

- **Significant reduction of thermal load by renovation of facade**
- **LED task & ambient lighting & control**
- **Ceiling radiant cooling & heating**
- **direct use of geo-thermal**
- **direct use of solar heat**



Think smart work-style




- **Divide into 3 areas in the office**
- **Moving promotion of workers and Work-mode change**
- **Environmental setting at each area**
- **Space of common area and Sharing of machines**
- **Wellness control**



Become resistant to disaster

- **Operation time increase, BCP performance increase**
- **Photovoltaics panel**
- **Solar heat**
- **Battery**

Concepts of this office ZEB renovation

-  Building Design
-  System Design
-  Operation Change



Change the theory of **comfort**

- Maximum use of **daylighting, natural vent.** & control
- Temperature control by **radiant cooling & heating**
- Humidity control by **desiccant air conditioning**
- Airflow control by **personal diffuser**



Create super **energy-saving** building

- Significant reduction of thermal load by **renovation of facade**
- **LED task & ambient** lighting & control
- Ceiling **radiant cooling & heating**
- **direct use of geo-thermal**
- **direct use of solar heat**



Think **smart work-style**

- **Divide into 3 areas** in the office
- Moving promotion of workers and **Work-mode change**
- Environmental **setting at each area**
- Space of **common area and Sharing** of machines
- **Wellness control**



Become **resilient** to disaster

- Operation time increase, BCP performance increase
- **Photovoltaics** panel
- **Solar heat**
- **Battery**

Smart work-style



Sharing copy machines and others

Filing area

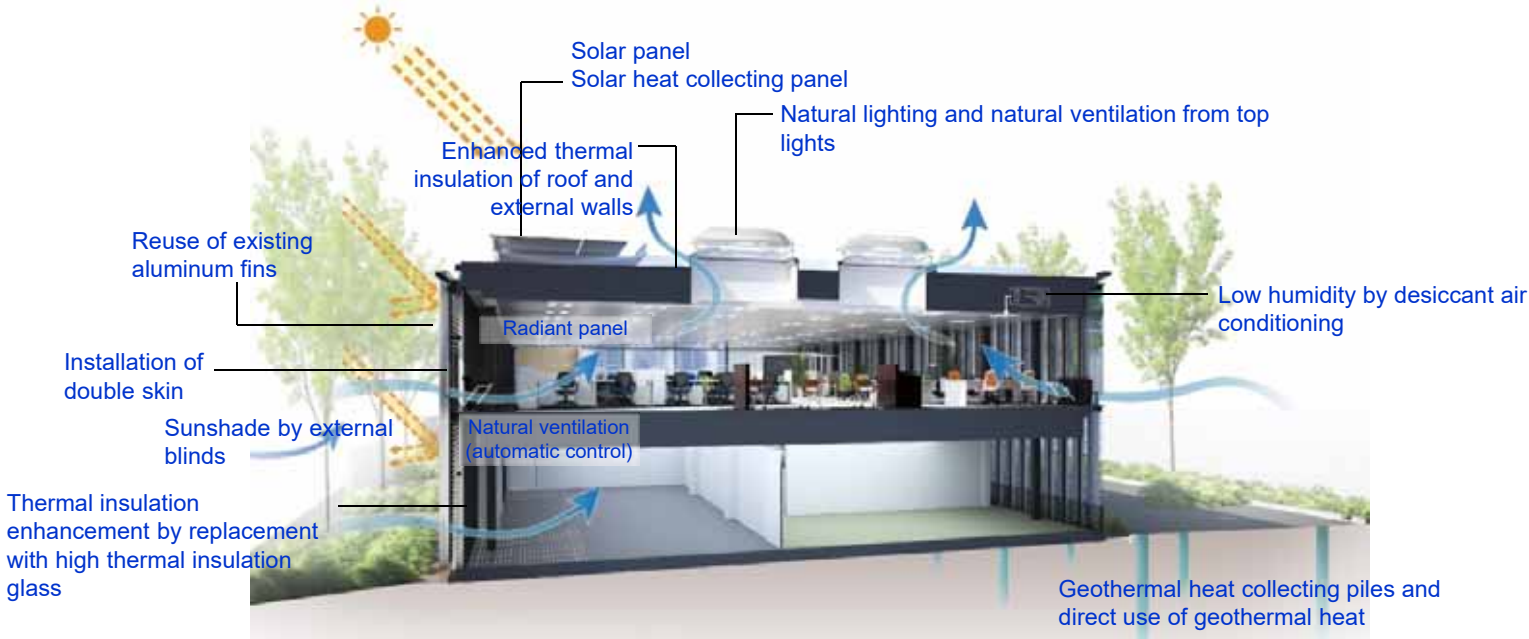
Communication area

Workplace

Entrance



Various Technologies for ZEB Renovation



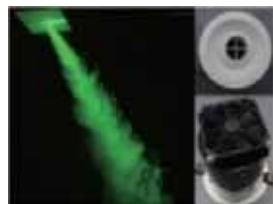
Double skin



Natural ventilation opening (automatic control)



Daylight from both side (blind automatic control)



Personal diffuser



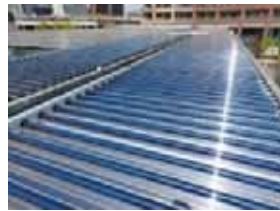
LED lighting



Radiant cooling & heating panel



Geothermal heat using pile (Heat exchanger: Borehole)



Solar heat collecting panel

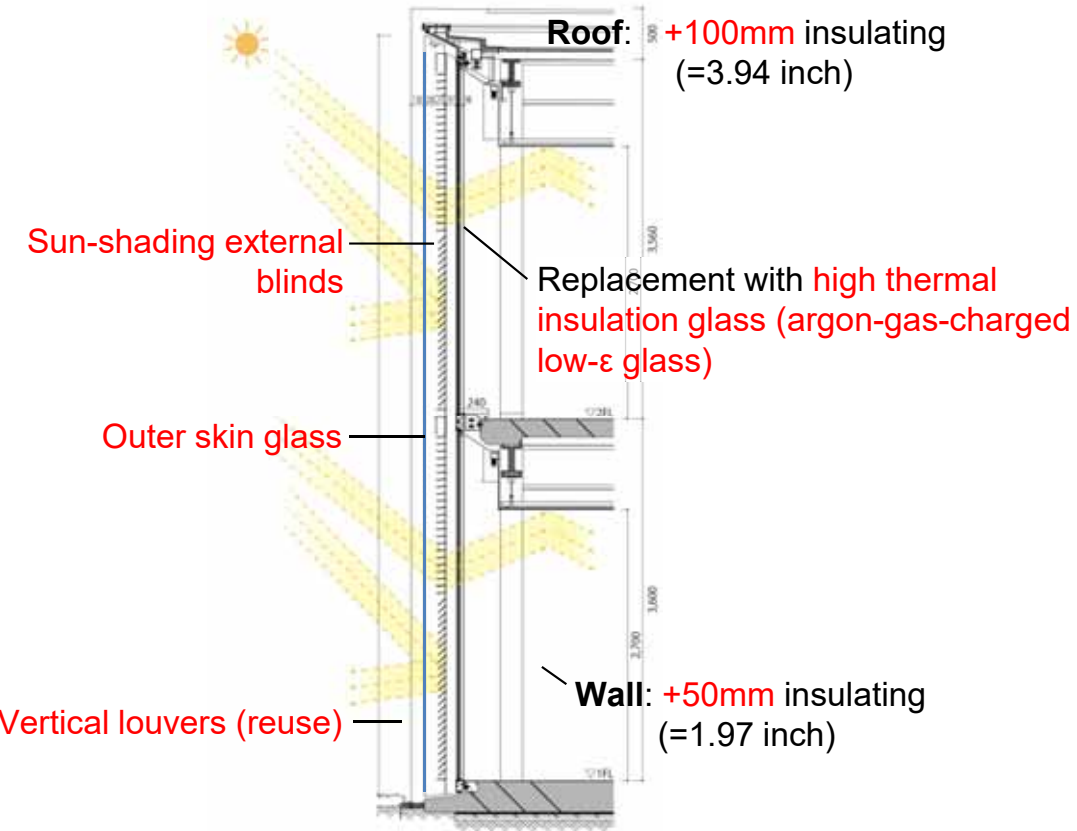


PV panel

Others;
Remote building control system with cloud,
Battery for BCP, and so on.

Technologies of ZEB renovation

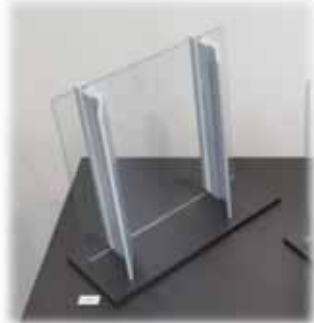
Enovation of Exterior (roof, wall, glass and double skin)



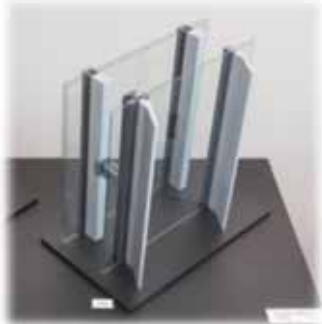
Detail of exterior



Before Renovation



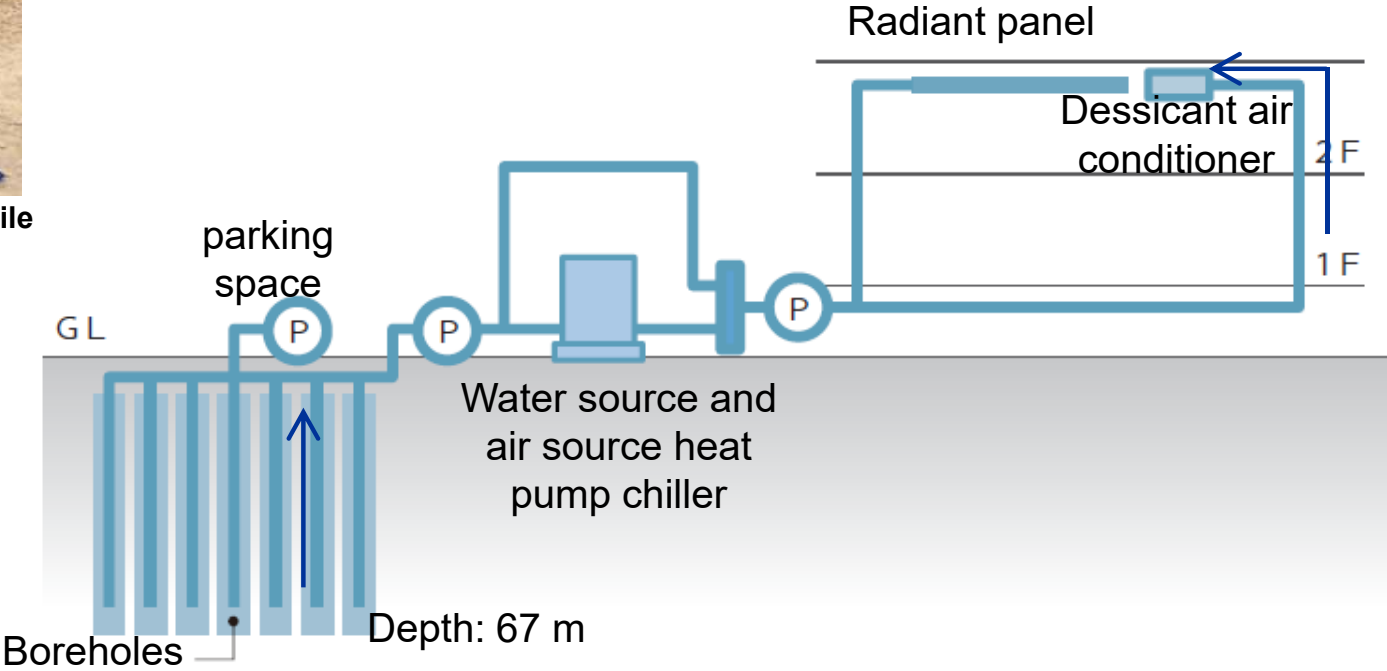
After Renovation



Direct Use of Geothermal Heat



Geothermal heat collecting pile (During construction)

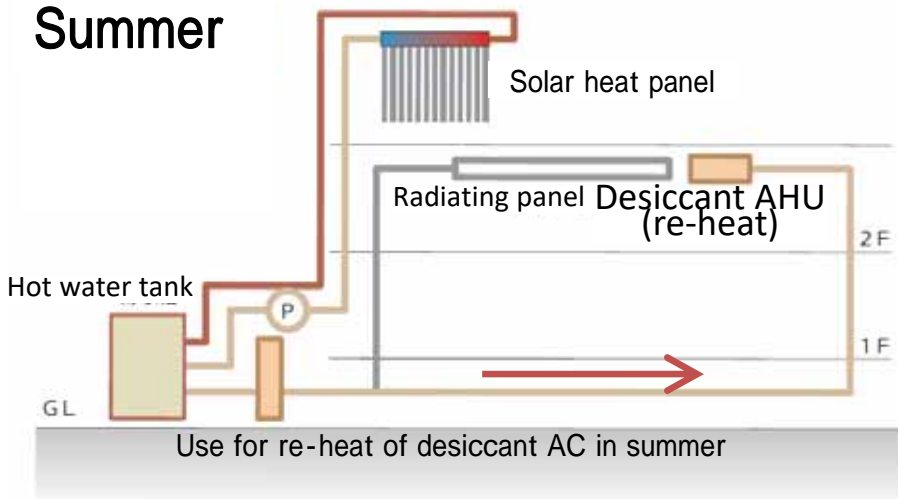


Geothermal heat collecting system

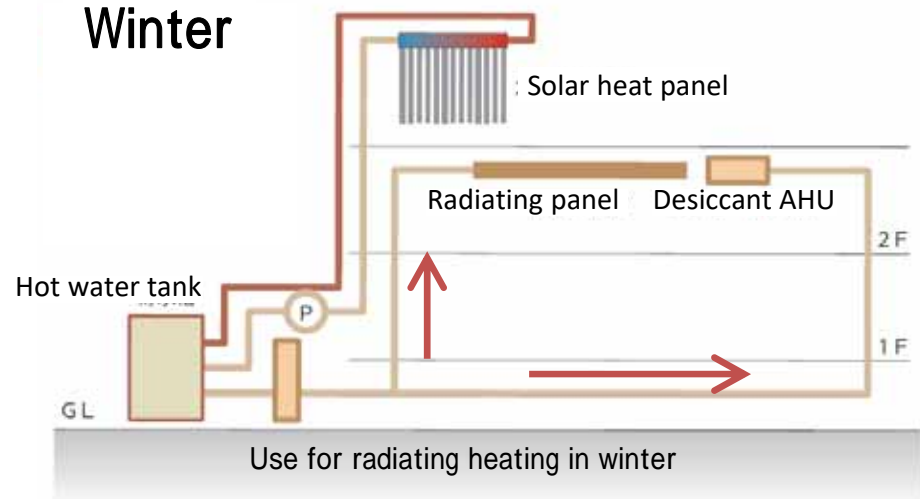
Direct Use of Solar Heat



Summer



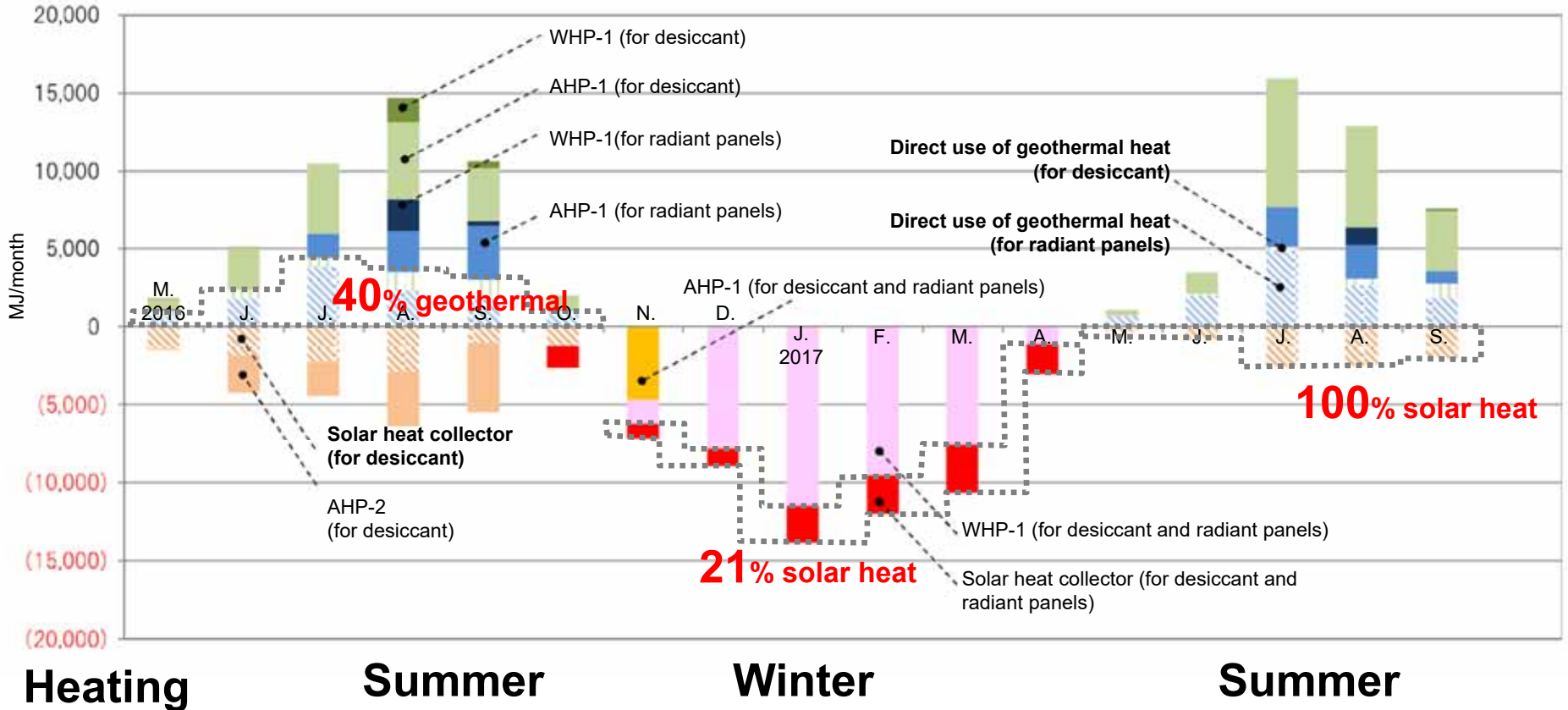
Winter



Solar heat utilization system

Direct Use of Geothermal & Solar Heat

Cooling



Detailed breakdown of annual heat usage in office on the second floor

Become resistant to disaster



Devices on the roof



Photovoltaics panel

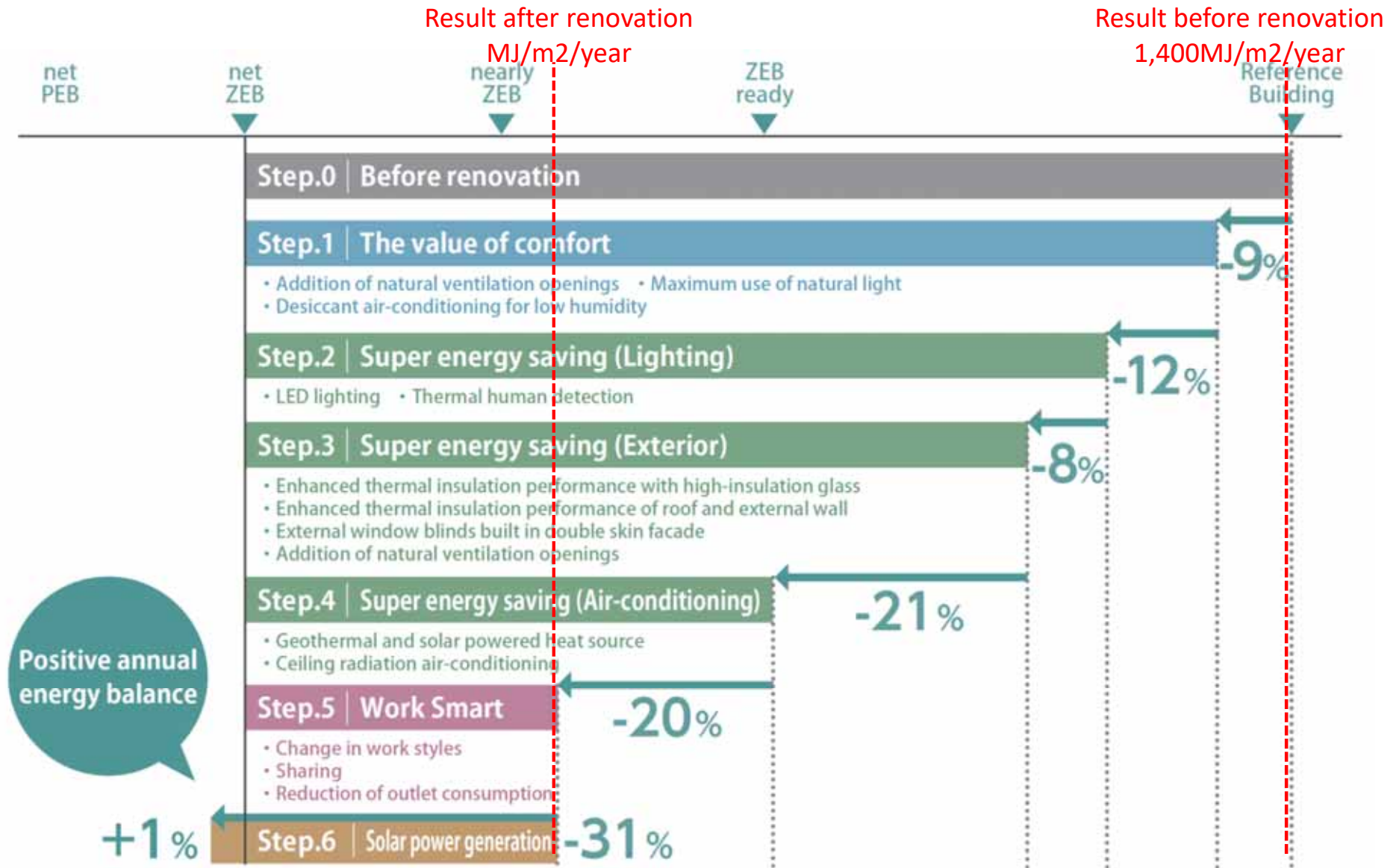


Solar heat panel



Re-use lithium-ion battery

The prediction of energy consumption and energy generation

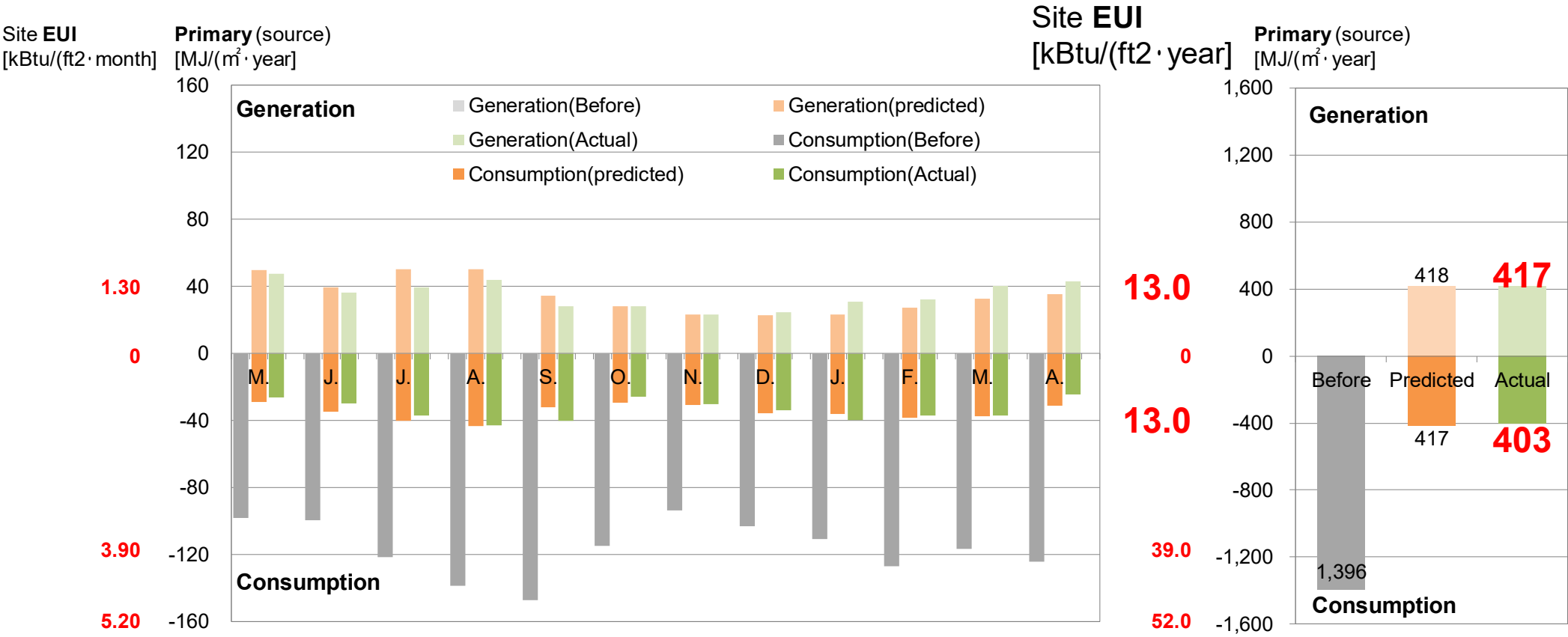


ZEB ready: over 50% reduction of consumption

Nearly ZEB: approximately 75% reduction of consumption and also has renewable energy

Net ZEB: approximately 75% reduction of consumption and remain are canceled by renewable energy

Thermal Load and Energy Consumption: Predicted and Actual Performance



Annual total consumption of primary energy (May 2016 – Apr. 2017)

* 403 MJ/year/m² = 35.5 kBtu / ft² (primary) = 13.1 kBtu / ft² (EUI)
 417 MJ/year/m² = 36.7 kBtu / ft² (primary) = 13.5 kBtu / ft² (EUI)

*Showing primary energy : 9.76MJ/kWh

Air Temperature & Humidity



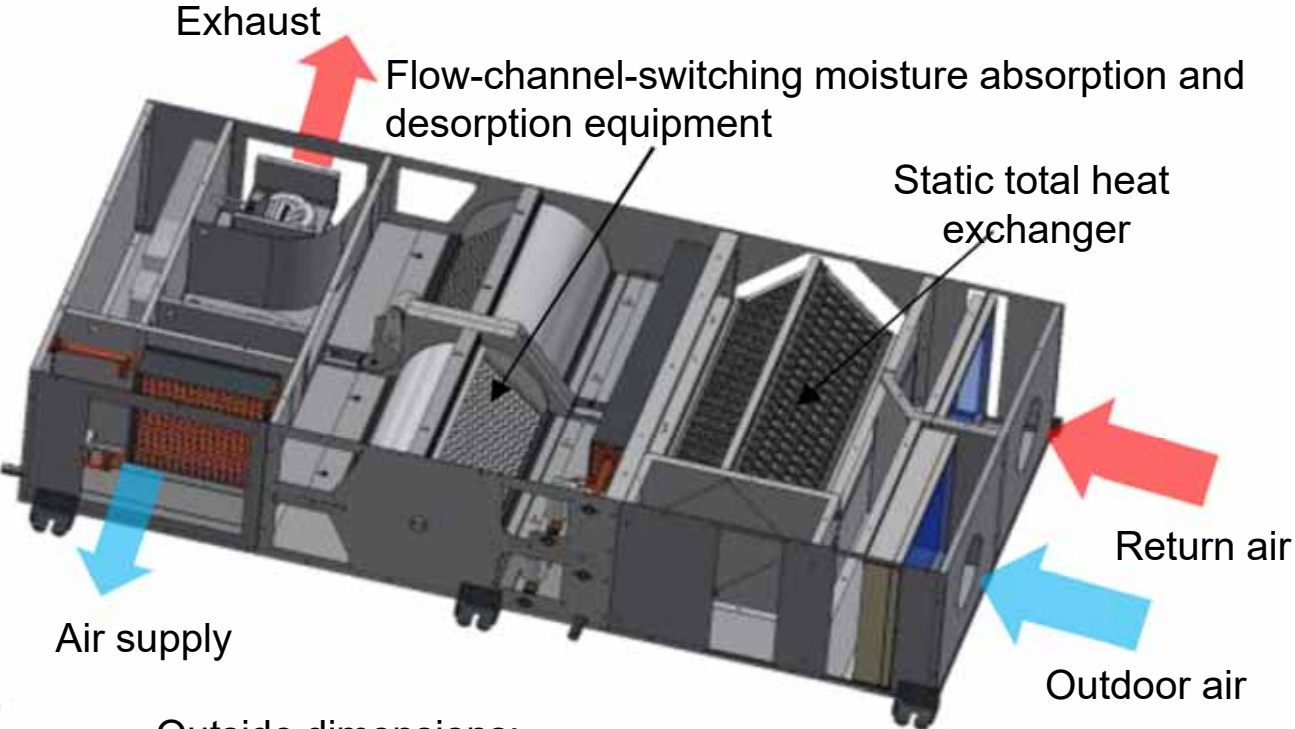
Radiant
Ceiling Panel

Desiccant
Air-Conditioner

Personal
Diffuser

Automatically Natural
Ventilation Controlled

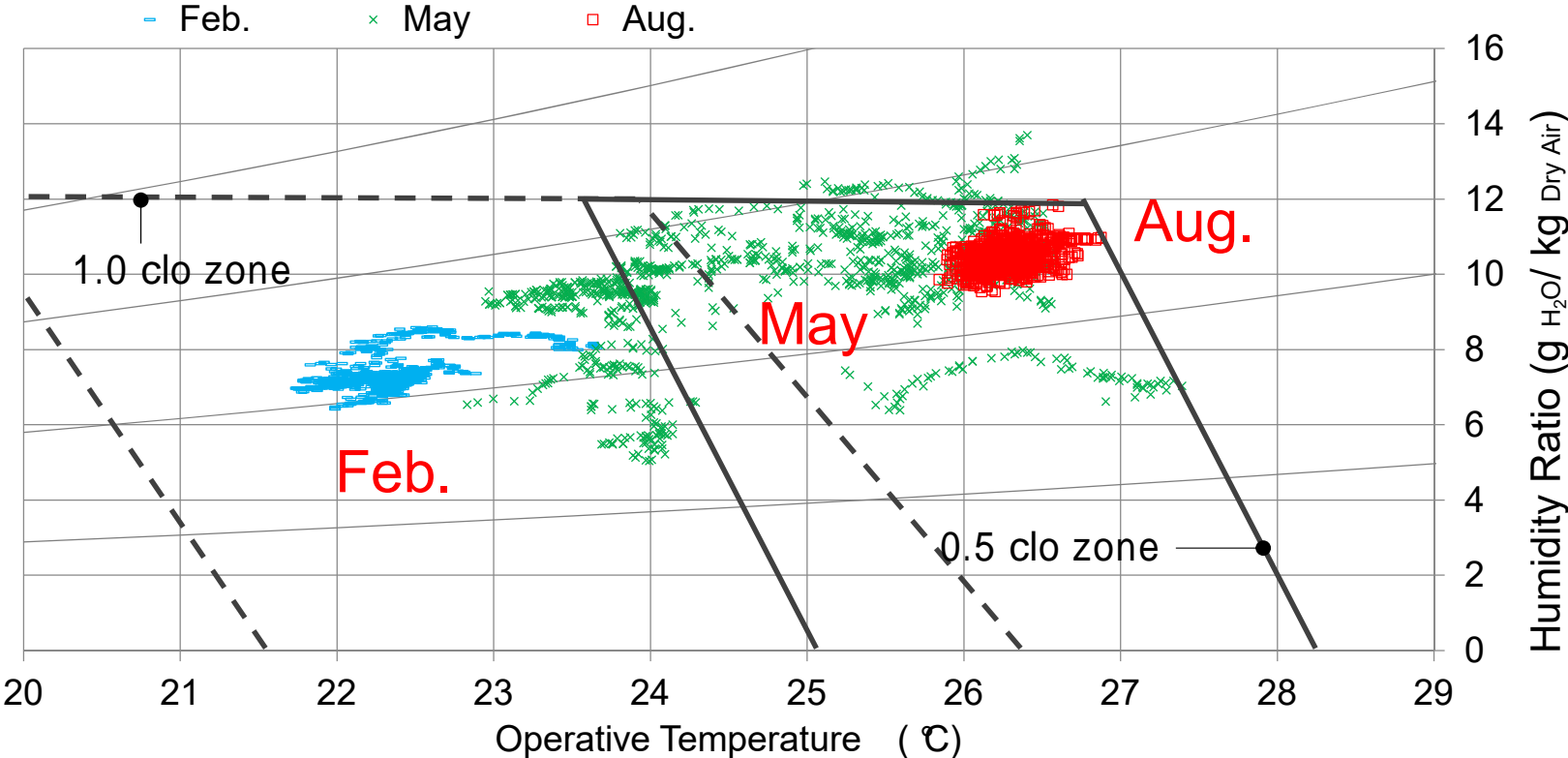
Ceiling Type Desiccant Air Handling Unit



Outside dimensions:
2,250 (W) × 1,050 (D) × 450 (H)

Internal structure of outside air handling unit for desiccant

Air Temperature & Humidity



Indoor temperature and humidity in Aug., Feb., and May
(ASHRAE 55 graphic method)

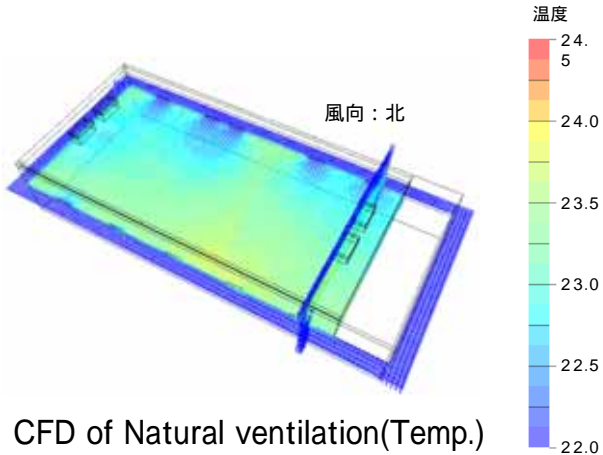
Air velocities & Ventilation



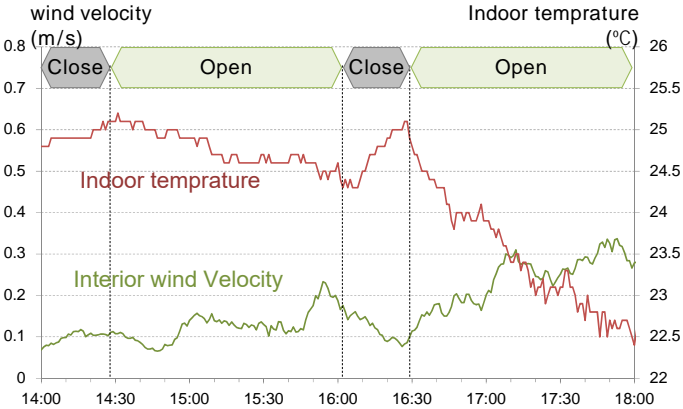
Natural ventilator (auto control)



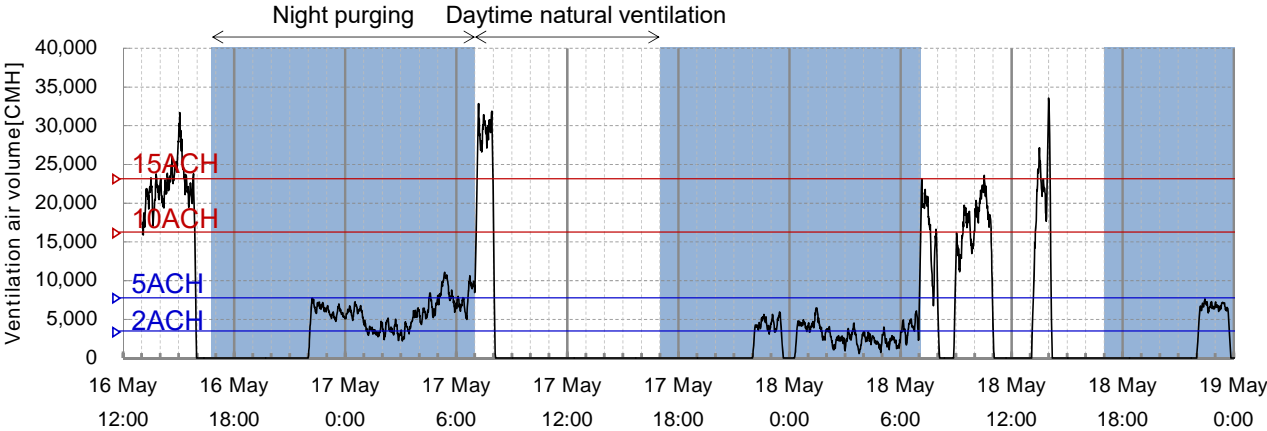
Natural exhaust (auto control)



CFD of Natural ventilation(Temp.)



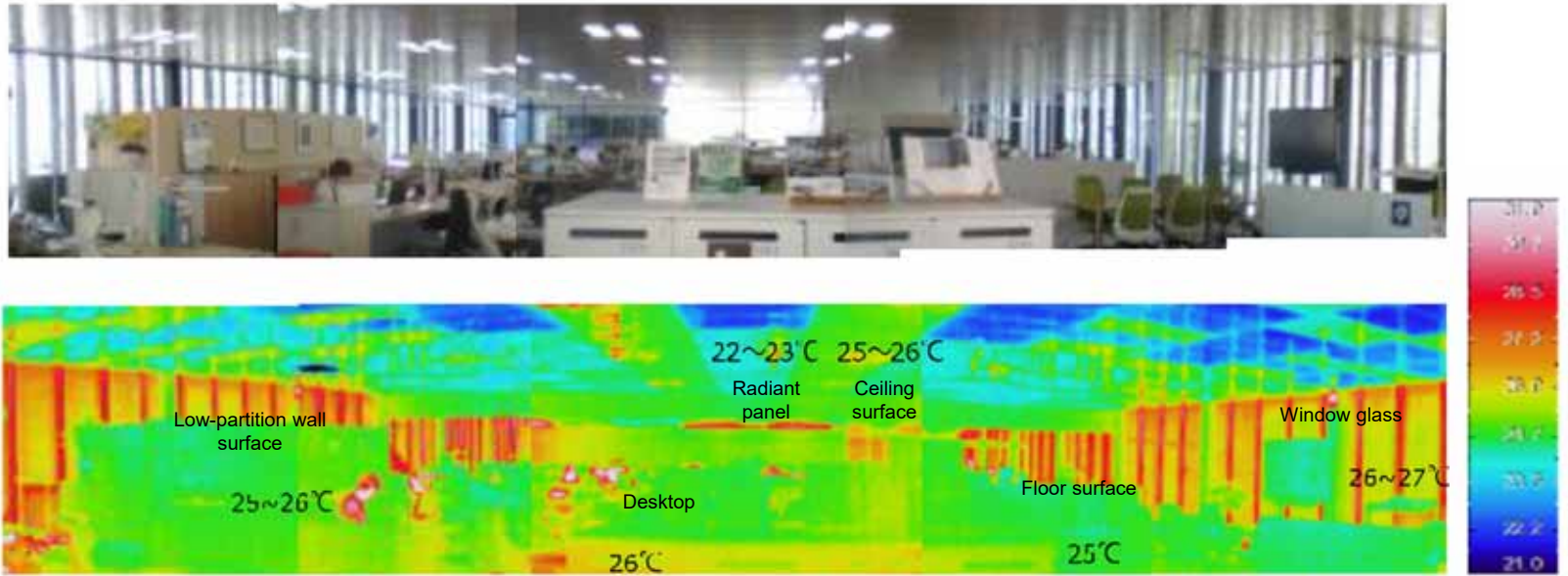
Indoor wind velocity and temperature under natural ventilation (on May 19)



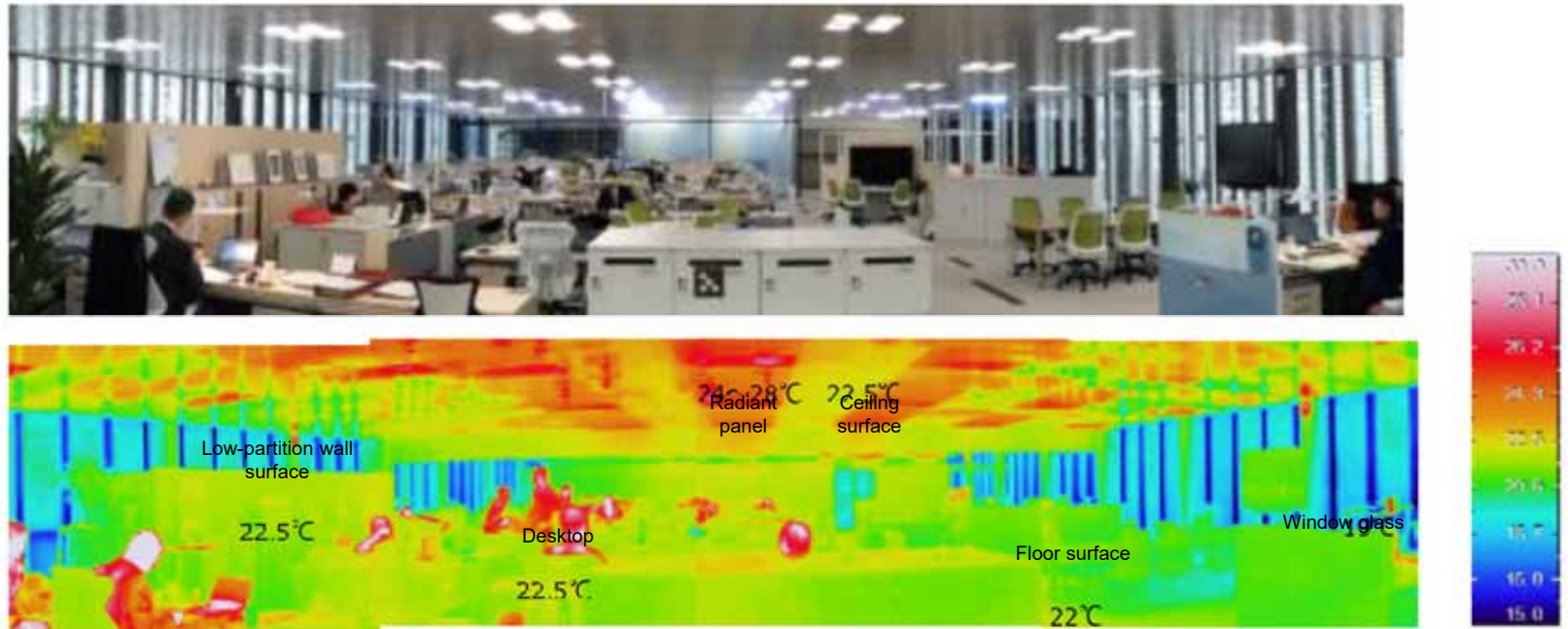
Measured air volumes supplied by natural ventilation (May 16 to 19, 2017)

Radiant Thermal Control

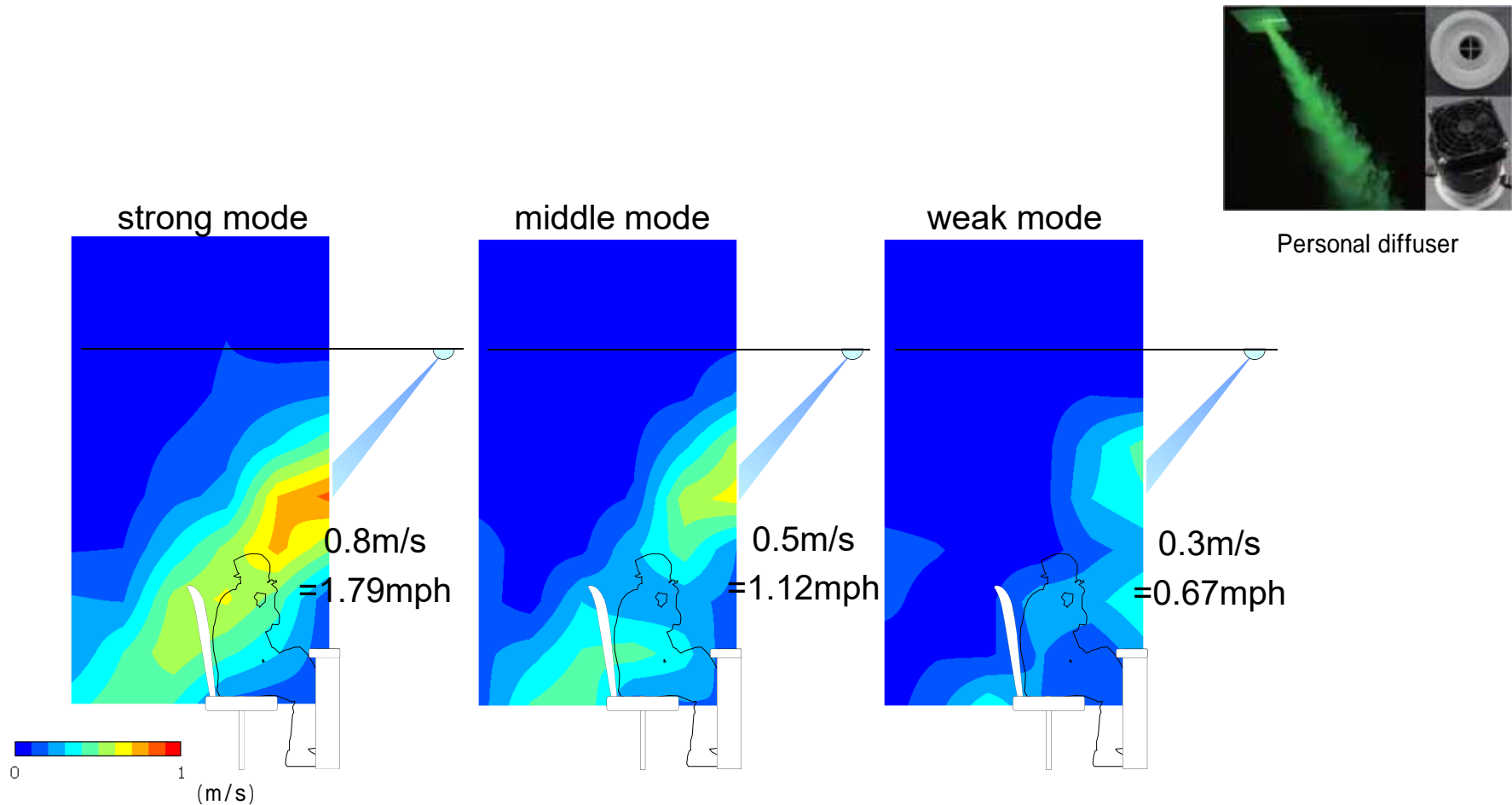
Summer(July)



Winter(Dec.)



Personal Diffuser



Measured distributions of air stream from personal diffuser

This personal diffuser utilizes a **nozzle installed on the ceiling surface** to create an air flow towards an individual's face.

Each worker can adjust the air volume from their own super-small fan.

Wellness Control by wearable devices



Wearable Devices

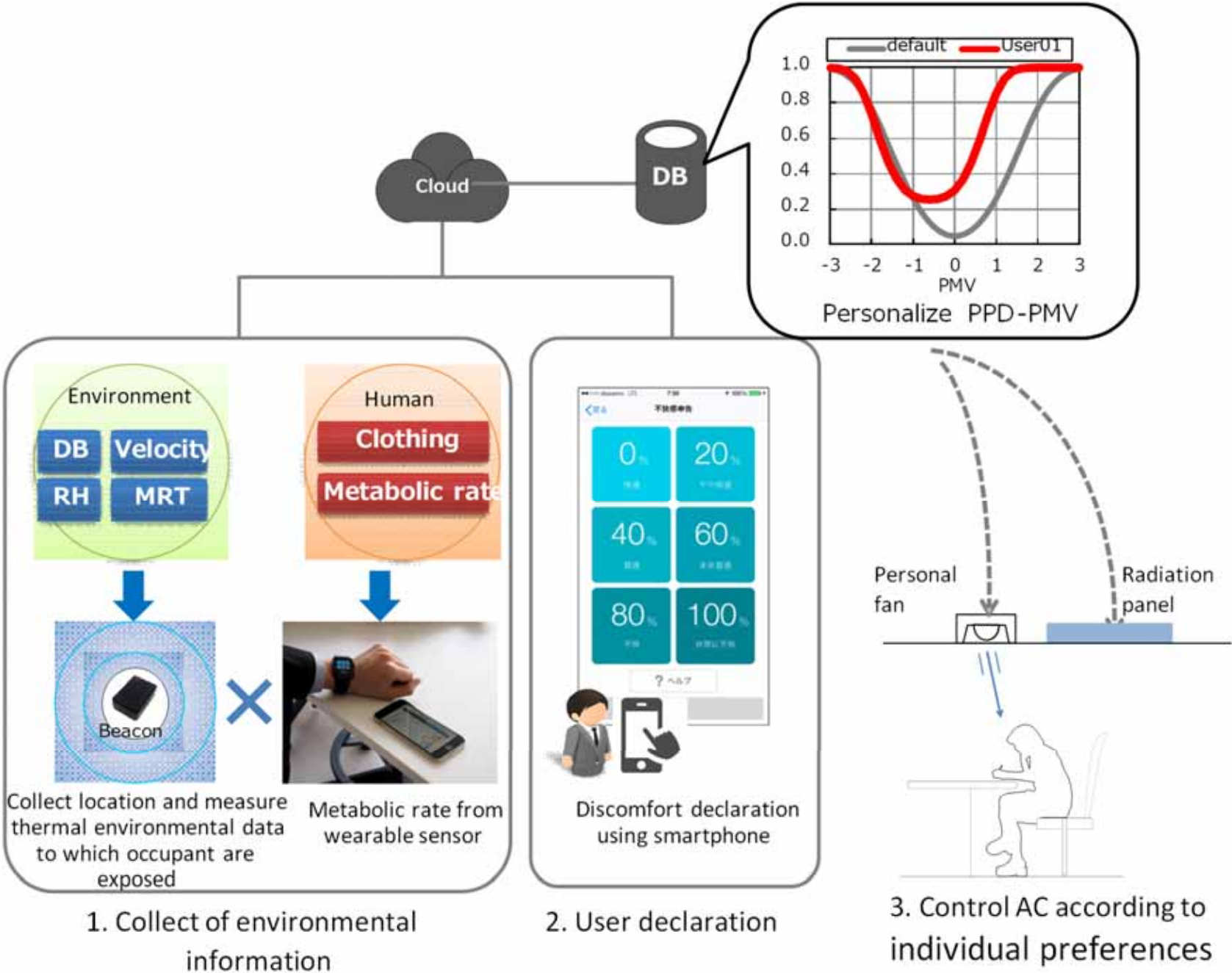


Personal diffuser

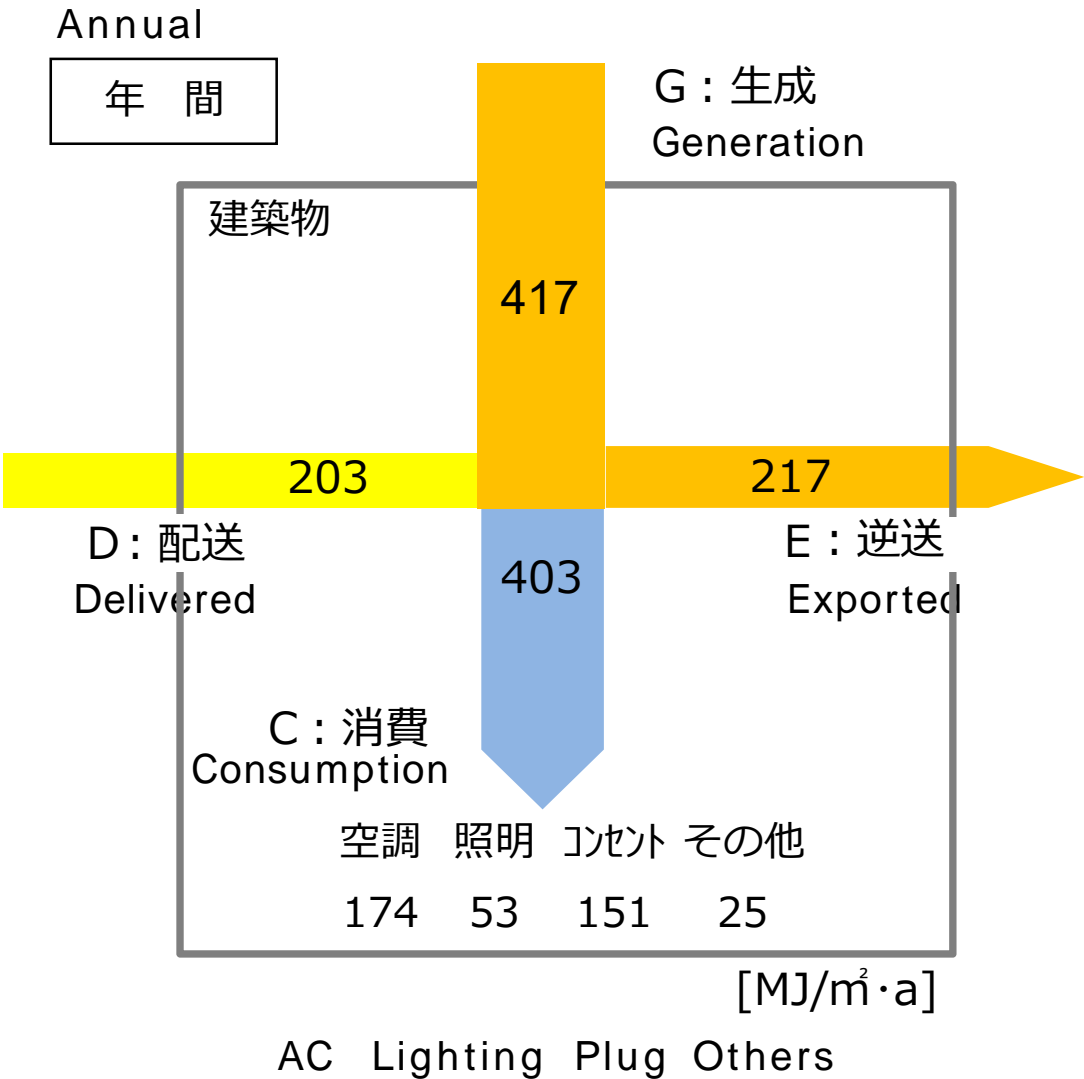


Radiant cooling & heating panel

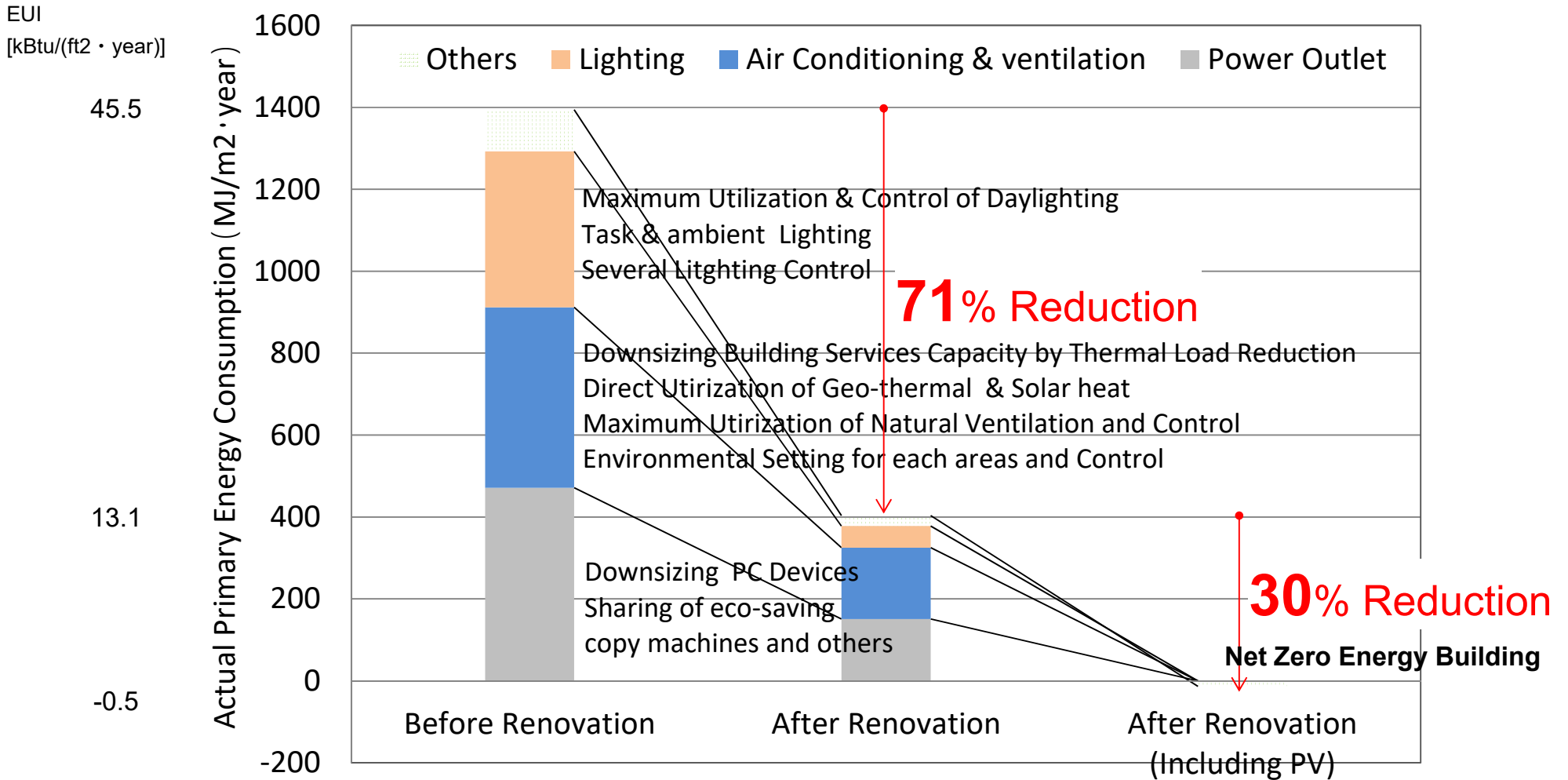
Wellness Control by wearable devices



Annual energy balance (Actual result)

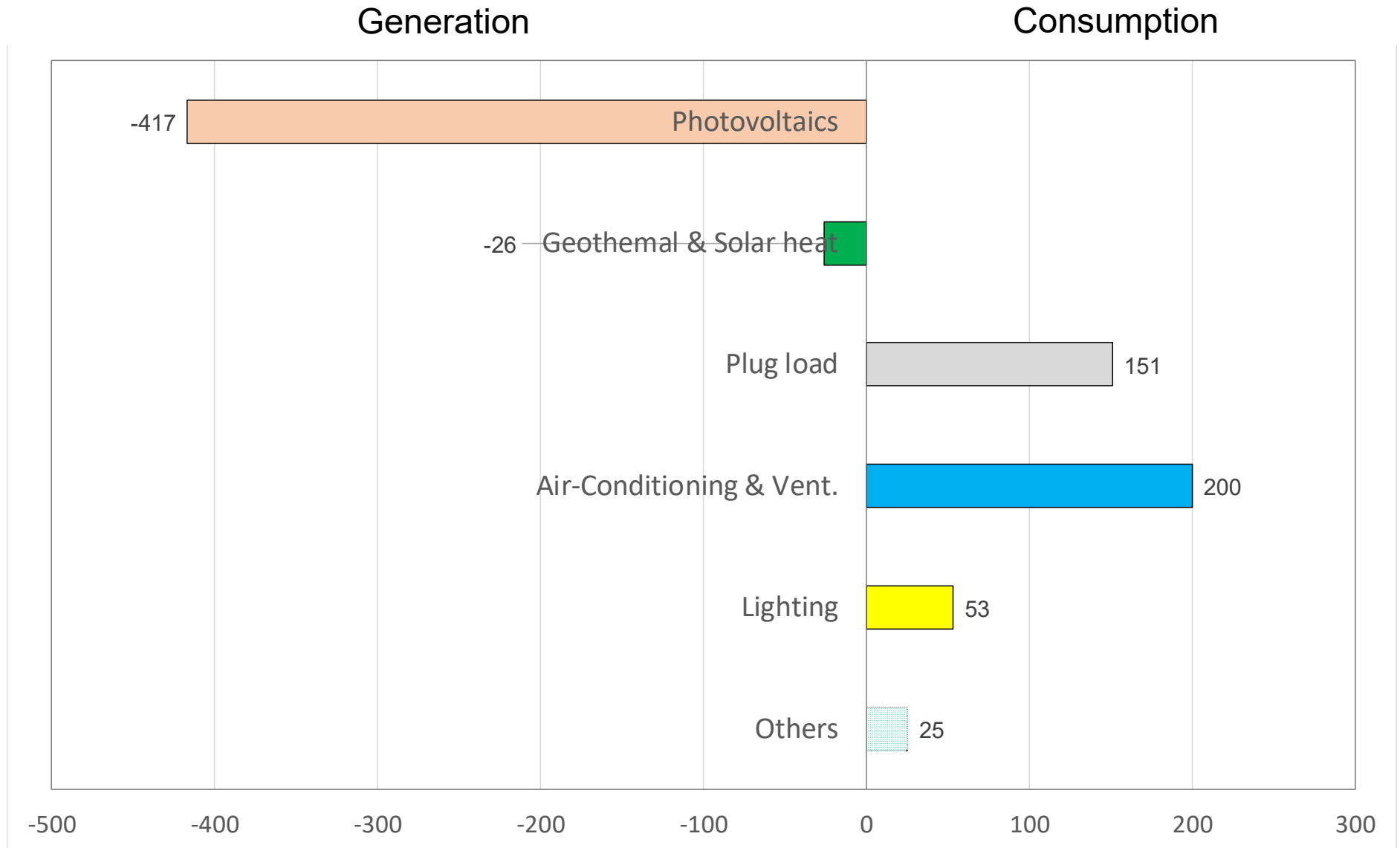


Comparison of primary energy consumption and annual energy balance before and after renovation



Comparison of primary energy consumption before and after renovation

Natural Energy and Energy Consumption of Whole Building (MJ/m²·year) (1 year actual result after renovation)



- Geothermal heat and Solar heat is 30% of Air-Conditioning supply energy.
- Photovoltaics power covers all of the rest.

Conclusion

This project is Japan's first Net ZEB project for renovating a thirteen-year-old building actually in use in order to convert it to **Net ZEB and also covers plug loads.**

This is an actual case, that not only achieved zero energy cost, but also brought about **co-benefits such as improved comfort, improved workplace productivity, work-style innovation, a healthy walking wellness office, and better business continuity during disasters.**