Introduction of ZEB in Japan

-Energy Efficiency Building Design and performance evaluation-

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   -Achievement of ZEB by state-of-the-art technology

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COMPANY

- Multi-Disciplinary Design Consultancy Firm
- Founded in 1900
- Established in 1950, incorporated in Japan
- Over 25,000 projects in more than 50 countries
- 1,903 Staffs (Group Total: 2,685) as of April, 2018
- Annual Turnover: Over 355 Million US dollar

We contribute to society through work that offers true value. With this as our core objective, we grow as individuals and develop as a worthy company.
ORGANIZATION

PLANNERS
- Urban Development
- Urban Design & Planning
- Landscape Design
- Urban Infrastructure
- Project Management

ARCHITECTS
- Office, Government
- Mixed Use, Residential
- Retail, Hotel, Hospitality
- Hospital, Wellness
- Sports, Culture, Education
- Airport, Station
- Life Cycle Design
- Industrial and Research

ENGINEERS
- Structural Engineering
- MEP, Environment
- Disaster Planning
GLOBAL REACH

Over 25,000 projects in more than 250 cities around 50 countries

12 Oversea Offices

Tokyo

Barcelona

Moscow

Dubai

Riyadh

Shanghai

Beijing

Dalian

Seoul

Hanoi

Ho Chi Minh

Singapore

Nikklen
GLOBAL NETWORK
1. **ZEB in Japan**
ZEB in Japan

Technical introduction of 14 ZEB projects

国内のZEB先進事例の概要
Overview of Best Practices in Japan

Location of 14 Best practices

No. 1
Unnan City Hall

No. 2
Shimizu Corporation Headquarters

No. 3
ZEB Demonstration Building, Taisei Corporation

No. 4
KT Building

No. 5
Takenaka Corporation Higashi Kanto Branch Office

No. 6
Obayashi Technical Research Institute Main Building, "Techno-Station"

No. 7
21 Komce, The University of Tokyo

No. 8
DAIKIN Technology & Innovation Center

No. 9
Minami-Osaka sales office of the Kasi Electric Power Company

No. 10
Tokyo Gas Tachikawa Building

No. 11
Sanken Setsubu Kogyo Tsukubamirai Technology Center

No. 12
DAI-DAN Kyushu Branch Office "Enefice Kyushu"

No. 13
The SNK Engineering Center "Demonstration Labo"

No. 14
Shinryo Headquarters Building

* ZEB chart for 14 Best Practices
14 ZEB projects
2. ZEB Project Case Study 1
-Achievement of ZEB by state-of-the-art technology
Daikin Industries, Ltd.  
Technology and Innovation Center
Daikin Yodogawa factory

Site Area (Yodogawa Factory): 396,666.66㎡

TIC site plan: 29,903.35㎡
Site plan

TIC Forest (約3,800㎡)

Main entrance
Daikin TIC (Technology and Innovation Center)

New Technology
Innovative Cx
Top level Energy and Environment

Passive and Active Method

Carbon Management

ZEB
LEED Platinum

Baseline
AC
OTHERS

1861 MJ/m²

Proposed

562 MJ/m² (▲ 70%)
TIC Forest
South-north cross section of Office zone

60m×60m×2 layers → Mega floor office (≒6,000㎡)

6F: Future innovation space

4-5F: Office

3F: Collaborative innovation space with outside experts

Sky light leading sun light

VOID connecting natural light, view, activity

60m×60m×2 layers → Mega floor office (≒6,000㎡)
Work place floors (3000 sqm x 2 stories) and Wai-Gaya Stage at a center position.
Each office zone is located within a 30-m radius from Wai-Gaya Stage, which functions as a place for cross-functional, collaborative creation activities.

Knowledge Flow Structure in which people, knowledge and information circulates. 2-storey office with Wai-Gaya Stage in the center accommodates 700 researchers through east and west atriums.
HVAC system - Passive and active method
Glazing duct
Control air humidity and air quality

“DESICA” with air-volume control system depending on the CO$_2$ concentration for TIC
Improvement of part-load efficiency

- Annual cooling and heating load distribution of an office.
- Most cooling and heating loads are less than 50% of peak load.
- Operation period at part-load is very long.
hs-VRF system (New VRF system for TIC)

The position of higher incidence

Device Efficiency Ratio(%) vs Load Ratio

- hs-VRF(outdoor25°C)
- hs-VRF(outdoor30°C)
- hs-VRF(outdoor35°C)
Solar and geothermal VRF
Real time visualization of indoor environment

4.5m×4.5m: Human sensor
4.5m×9m: Temperature, humidity, CO2,
Real time visualization of indoor environment

5th Floor Indoor air Temperature (Oct 20th 2016)

natural ventilation + VRF System
Real time commissioning

Real-time energy analysis
(Comparison between “Theory” and “Practice”)
[ every 30min.]

- Wh/m2

- Saving of elemental technology

- Plug and others

- Lighting
- Air Conditioning (Indoor load)
- Air Conditioning (Fresh air load)
- Solar power

Practice: Actual
(Advanced system)

Theoretical simulation-1
(Advanced system)

Theoretical simulation-2
(Conventional system)

Real-time visualization

Environmental data with many sensors
- Temperature
- Humidity
- CO2 concentration
- Illumination
- Heat Load
- Operation time
- et al.
LEED Platinum 85/110
LEED Score

敷地  Sustainable Sites  24/26
材料  Material & Resources  7/14
地域特性  Regional Priority  4/4
水  Water Efficiency  10/10
空気質  Indoor Environmental Quality  11/15
エネルギー  Energy & Atmosphere  23/35
新技術  Innovation in Design  6/6

85/110
3. ZEB Project Case Study 2
-Achievement of ZEB
by architectural elements and education
1. Background and Concept

2. Technology for ZEB

3. Education and Operation
1. Background and Concept

2. Technology for ZEB

3. Education and Operation
Four Keywords of this project

**Living**
- Enclosed in rich green
- A comfortable classroom to serve as the base of life

**Region**
- Using local materials actively
- Deepen interaction with the community, rooted in the local

**Learning**
- Learning commons promoting voluntary learning
- Realization of a pleasant learning environment

**Environment**
- Realization of zero energy school
- Operation system conducted by the students themselves
What is Super Eco-school?

- Reduce energy consumption by thorough energy conservation
- Energy consumption is covered with renewable energy and annual energy consumption is made substantially Zero

“Promotion project of MEXT”

MEXT: Ministry of Education, Culture, Sports, Science and Technology

![Energy Saving Effect and Energy Creation Effect comparison chart]
What is Super Eco-school?

Subsidy system for project cost

■ Super Eco School Demonstration Project
  “MEXT” : Ministry of Education, Culture, Sports, Science and Technology
  + 5 millions $

■ Sustainable Buildings Leading Project
  “MLIT” : Ministry of Land, Infrastructure, Transport and Tourism
  1.5 millions $

■ Interior woodening support project
  “Gifu prefecture”
  0.5 millions $
Scheme for achieving zero energy

- Cooling
- Heating
- Lighting
- Ventilation
- Plug load
- Others
- Renewable Energy

Primary Energy Consumption MJ/sqm.a

- Standard School
  - Cooling: 364 MJ/sqm.a
  - Heating: 181 MJ/sqm.a
  - Lighting: 189 MJ/sqm.a

- Standard Specification
  - 50% Energy saving

- Proposal Specification
  - 52% Energy management

ZEB target line

Energy saving
Energy management
Renewable Energy

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Level of ZEB in this project

- **This Project**
  - Nearly ZEB Level I
  - Nearly ZEB Level II
  - ZEB Ready
  - ZEB Oriented

- **net Zero Energy Building**
- **net Plus Energy Building**
- **net Minus Energy**

- **Level of ZEB in this project**
  - **Demand Ratio**
  - **Supply Ratio**

**Environmental Load**

**Environmental Quality**

- **Management**
- **Energy Saving**
- **Reference Building**

**BEE = 3.7**

**Level**

- Level I
- Level II

**NIKKEN**

**NIKKEN LEEKI LTD**
Toward achieving Zero Energy Building

Instead of automatically controlling everything, utilize SI (Student Intelligence) to lead to environmental learning

Encourage school to zero energy promote environmental education

Super Eco-school

1. System operated by students
   - Eco activities by students themselves
     - Eco monitoring
     - Student’s own activities

2. Zero Energy System as Mizunami method
   - Use natural energy based on industry and climate
     - Natural Ventilation
     - Underground Heat Exchange
     - Daylighting
     - Solar Energy

3. Lighting, HVAC, Water saving system
   - Energy saving efficiently
     - Reduction of Heat Load
     - Heat exchange
     - CO₂ control
     - Water Saving Equipment
     - Power Saving
       - LED lighting
       - Occupant detection sensor
1. Background and Concept

2. Technology for ZEB

3. Education and Operation
Project site
Project site

Mountain slope site with urban area and river in the south
Climate conditions of the site

The site is a basin sandwiched between mountains. High temperature and day and night temperature difference in summer.

Source: Extended AMEDAS Weather Data 2002
Design process of achieving zero energy

1. Optimization of outside environment
2. Optimization of indoor environment
3. Load reduction
4. Use of natural resources
5. Use of unutilized energy
6. High Efficiency system
7. Consideration for Resources and material and
8. Use of renewable energy
9. Energy management system
10. Efforts outside the site

(active method)
Placement of building along ridgeline of mountains

Consider the terrain

Wind from the forest

Chu-o Highway
Familiar with the surrounding environment

Arranged along the slope of the mountain facing the south, the building height was kept low.
Familiar with the surrounding environment

From any classroom you can have a view to the city
Familiar with the surrounding environment

The School building with a horizontally spreading mountain back
Exterior view from the main gate
Courtyard surrounded by the building
Enclosed in rich greenery

Two type of forest leading “Breeze” and “Sunlight“
Planting with tall trees

- Reduction reflection from the ground with the shade.
- Reducing the heat environment of the courtyard by lowering the surface ground temperature.
- Lower the air temperature from the outside to the classroom in the summer
High comfort classroom

A classroom that feels warm, making use of wooden beams
Bright classroom with both north and south Daylighting using gradient roof
Multipurpose room utilizing wooden beams

Facing the “Breezing” Forest, a place surrounded by greenery
Utilizing the materials of the local area of Mizunami

Tiles

Produced at the factory in the city from the soil in the vicinity of Mizunami

Hinoki plywood

Utilizing plywood of Hinoki from Gifu Prefecture as a wall finish

Cedar/ Hinoki Flooring

Use cedar from Gifu prefecture for consolidation flooring Conference room only Mizunami hinoki
Spiral staircase with shellfish motif
Arrangement of the building leading the wind

Wind to the courtyard goes through the whole school building
Arrangement of the building leading the wind

- Based on the wind flow simulation, the building layout of the South wing was tilted by 10 degrees.
- We curved the outer wall of the indoor playground.

No tilt
Since natural wind is not blown into the courtyard, wind speed is small and natural ventilation is not promoted.

Tilted by 10°
Wind flowing down the inner courtyard without the wind speed falling
Cross section of the building and technology for ZEB

Natural ventilation system passing through the hall
Indoor playground like a whale shape
Solar collector roof
Collect solar energy and warm air. Send to arena.
Natural ventilation window
Perform efficient hot venting from high windows
Light shelf

Guide light through the diffusion film into the classroom
Learn the changes in the sun altitude for each season on the scale of the science room
Light shelf

Perform lighting simulation only with natural lighting
Reduce lighting energy as much as possible by natural lighting on both sides
Ordinary classroom

Think about their living environment and carry out eco activities
Ordinary classroom
Students themselves think about a comfortable and energy-saving environment
Underground heat recovery and Solar heat collecting

Blow out solar heated warm air or air cooled by geothermal heat from the locker shelf.
Air cooled and warmed by using geothermal heat

- North Building
  - 120m
  - 9,000m³/h
- East Building
  - 120m
  - 6,000m³/h
- South Building
  - 150m
  - 12,000m³/h
- Indoor playground
  - 115m
  - 4,800m³/h
- Outside air intake
Underground heat recovery

Enhance students' interest by making intake and routes visible

To each classroom

Outside air intake

Air intake under spiral staircase

To each classroom

Outside air intake

Window to observe the underground pit
Prediction of cooling and heating effect by using geothermal heat

Outlet temperature
Summer: 25〜26℃
Winter: 10〜12℃

Cooling and heating Calculation

[Graph showing outside temperature and outlet temperature fluctuations over a year]

[Bar chart showing monthly amount of heat exchange in kWh/month]

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Natural Ventilation

Use the principle of ascending heat in a pottery baking kiln
Natural Ventilation

Air continually rises to the upper floor and heat escapes from the ventilation window in the wind tower. Mechanism for encouraging natural ventilation throughout the building.
Solar power panels and accumulators batteries

Install up to 120 KW solar cells on the slope roof. Part of the electricity generated is stored in the storage battery and it can be used even during a power outage.
Wind power generator

Wind power generator 1kW that can sense wind direction and wind speed
Placed at the entrance to the “Breezing” forest
Roof top greening

Increase the insulation performance of the building and create a green landscape
Rainwater retention

Rainwater falling on the roof of indoor playground is used for watering for planting
Pellet stove

Heating equipment using pellet fuel utilizing local waste wood waste
1. Background and Concept

2. Technology for ZEB

3. Education and Operation
Opertation management

SI / student intelligence drives the operation of ZEB
Teachers and students have deepen their understanding of buildings and realize zero energy

Know the climate and buildings

Understand how to use eco tools

Actually use them

Consider the results

Further devising, think about the environment
Eco monitoring

The concept of real-time eco monitoring
Eco monitoring

Example of real-time eco monitoring

CO₂ emissions converted into familiar activities and products

Last week

CLASS

CO₂ emissions this week by school class

PV generation

Power consumption

Example of real-time eco monitoring
Eco monitoring

Get information visually by simple operation like a smartphone

- Environment Information
- Eco sign for good behavior
- Energy Saving rate
- Energy Saving Ranking
- Icons for Eco tool
- Q / A
- Information
- Lighting power
- Plug load / HVAC power
- CO2 Concentration
Eco monitoring

Touch panel monitor for students themselves to take action by obtaining information on indoor temperature and humidity and power consumption.
Conclusion

- In order to aim for ZEB, it is necessary to take regional and climate into account for building.
- It is important to consider not only for energy saving but also for the surrounding environment.
- Adopt the latest technology in consideration of operation.
- Continuing ZEB realization by working on education system for operation.