Energy Saving Technology Towards ZEB and SLEB as a Private Construction Company in Singapore

9th February 2023

Kajima Technical Research Institute Singapore

©2023 KAJIMA CORPORATION
Contents

1. Introduction of Kajima Corporation
2. Solutions for Zero Energy Building
3. Our new building ”The GEAR” in Singapore
Contents

1. Introduction of Kajima Corporation

2. Solutions for Zero Energy Building

3. Our new building “The GEAR” in Singapore
<table>
<thead>
<tr>
<th><strong>Company Name</strong></th>
<th>KAJIMA CORPORATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Head Office</strong></td>
<td>Tokyo, Japan</td>
</tr>
<tr>
<td><strong>Established</strong></td>
<td>1840</td>
</tr>
<tr>
<td><strong>Incorporated</strong></td>
<td>1930</td>
</tr>
<tr>
<td><strong>Revenues</strong></td>
<td>¥2,079Billions (~US$15B, FY2021 consolidated)</td>
</tr>
<tr>
<td><strong>Number of Employees</strong></td>
<td>8,080 (As of March 31, 2022)</td>
</tr>
<tr>
<td><strong>Business Domain</strong></td>
<td>Construction (Civil Engineering and Building Construction), Real Estate Development, Architectural Design, Civil Engineering Design, Engineering, and Other</td>
</tr>
<tr>
<td>Name</td>
<td>Kajima Technical Research Institute (KaTRI)</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Established</td>
<td>In 1949 as the 1st research institute among construction industries in Japan</td>
</tr>
<tr>
<td>Number of employees</td>
<td>290 (As of April 1, 2020)</td>
</tr>
<tr>
<td></td>
<td>Research engineers: 242</td>
</tr>
<tr>
<td></td>
<td>(including Ph.D. holders: 86)</td>
</tr>
</tbody>
</table>

**Contribution to clients & society through business**

- **R&D**
  - Development of pioneering basic technologies
  - Technology development and deployment for practical use

- **Technical cooperation**
  - Technical support and consultation for D&C divisions

- **Education & Promotion**
  - Seminars & Workshops
  - Technical promotion

©2023 KAJIMA CORPORATION
KaTRIS

Kajima Technical Research Institute Singapore (KaTRIS) as a truly **global Research innovation hub** for the built environment sector, smart city innovation, and construction tech.
1. Introduction of Kajima Corporation

2. Solutions for Zero Energy Building

3. Our new building ”The GEAR” in Singapore
We have formulated the "Environmental Vision: Triple Zero 2050" to realize a sustainable society that balances the environment and the economy.

We will actively work with customers to develop not only our own business activities such as construction sites but also environmentally friendly construction materials and CO₂ reduction from long term operation of buildings. We are aiming for zero in three fields of carbon, waste and impact for nature.

For "Zero Carbon", we will promote the spread of ZEB by our design and construction.
Solutions for Zero Energy Building (ZEB) for Sustainable Society

ZEB (Zero Energy Building) is the idea of reducing energy consumption at the building operation stage by saving energy and using renewable energy, and making it as zero as possible.

Companies are beginning to adopt the idea of integrating environmental initiatives and corporate management, such as SDGs and ESG investment.

In response, KAJIMA will broadly strengthen environmental proposals along with ZEB proposals.
ZEB is realized by 4 categorized technologies

01 Eco-design
- Reduction of energy waste
  - Facade engineering
  - Natural ventilation
  - Daylight use
  - Task and ambient control
  - Control by advanced sensor & IT

02 Eco-workstyle
- Compatibility between productivity and energy saving
  - Diversified places according to the activity
  - Information on demand
  - Active communication
  - Enjoy nature
  - Relaxation and concentration

03 Energy Management
- Optimization of the energy conservation performance
  - Combined heat and power
  - Smart energy network
  - Optimization by BEMS
  - Visualization technology
  - Energy conservation enlightenment
  - Demand response

04 Renewable Energy
- Optimum use of renewable energy
  - Photovoltaic generation
  - Solar Heat
  - High efficiency heat pump
  - Geo thermal heat pump
In order to realize and promote the spread of ZEB, not only "net ZEB" with net energy consumption of less than 0% but also expanded "ZEB series" is defined.

Recently, it has become possible to apply "ZEB Oriented" to large buildings.
01 Eco design

Energy-saving design by integrating architecture and engineering
Facade design that integrates architecture, structure and mechanical engineering

By incorporating the structural frame into the exterior design, we have realized a façade design that not only achieves both structural performance and design, but also balances solar radiation control and a good view.
Evaluation of thermal performance of facades

• We developed window models that can evaluate both thermal loads and the thermal environment near the windows.
• The accuracy of the window models has been verified through a comparison with tests and measurements.
• Use this method to optimize facade performance.
Application examples in Japan

Double-skin Façade (T project)

Low-E Double Glazing with Small Solar Transmittance (HQ building)

Natural Ventilation (P project)

©2023 KAJIMA CORPORATION
Eco work style

Realization of both intellectual productivity and energy saving

©2023 KAJIMA CORPORATION
We aim for the ZEB that achieves both energy saving and intellectual productivity.

- We propose offices that support the improvement of intellectual productivity by ABW.
  ※ ABW: Activity-Based Working, Work style to choose a place to work according to the content of work
- We propose eco-work styles that reduce CO₂ emissions by optimization of lighting and air conditioning according to work style and encouragement of energy-saving behavior.
Energy management

Reduction of energy consumption during operation
Real-time energy visualization and energy-saving control

Image of IP integrated network “B・OA net“ (KI-ZEB renovation)

©2023 KAJIMA CORPORATION
KAJIMA and affiliated company operate the cloud-based building management platform "KAJIMA Smart BM" in collaboration with Microsoft Japan.

System configuration of "KAJIMA Smart BM"

- Operating status of air conditioning, lighting, etc.
- Indoor environment such as temperature and illuminance
- Energy consumption, etc.
- Reduction of running costs by optimal adjustment of equipment
- Early identification of equipment abnormalities etc.
04 Renewable energy

01 Eco design
02 Eco work style
03 Energy management
04 Renewable energy

Utilization of renewable energy

©2023 KAJIMA CORPORATION
Solar power generation

PV modules integrated with roofing materials of the existing factory (F project)

Top light integrated with PV panels (A project)
"ReHP ®" that integrates and optimizes multiple renewable energies

The heat source water loop is combined with geothermal coils using piles, exhaust heat from a refrigerator, and cold exhaust heat from heat pump water heater. As a result, the water heat source package air conditioner in the office and common area and the water heater in the research area can be operated with high efficiency.

ReHP system configuration

©2023 KAJIMA CORPORATION
Hybrid air conditioning system combined with ceiling fan and conventional AC unit

Collaboration research with National University of Singapore (NUS)

- Improvement of thermal comfort
- 20-30% energy saving
- Reduction of COVID-19 infection risk
Contents

1. Introduction of Kajima Corporation

2. Solutions for Zero Energy Building

3. Our new building ”The GEAR” in Singapore
The GEAR

The GEAR (Kajima Lab for Global Engineering, Architecture & Real Estate)
• Kajima Group’s Asia Pacific Headquarters / Global R&D Hub & Innovation Center
• Utilize as testbed for R&D and open innovation

13,087 sqm
GFA

1 + 6
Basement and Floors

400 pax
Capacity

Q1 2023
TOP

©2023 KAJIMA CORPORATION
The GEAR
Digital Twin Platform in The GEAR

- **Digital Twins**
  - BMS (ACMV, Lighting, Electricity, etc.)
  - Collabo Space
  - Lift
  - Rest Room
  - Parking
  - Ingress/Egress Checking With Facial Recognition
  - Security Camera
  - Location Tracking
  - Auto Irrigation
  - PV panel
  - Optical Fiber Sensor
  - Vital Sensor
  - Borehole (underground monitoring)

- **Analytics, Simulation**
  - Improve Maintainability
  - Energy Saving
  - Decarbonization
  - Eco-Friendly

- **Occupants Well-being**
  - Auto Irrigation
  - Location Tracking
  - Auto PV panel
  - IAQ Sensor

- **Innovation**
  - 1,800+ Data Points

- **Virtual Space (Digital)**
  - The GEAR Digital Platform

- **Feedback**

- **Monitoring**

©2023 KAJIMA CORPORATION
The GEAR Data-driven framework

Well-being
Empowerment
Engagement

Occupants
Employees
Visitors
Tenants

Comfort Condition, Activity
Recommend, etc.

Activity Tracking, Claim,
Vital sensing data, etc.

Telemetry, Management
Review, etc.

The GEAR
& Future Smart
Building Projects

Data
Intelligence

Better Operation, Optimized
maintenance timing, etc.

Management Report, Log,
etc.

Optimize equipment operation,
Better design, retro-fit, etc.

Facility Management

Maintainability
Worker shortage
Attractive work

Digital Feedback Loop

©2023 KAJIMA CORPORATION
The GEAR SLEB achievement

GreenMark SLE certification on June 2022

Annual Energy consumption (calculated)

- Baseline
- The GEAR
  - Data-driven control

>45% SLE requirement

Radiant air conditioning system

PV system

©2023 KAJIMA CORPORATION
Thank you!

Exploring today, building tomorrow.