A Glance at Green Building

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Japan Green Building Council
Founder/Vice-Chairman

- “All of the environmental problems we have before us are perceptual to some extent, meaning extent to which we are able to see the problems will determine how we will solve them.”

  - Dr.Asher Derman

- Environmental problems “are the result of my behavior, not the result of nature. So when we say there are environmental problems, there are no environmental problems. I am the problem. We are the problem.”

- Dr.Asher Derman

Singapore, 1971

Singapore, 1991

View from Mount Faber

Singapore, 1971

View from Mount Faber

Singapore, 2006

Singapore, 1971

“Keep Singapore clean.

No Littering: Fine $500”

Singapore, 2007

“Let’s take ownership of our litter & make Singapore Litter Free”

What is Green Building?

- The term “green building” is used as a synonym for “sustainable building.” It means that the building is environmentally friendly.

How do buildings impact on global environmental problems?

- Exhaustion of energy resources (fossil fuels)
- Emission of sulfur dioxides, nitrogen oxide, particulate matters and carbon dioxide
- Excessive water consumption
- Resource exhaustion (forest resources, etc.)
- Damage to the environment through mining and factory production
- Damage to human health through toxic building materials
- Dumping of solid wastes

Environment- Current Issues in Singapore

1. Industrial pollution
2. Limited natural fresh water resources
3. Limited land availability presents waste disposal problems
4. Seasonal smoke from forest fire in Indonesia

How can we solve them?

- Site selection
  - No harm to ecosystems, use of existing infrastructure & reuse of existing structures
- Renewable energy and resources
  - Solar, wind, geothermal, rain water ,river ,etc.
- Renewable materials
  - Timber from certified forests, agricultural wastes, earth materials.
- Recycled , recyclable & reduction resources
  - Less virgin materials & less pollution
- Utilization of energy efficient systems
- Low embodied energy
  - Review excavation, transportation, production & distribution processes
- Reusable materials & Non toxic materials
  - Disassemble, sort and then store

How to design Green Building

1. Use as much natural energy as possible. Use natural resources efficiently.(passive way)
   - **Sun**: daylighting ,
   - **Wind**: natural ventilation
   - **Soil**: earth tubes
   - **Rainwater/gray water**: toilet water
2. Use renewable energy.(active way)
   - **Sun**: photovoltaic (electricity); solar panel (hot water)
   - **Wind**: electricity
   - **Soil**: geothermal energy
3. Reduce total energy consumption. (global warming)
   - Thermally well-insulated exterior walls and glass windows
   - Energy efficient machines and equipments
   - Daylighting with sensor and occupant sensor
   - Water conservation: rainwater/gray water and low-flow fixture

How to design Green Building (cont.)

4. Use harmless and local building materials.
   - Non-toxic materials: good for indoor air quality
   - Non-CFC, non-HCFC materials (non-ozone layer depleting materials)
5. Use recycled and easy-to-recycle materials.
   - Low embodied energy: review production, transportation and construction processes
   - Waste reduction: Modularized and factory-fabricated products
6. Conduct appropriate site selection. (conserve ecosystem)
   - Minimize impact to the environment
   - Maximize the use of solar energy and landscape benefit

How to design Green Building (cont.)

7. Improve occupants' and workers' health.
   - Indoor air quality: prevent sick building syndrome
8. Enhance productivity through greater comfort.
   (thermal ,visual,acoustic)
   - Less Sick days leave
9. Promote positive economic effect from construction and operation.
   - Local labor and local products promotion
10. Be aesthetic and of high quality in design.
   - vernacular

“Every aspect from design and demolition to construction and finishes has to be considered from a new perspective – environmental responsibility.”

- Pamela Lippe

Green Buildings in Japan

Map of Japan

Singapore: (1° 17' N, 103° 51' E)

Example 1:
Ecolodge Shimanto

「Eco Lodge Shimanto」is a complex facility to heal the people and the earth totally, consists of three parts, Eastern-Chinese Clinic, Center Facility with spa and restaurant , and 30 room hotel.

Project Outlines

	CENTER FACILITIES	HOTEL
Owner	Nakamura City （Shimanto City）	Japan Railroad -Shikoku Company
Structure	reinforced concrete and steel frame; 3 Stories	reinforced concrete and steel frame; 2 Stories
Main Use	Hotel Front Spa , Restaurant, Conference Rooms	Hotel Guest Room（30 rooms） （All different types of Interiors） Cafe/ Bar
Site Area	6,348.65㎡	2,159.86㎡
Building Area	1,540.19㎡	554.93㎡
Total Floor Area	2,069.93㎡	1,131.03㎡
Location	Shimanto City, Kochi Prefecture, Japan	
Completion Date	July 2, 2002	

Design Phase

1. Site Selection
   ↓
2. Vision
   ↓
3. Design Concept
   ↓
4. Charrette
   ↓
5. Utilizing Green Features
   ↓
6. Pay Back Period Calculation
   ↓
7. Designing

1.Site Selection

- Site Planning Issues
  Tree Protection
  Erosion Control
  Solar Access
  Feng Shui
  Topography

2.Vision

- Healing Resort with Nature
  (Shimanto River/ Pacific Ocean/
  Forest/ Seasonal Flowers/
  Local Food/ Hot Spring)

3.Design Concept

- Pause
- Slow & Lazy
- Vernacular

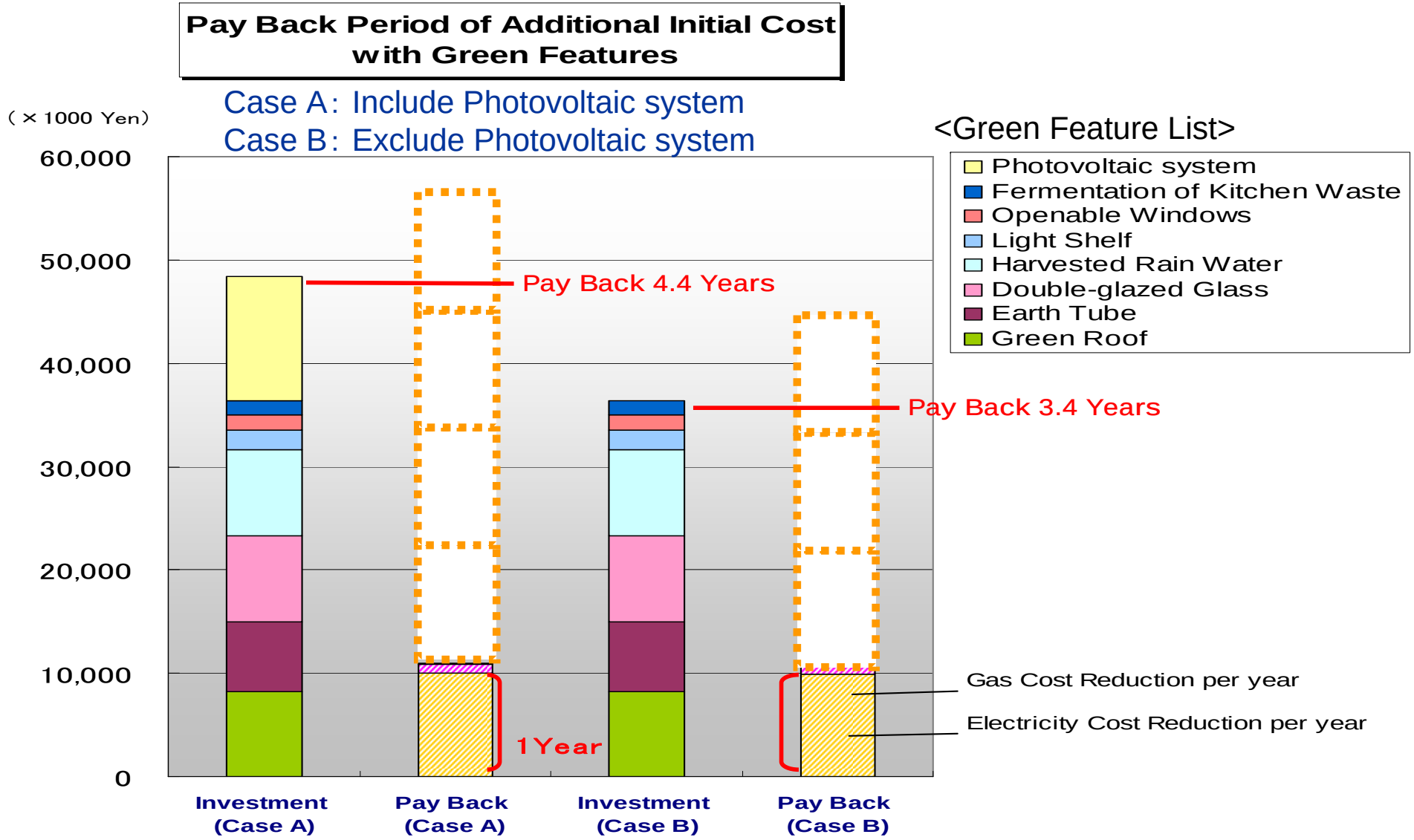
4.Charrette

At the beginning of the project, collaboration of all stake holders joined the discussion about how to develop environment-friendly project.

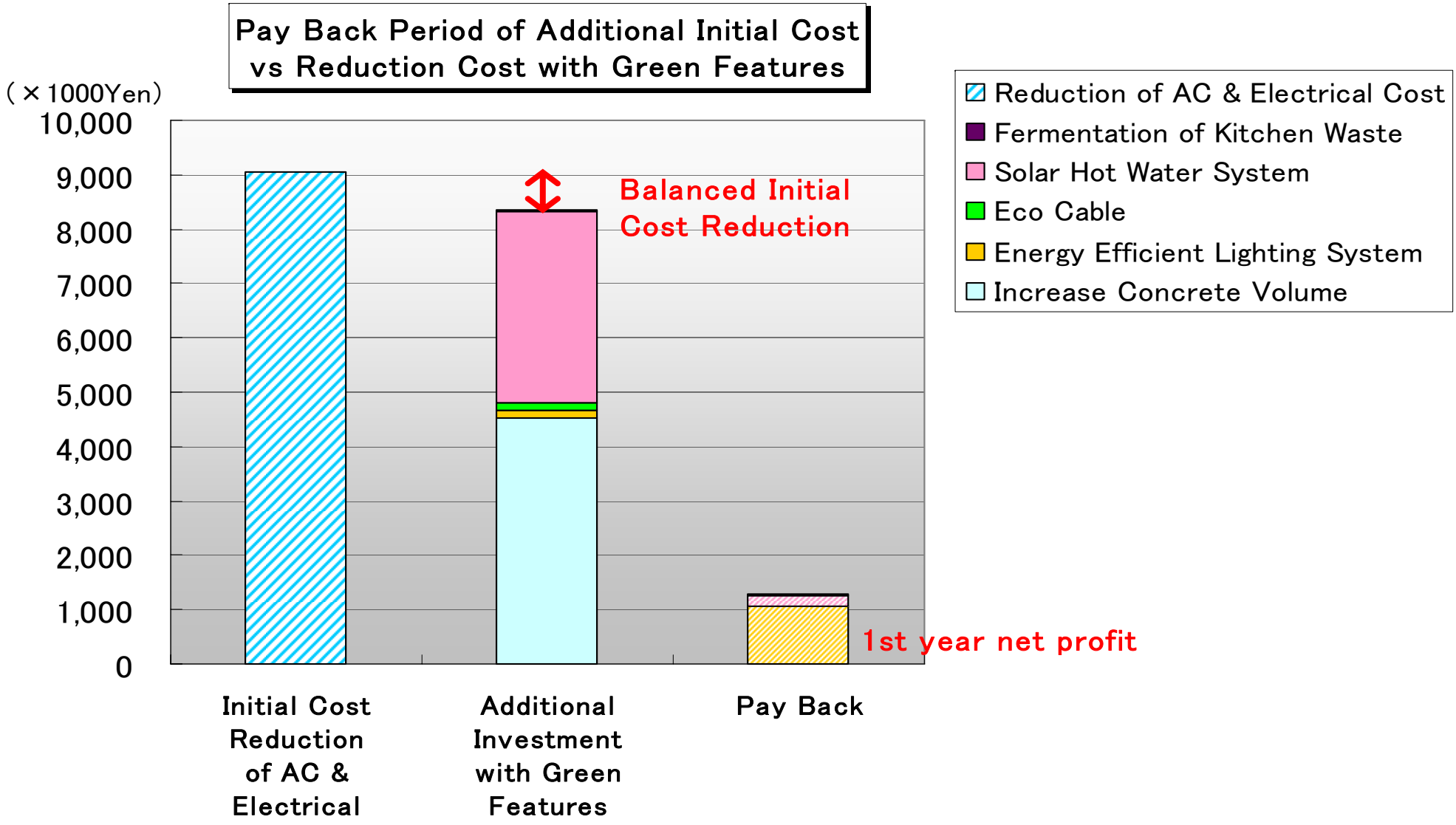
5.Utilizing Green Features

1. Co-existence with surrounding nature
2. Use of Solar Heat and Light
3. Soil (Earth)
4. Wind
5. Water
6. Other Features

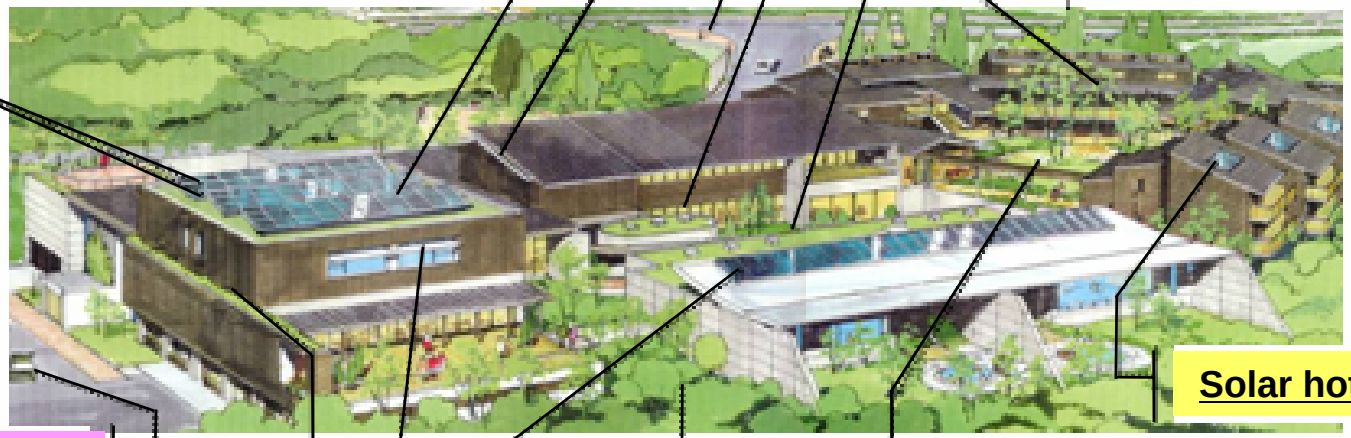
6.Pay Back Period Calculation
(Center Facilities)



6.Pay Back Period Calculation (Hotel)



7.Designing



Natural ventilation

Daylighting

Photovoltaic system

(Foundation base is provided on the roof for photovoltaic panels)

Green roof &wall

Use of harvested rain water)

Permeable pavement

Daylighting

Green roof &wall

Daylighting

Natural ventilation

Solar hot water system

Minimize light pollution Garden

Green roof &wall

Daylighting &light shelf

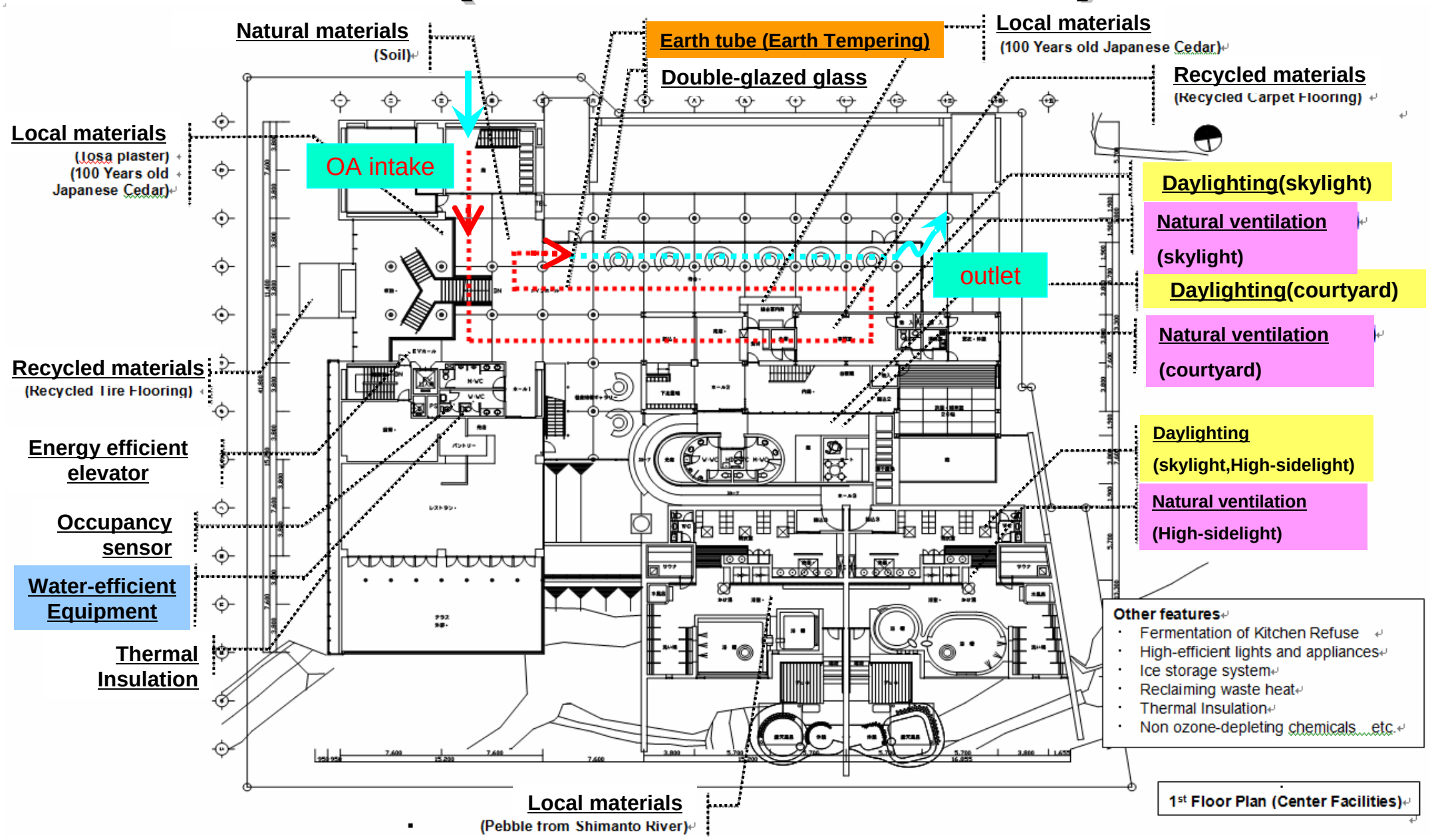
Use of harvested rain water)

Railroad tie (reused)

Preserved topography

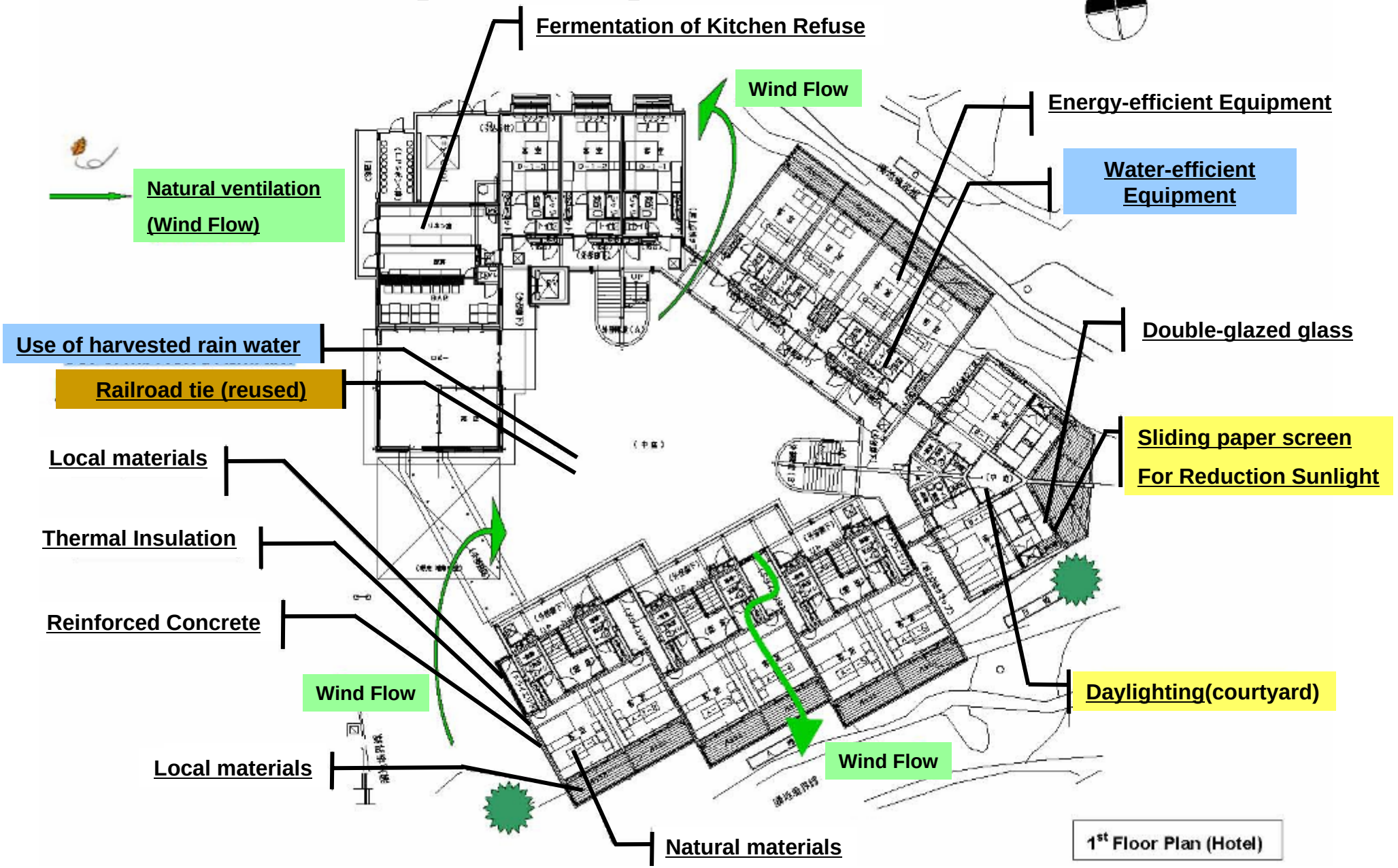
Solar hot water system

Floor Plan (Center Facilities)



Floor Plan (Hotel)

30 rooms like as Japanese Ryokan style;maximum capacity 80 people



Preserved topography

South

Shimanto river view

Daylighting

Galvanized Steel (Ceiling)

Vernacular design

North

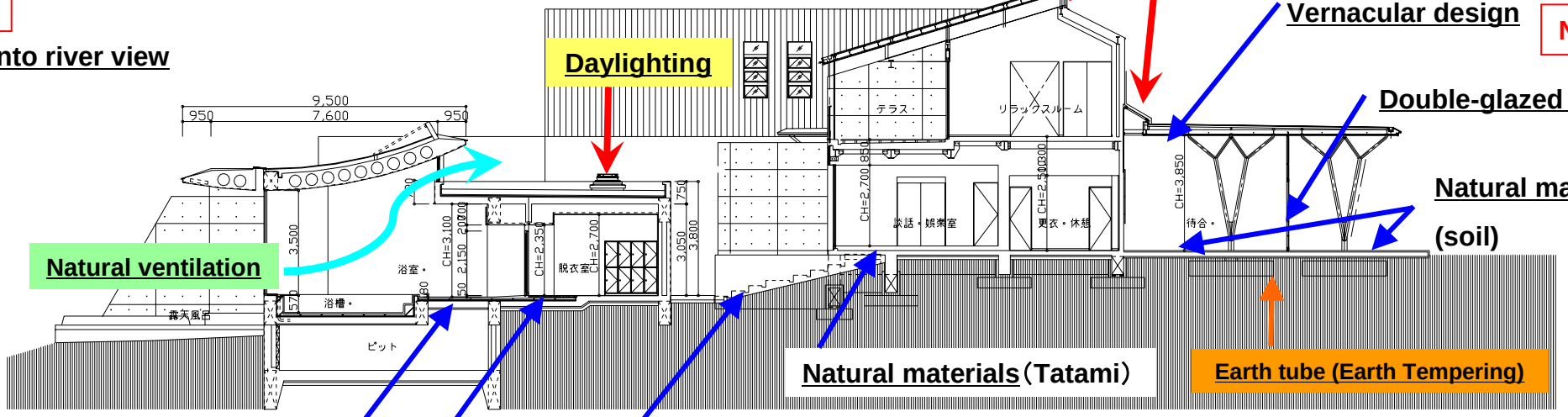
Daylighting

Double-glazed glass

Natural materials

(soil)

Natural ventilation



Natural materials（Tatami）

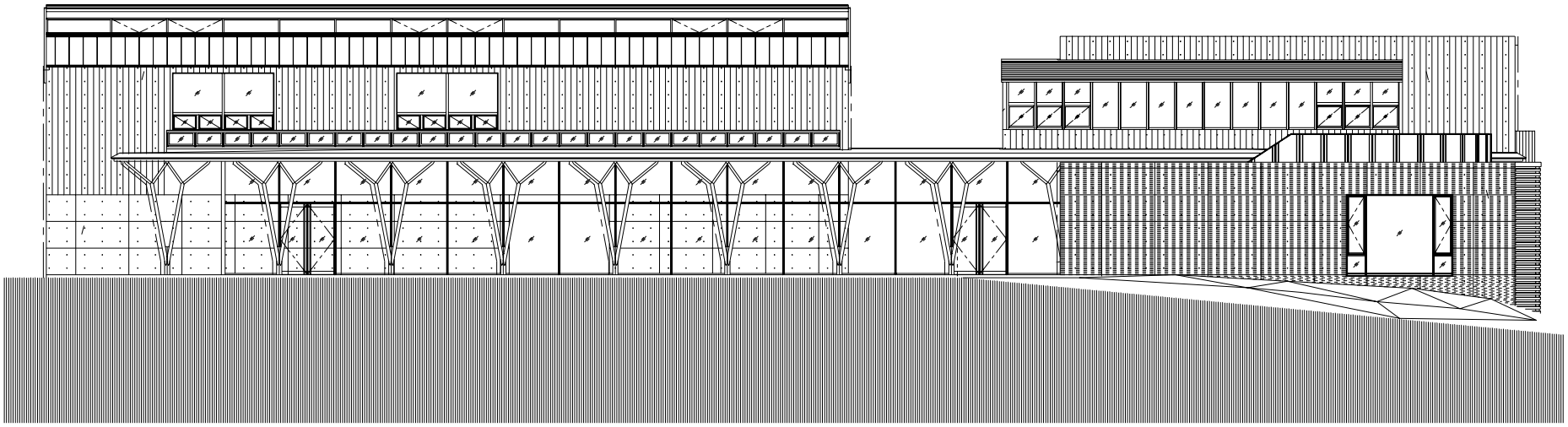
Earth tube (Earth Tempering)

Local materials（ Shimanto river pebble）

Natural materials（palm）

Natural materials（rattan）

NORTH - SOUTH SECTION



NORTH ELEVATION

Landscape

Construction Phase

Construction Phase (1/2)

Bicycles are used within the construction site

Micro climate data collection such as earth temperature, rainfall, ……

Harvested rainwater for cleaning, washing cars and flushing toilet.

Construction Phase (2/2)

Workers Education

Steel Deck instead of Rain Forest Wood

Construction Waste Sorting to Recycle

Spreading Excavated Soil

Minimum Packing

After Completion

Environmental Education to visitors

Illustrated Green Features utilized in this building, Environmental Issues, Design Concept

Green Features in Detail

1. Co-existence with surrounding nature
2. Use of Solar Heat and Light
3. Soil (Earth)
4. Wind
5. Water
6. Other Features

1. Co-existence with surrounding nature

- Preserved topography
- Restoration of Woodland
- Green roof and wall
- Landscape
- Effective use of local materials

Preserved topography

Mouth of Shimanto river

Pacific ocean

Site plan and buildings form reflect the original topography.
Building design responds to the surrounding nature.

Restoration of Woodland

What happened to many trees around here?

Those trees were temporarily planted in a different place during construction. Then the trees were put back !

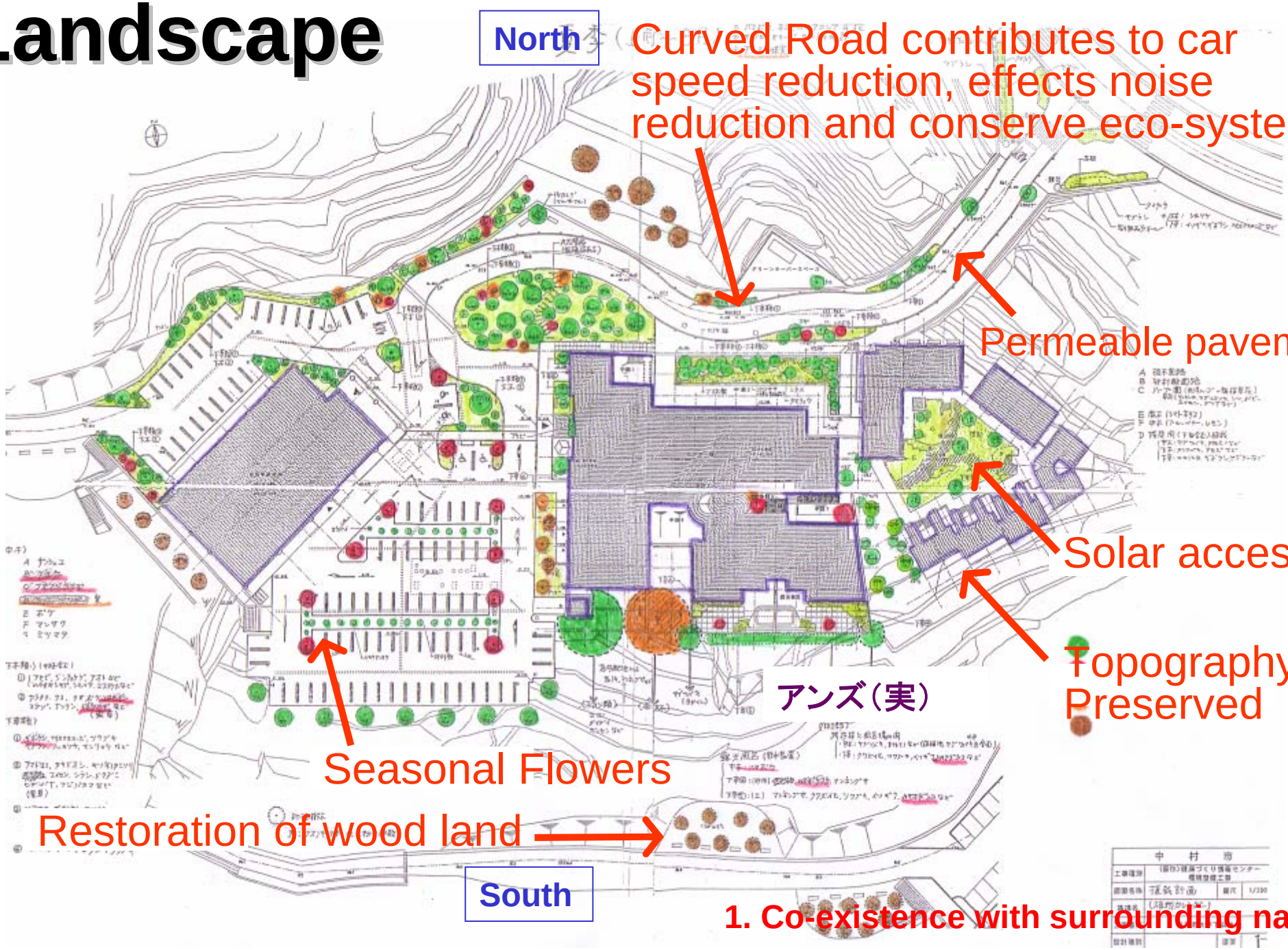
Green roof and wall

Drip irrigation

Rooftop of the spa：Green roofs and walls, which correspond with the surrounding nature, help energy conservation by reducing heat loss.

1. Co-existence with surrounding nature

Landscape



1. Co-existence with surrounding nature

Effective use of local materials（1）

① Symbolized pillar and ② Art pieces are 100 Years old Japanese Cedar from local forest.
Local and domestic materials are chosen in order to minimize CO2 discharge from transportation and respect the local history, culture, and economy.

Effective use of local materials（2）

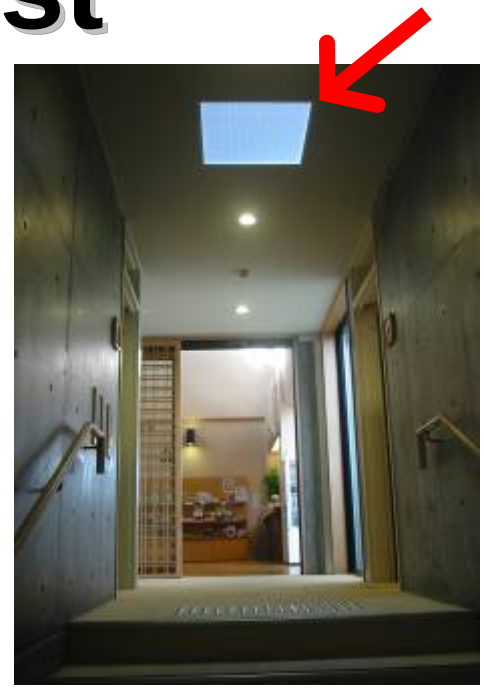
① Front staircase made of local cypress.
② Information counter board made of 100 Years Cedar.
③ Spa floor using pebbles from Shimanto River.

2. Use of Solar Heat and Light

- Day lighting & Heat exhaust
- Light shelf
- Green roof and wall
- Photovoltaic system（Future）

Day lighting & Heat exhaust

skylight



North facing high-side windows
Natural light coming through the skylight windows
Openable window

Light shelf

Exterior view of light shelves in the south facing windows

Interior view of light shelves

Light shelves distribute daylight throughout the space,

by reflecting light off its top surface to the ceiling.

Solar hot water system

Solar collectors placed on the roof. Storage tank placed in the mechanical room : The sun heats the water as it passes through the collector and then is circulated to a storage tank.

Photovoltaic system（Future）

Foundation base is provided on the roof for photovoltaic panels

3. Soil (Earth)

- Earth tube (Earth Tempering)
- Use of Natural Materials
  (Soil , Tosa plaster,・・・)
- Fermentation of Kitchen Waste

Earth tube (Earth Tempering)

Trench under the floor
(view during the construction)

Outdoor Air
Intake

Air Outlet of
Earth Tube

The temperature of the ground several feet below the surface does not fluctuate much. The earth tube system can cool incoming ventilation air in summer and warm it in winter.

Use of Natural Materials
(Soil,Tosa plaster,・・・)

Local plaster wall, Tatami and Cedar flooring / Earth flooring / Cedar flooring.
They have function of moisture absorbing /discharging and deodorizing.

Fermentation of Kitchen Waste

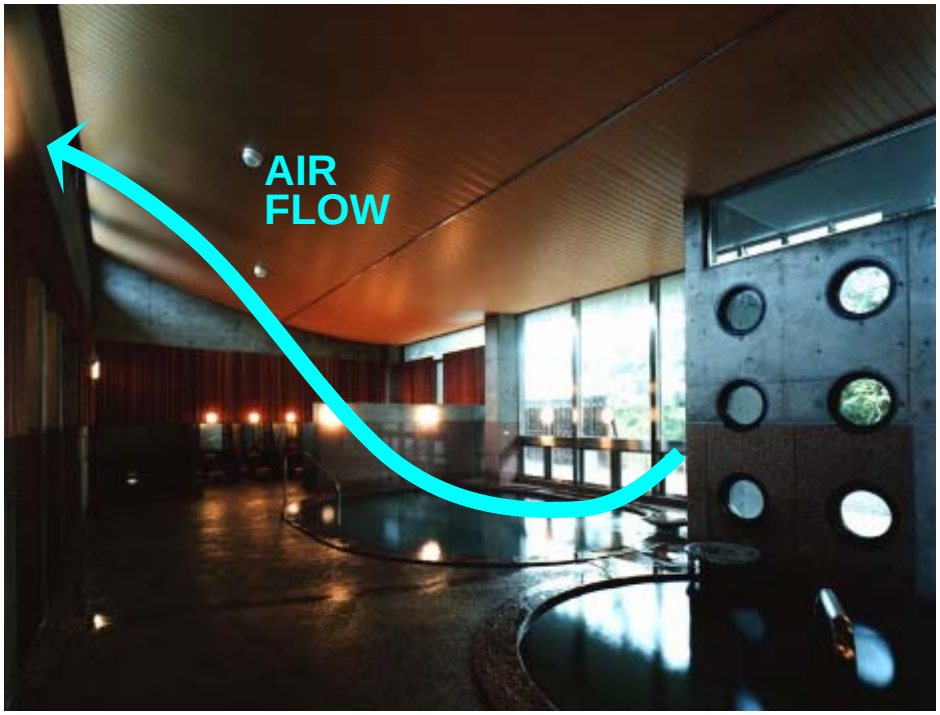
Pieces of cedar could help fermentation
It reuses fresh garbage as fertilizer

4. Wind

- **Natural ventilation**

Natural ventilation

Upper windows for air exhaust (Bathhouse)



Lower windows for air supply (Bathhouse)

The vertical distance between the inlets and outlets causes the air movement without electricity.

5. Water

- Use of harvested rain water
- Water-efficient equipment
- Permeable pavement
- Recycling System of Gray Water

Use of harvested rain water

Reused SAKE cask

Collecting rain water from the roof into the storage tank for irrigation of plants and sanitary usage.

Water-efficient equipment

（Automatic Faucet/ Sensor Flush Valve)

Automatic faucet, sensor flush valve save water

Permeable pavement

Permeable pavement allows storm water to drain naturally through the soil below, rather than becoming runoff.

Recycling System of Gray Water
（provided piping installation for future use)

6. Other Features

- High-efficient lighting systems
- Minimize light pollution
- Double-glazed glass
- Thermal Insulation
- Ice storage system
- Reclaiming waste heat
- Non Ozone Depleting Chemicals
- Energy- efficient elevator
- Recycled materials

High-efficient lighting systems





Compact fluorescent lamps (Slope) (Entrance)

High efficient fluorescent lamps (Office)

These high efficient lighting fixtures save energy and last longer

Ceiling daylight sensors: it is automatically switched on or off when day lighting reaches a certain level.

Ceiling occupancy sensors: it is automatically switched on or off with sensing the occupant

Minimize light pollution

Outside lighting in the garden
Too much artificial illumination in the nighttime environment affects the growth of animals / plants and obstructs stargazing. Lighting fixtures used outside minimize these impacts.

Double-glazed glass

View of Lobby from outside
Double glazed glass, compared to single glazing, cuts heat loss in half due to the insulating air space between the glass layers. In addition to reducing the heat flow, a double-glazed unit allows the continuity between inside and outside nature with high visibility.

Thermal Insulation

Polystyrene Form Fiberglass – Non-CFC
Thermal insulation of the exterior wall could reduce the heat transfer through the wall between inside and outside to save energy for an air conditioner.

Panel Walls

- Easy to repair, replace, disassemble and recycle
- Exterior thermal insulation

Ice storage system

Ice storage systems make ice during the night when electric utilities charge less for energy. The ice supplements or even replaces mechanical cooling during the day and can result in significant operating cost savings

Reclaiming waste heat

Air to air heat exchanger
Without heat recovery device, the air conditioner operates less efficiently because it has to work with heat loss when it exchanges the outdoor air and indoor air.

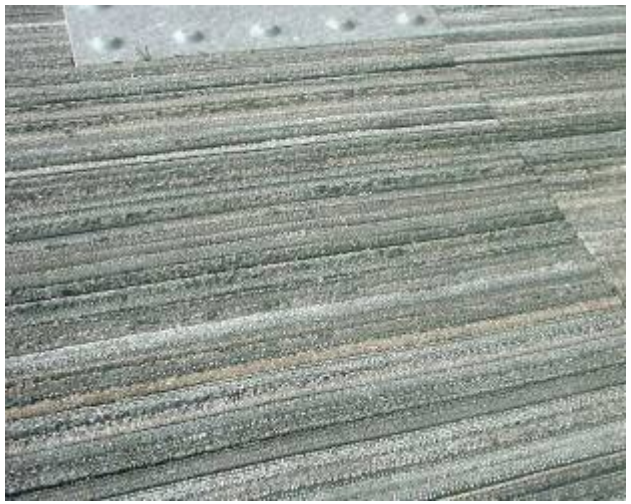
Non Ozone Depleting Chemicals

Ice storage units use R407C instead of CFCs as the refrigerants
: Chlorofluorocarbons (CFCs). R407C and R410A has been developed as replacement refrigerants.

Energy- efficient elevator

In addition to the high efficient motor, the electronic controller that adjusts the usage of electricity to the required operation is used in the elevators to save energy.

Recycled and natural materials



Recycled PET Bottle Carpet at the office
Recycled Tire Flooring at the entrance hall
A rubber Tile is used as a natural material
Environmentally friendly materials are chosen as much as possible for interior finishes.
(recycled materials/ natural materials/ local materials)

6. Other Features

Hotel Guest Room Finish Materials

Guest room A

FINISH SCHEDULE [A Type]

Floor	Soil Ceramic Tile (Waste heat used)
Wall	Rice Paper
	Cedar / Cypress Board
	Diatom Soil Plaster
	Soil Ceramic Tile (Moisture Control)
Ceiling	Rice Paper

6. Other Features

FINISH SCHEDULE [B Type]

Floor	**Tatami Mat**
	Soil Ceramic Tile (Waste heat used)
Wall	**Diatom Soil Plaster**
	Cedar / Cypress Board
Ceiling	**Rice Paper**

Guest room B

6. Other Features

Guest room B

Outdoor Bathtub

Traditional Japanese-style

6. Other Features

FINISH SCHEDULE [C Type]

Floor	**Hemp Mat**
Wall	**Rice Paper**
	Cedar / Cypress Board
Ceiling	**Rice Paper**

Loft-style

Guest room C

6. Other Features

Guest room D

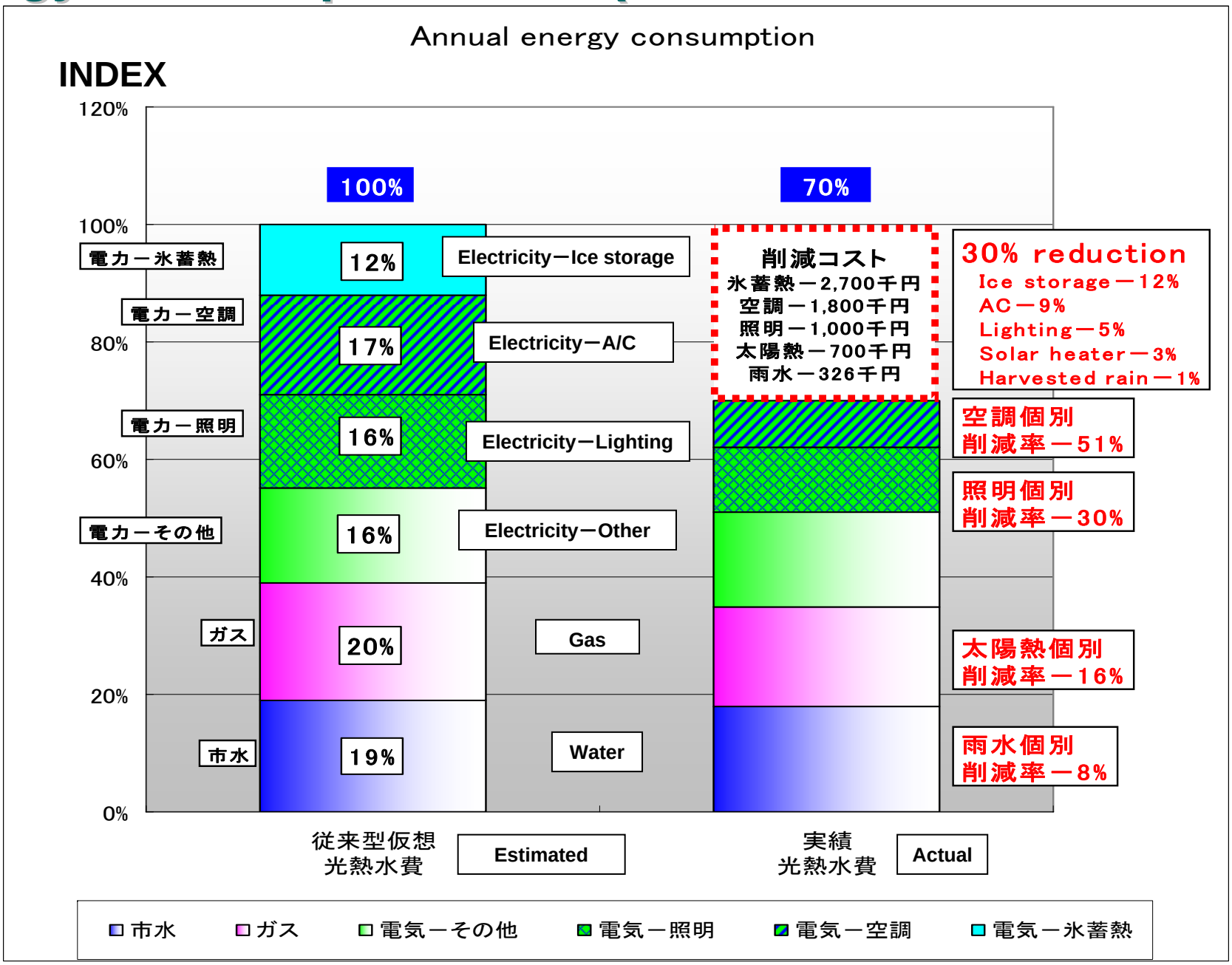
FINISH SCHEDULE [D Type]

Floor	Cedar / Cypress Flooring
Wall	Diatom Soil Plaster
Ceiling	Cedar Board

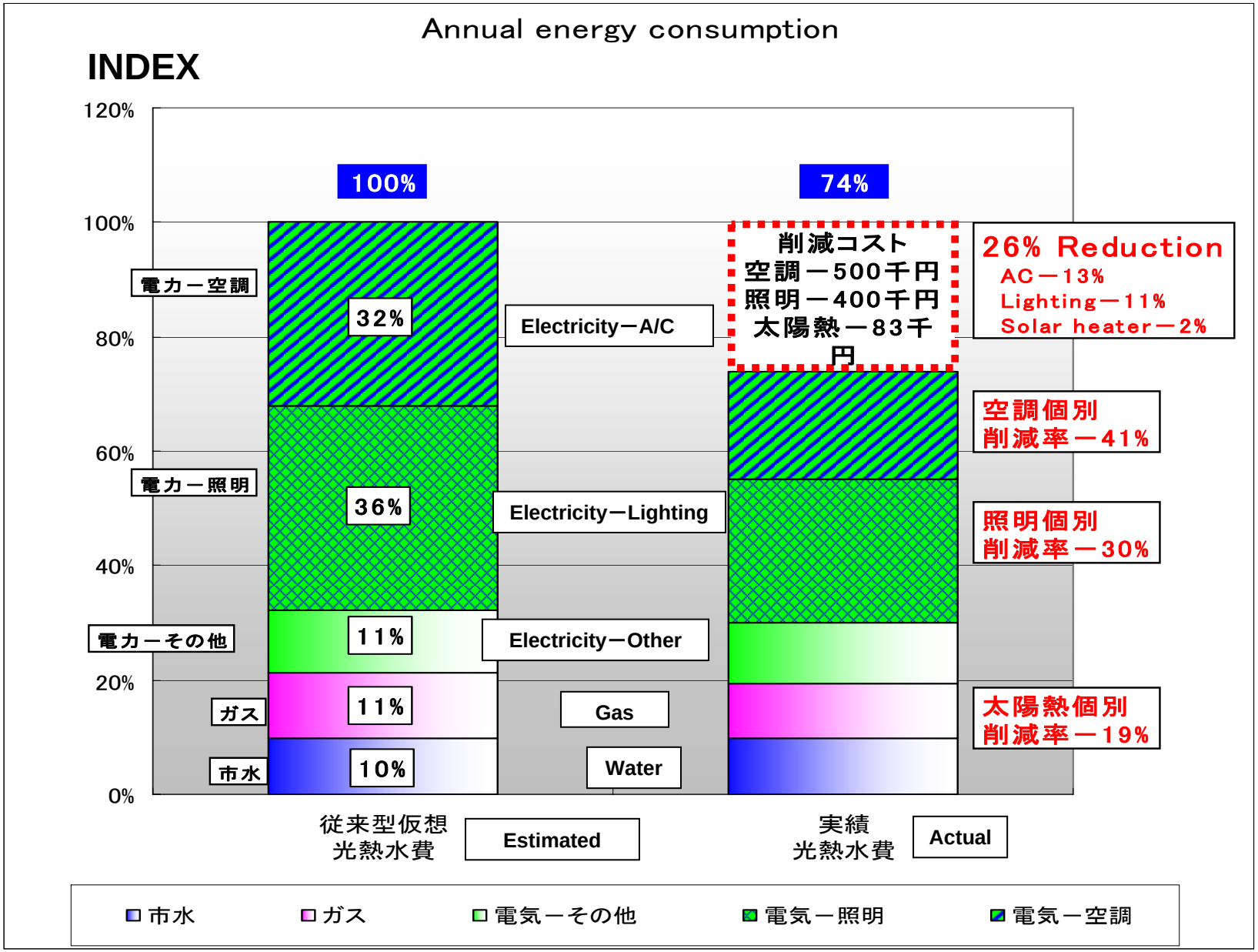
6. Other Features

Result

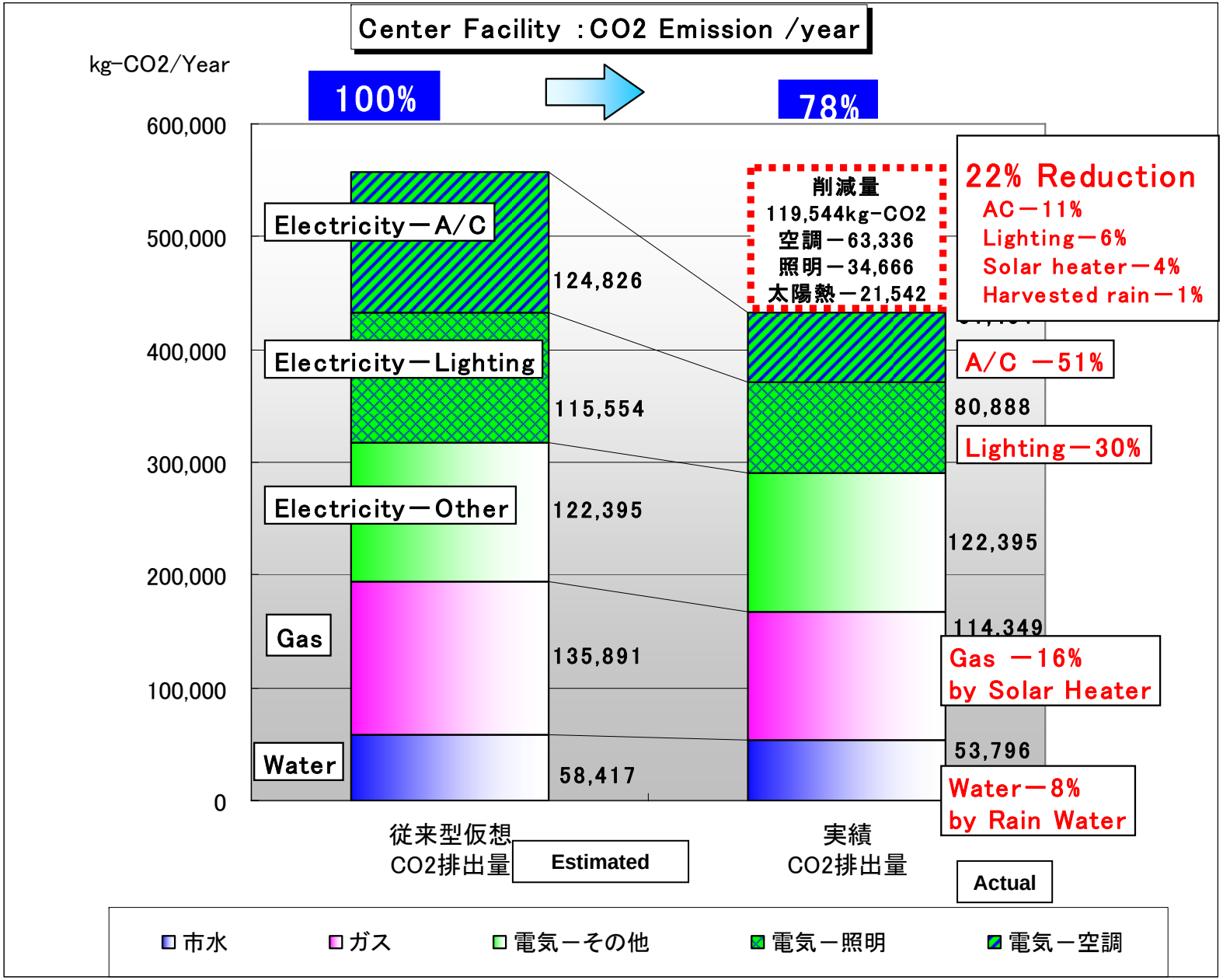
Energy Consumption Cost (Center)



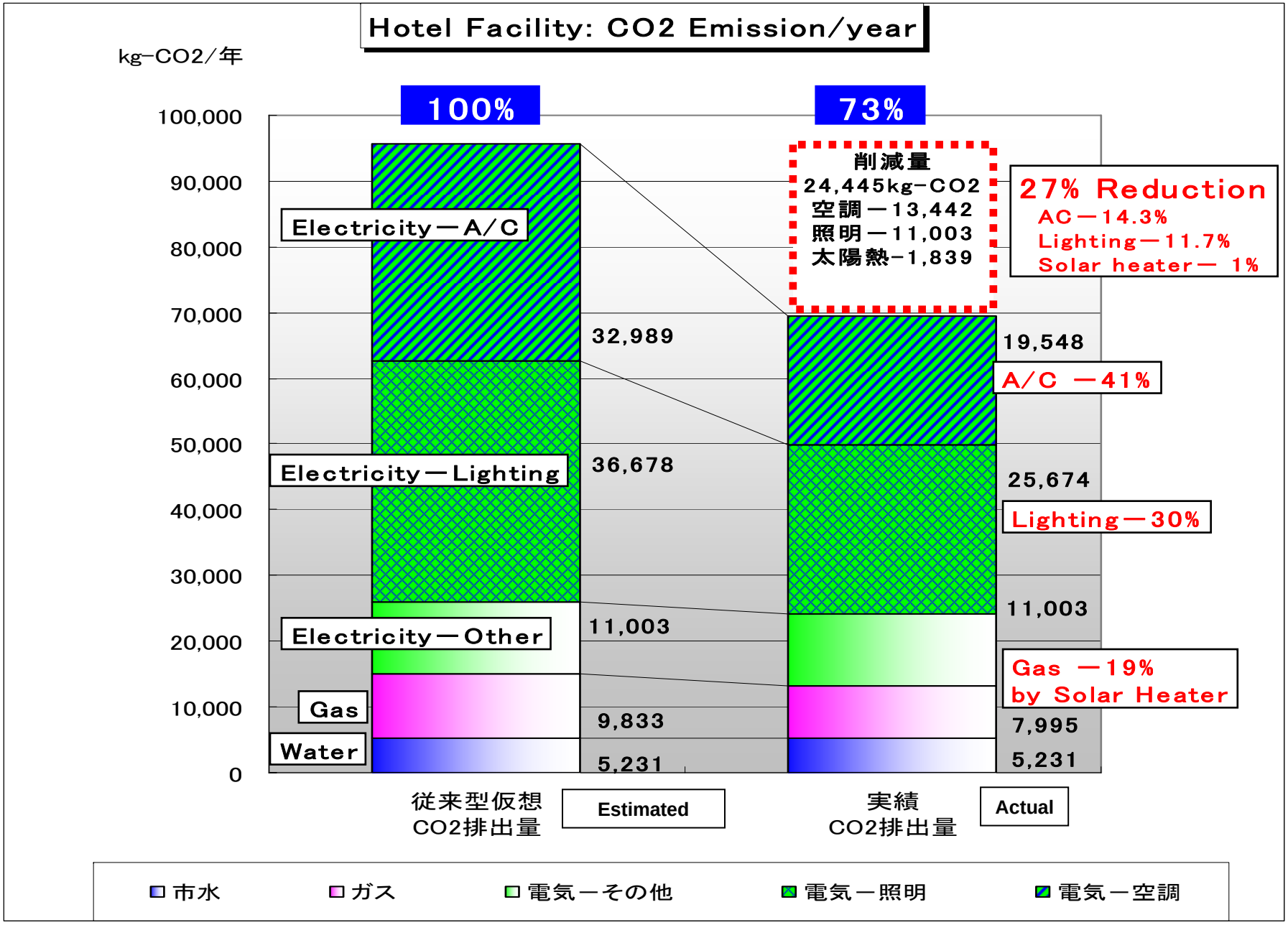
Energy Consumption Cost (Hotel)



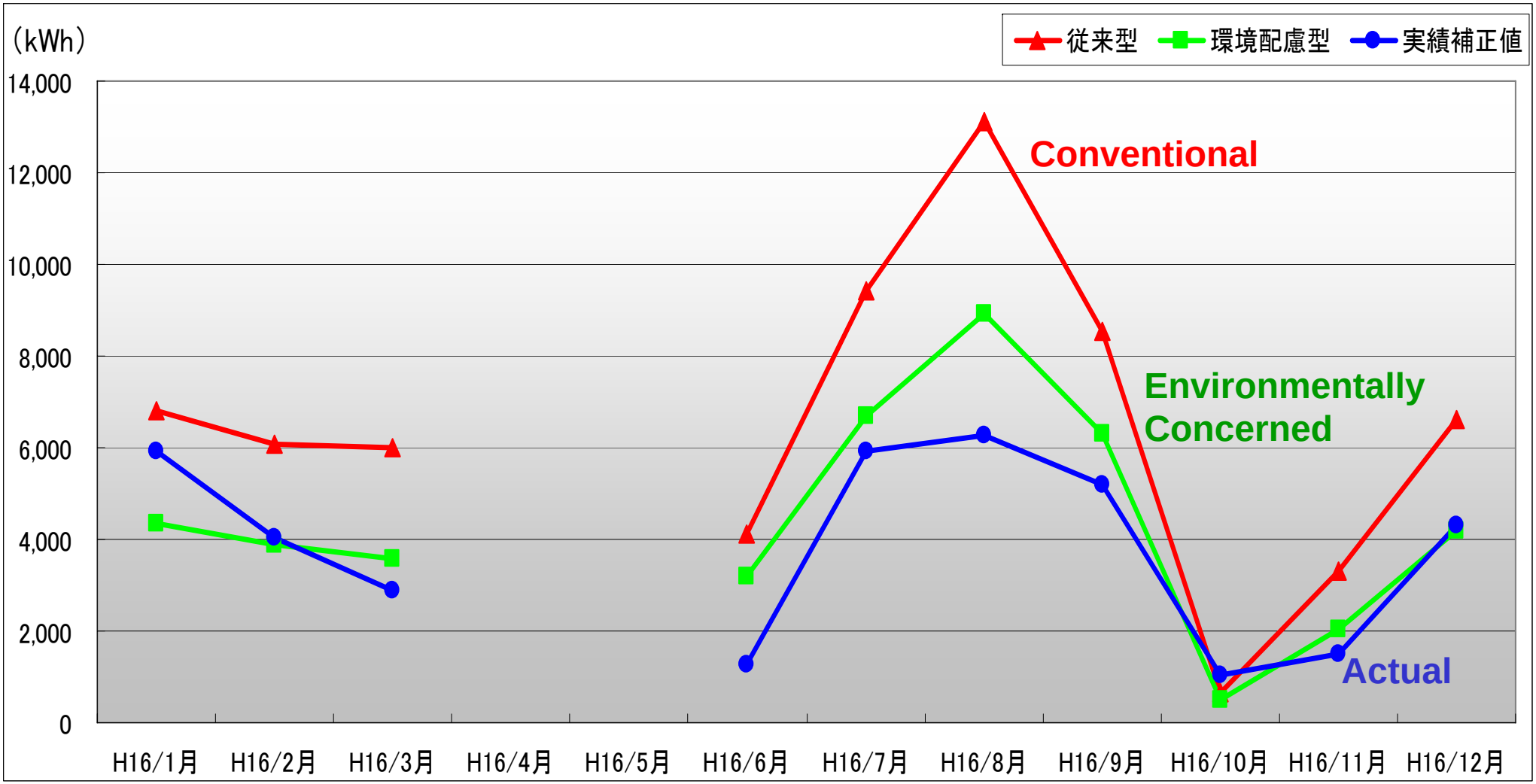
CO2 Emission (Center)



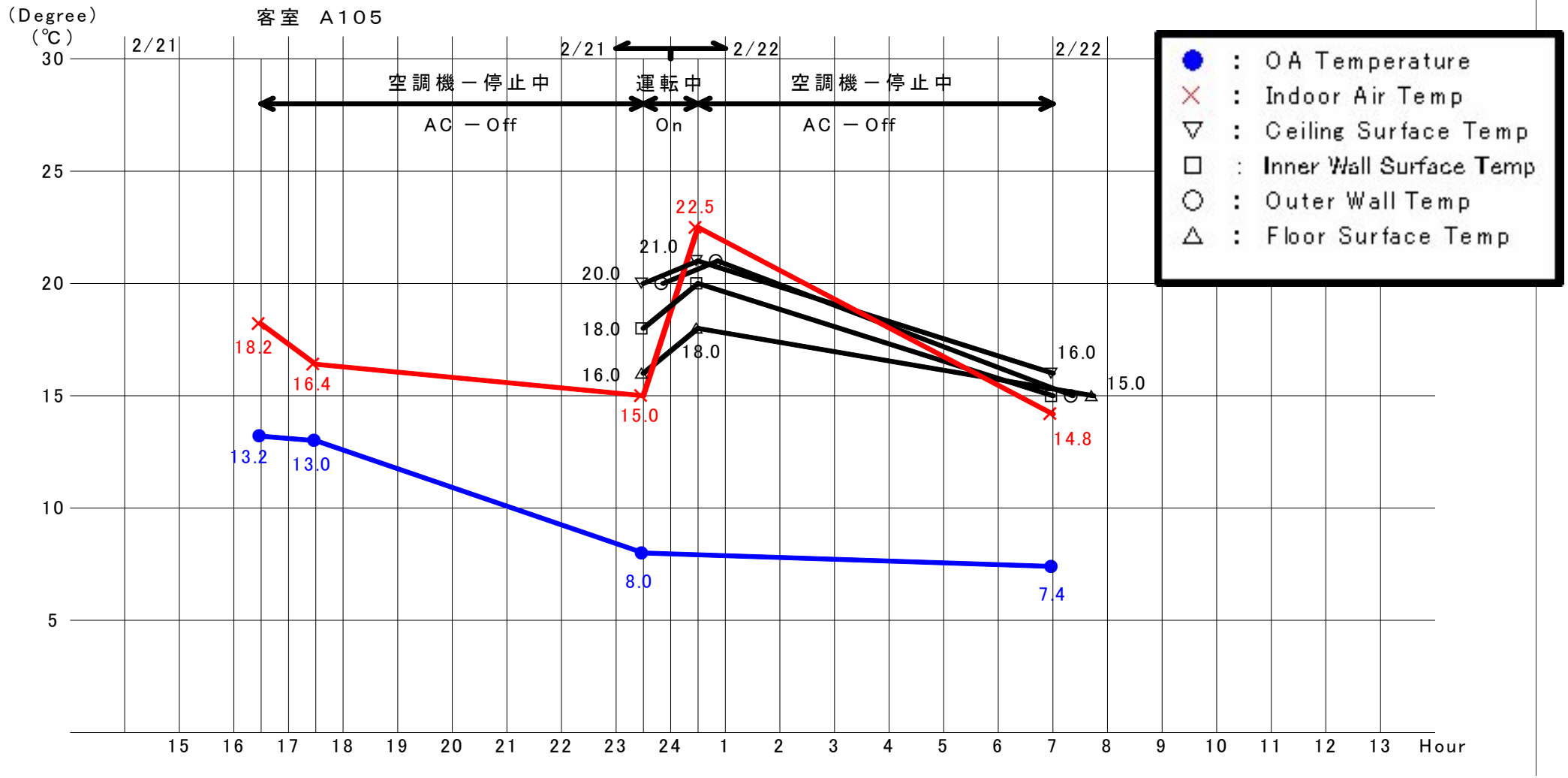
CO2 Emission (Hotel)



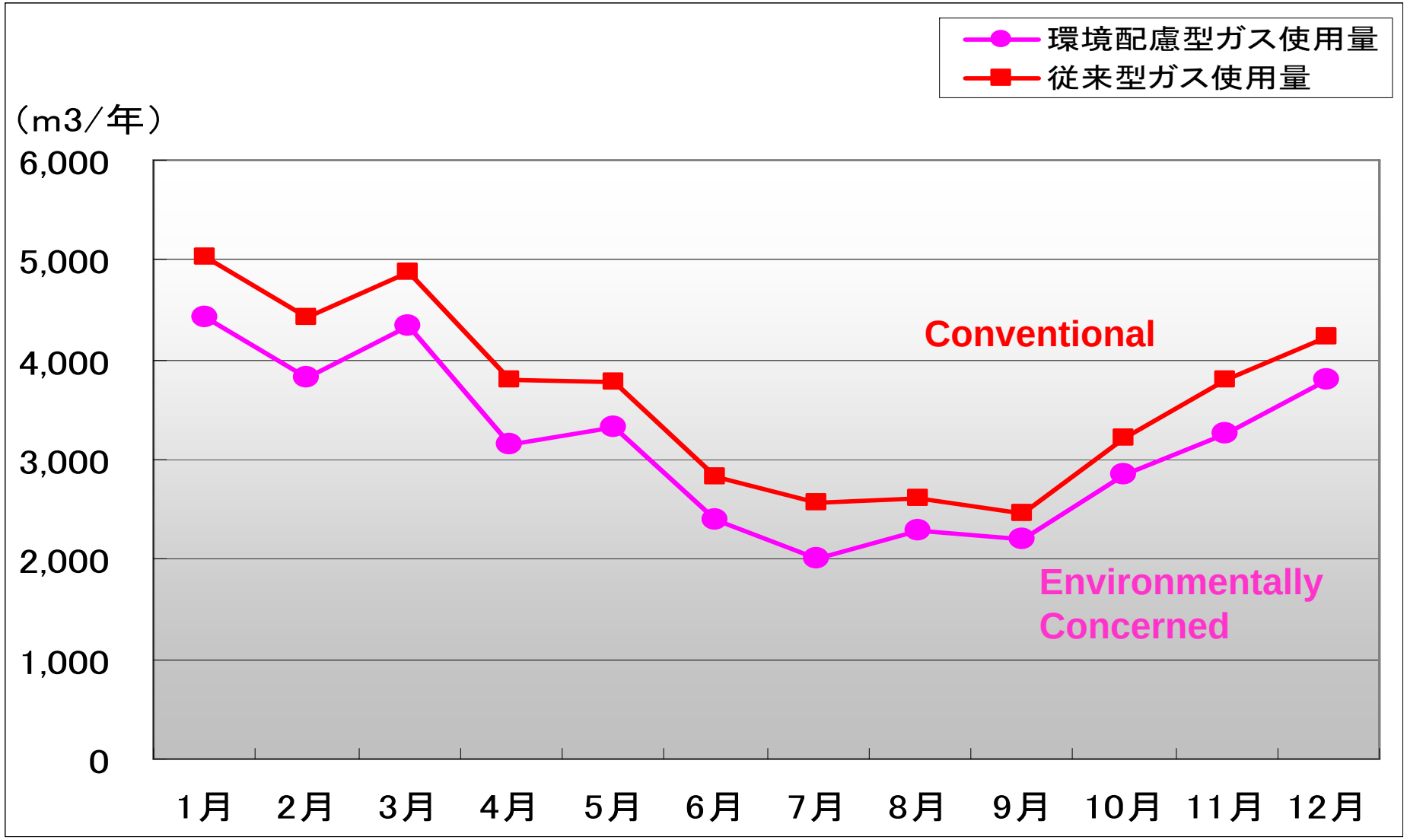
Eco lodge Shimanto－AC Load Reduction　Monthly Energy Consumption



Eco lodge Shimanto –Verification :Room Temperature



Eco lodge Shimanto－GAS Consumption Environmentally Concerned
Solar Hot Water System



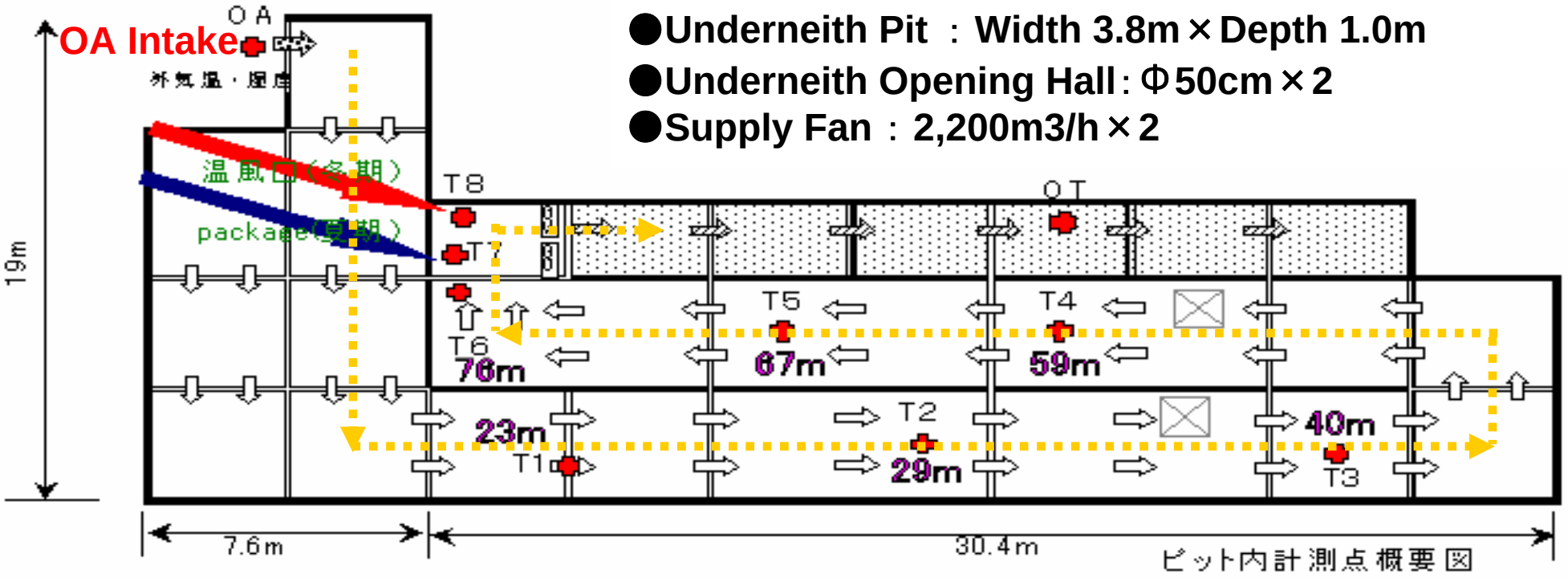
Earth Tube

●Length：About 80m（外気取入口～吹出手前）

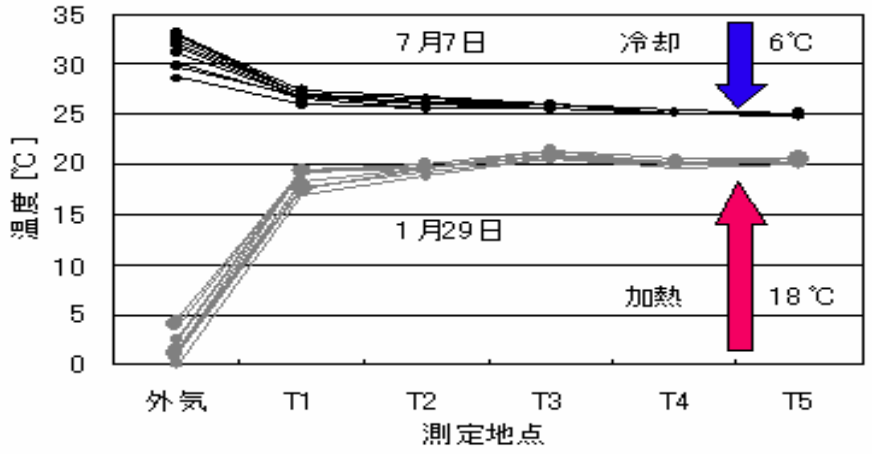
●Underneith Pit ：Width 3.8m×Depth 1.0m

●Underneith Opening Hall：Φ50cm×2

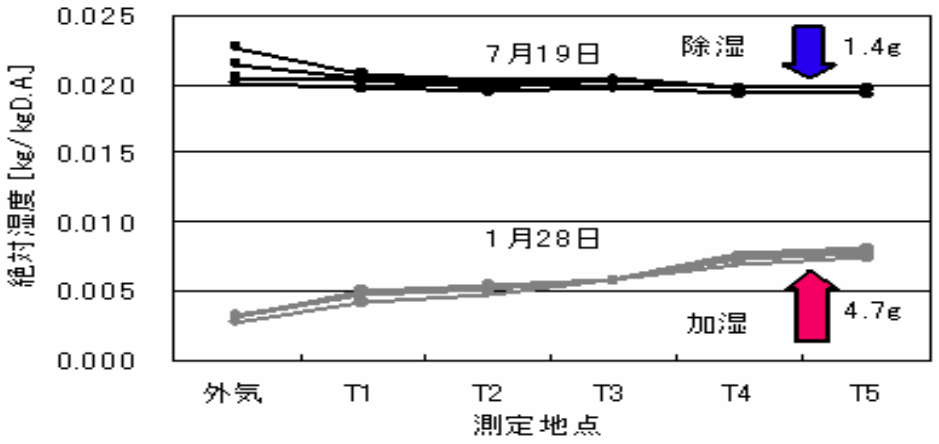
●Supply Fan：2,200m3/h×2



ピット内計測点概要図

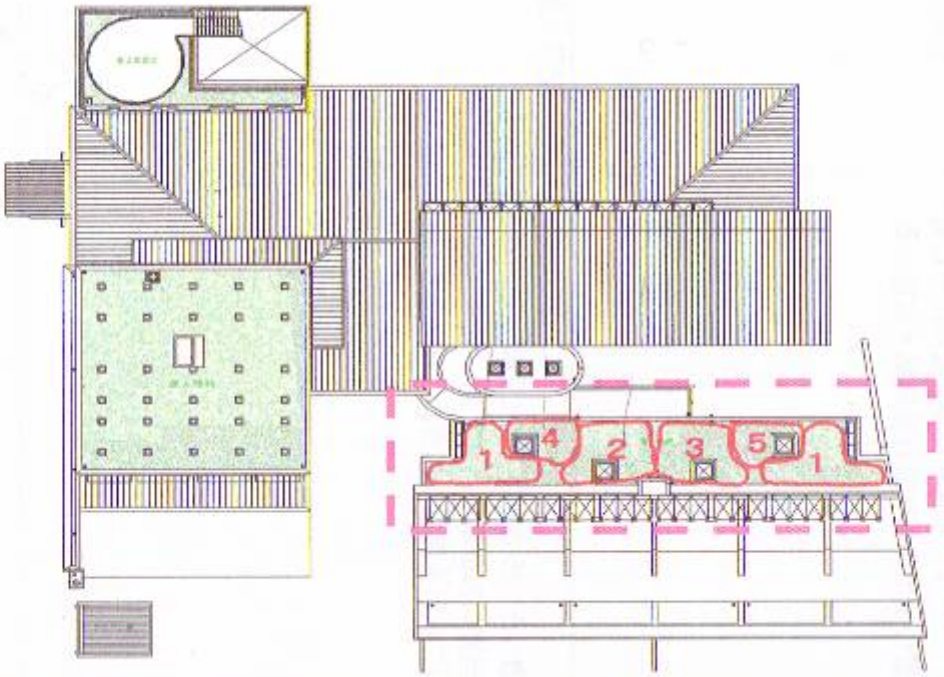


夏期と冬期のピット内温度変化



夏期と冬期のピット内湿度変化

Green roof ;winter

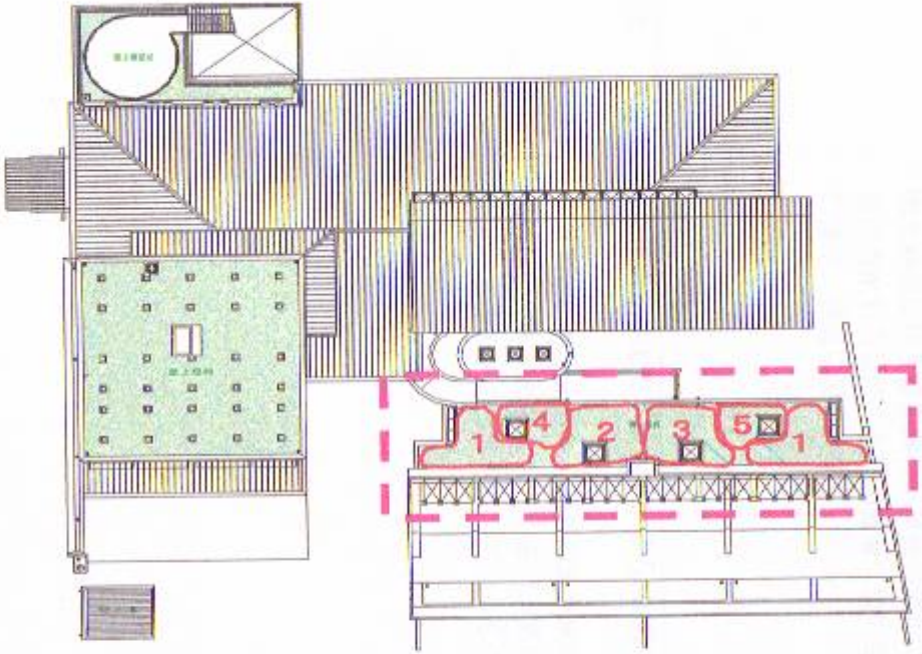


1　葉が茶色く枯れている。

2　よく育っている。
外壁側の浴室排気の当たる場所は特によく繁殖している。

1	アシズリノジギク
2	メキシコマンネングサ
3	タイトゴメ
4	オノマンネングサ
5	ツルマンネングサ

Green roof ;summer



1	アシズリノジギク
2	メキシコマンネングサ
3	タイトゴメ
4	オノマンネングサ
5	ツルマンネングサ

Example 2:
Kariya Regional Government Office Building

Kariya Regional Government Office Building

Facility Overview

Facility Name: Kariya Godo Chosha
Address: 1-46-1 Wakamatsu-cho, Kariya-shi
Completion Date: August, 2004

Facility Size

Site Area: 4,414㎡ Building Area: 1,735㎡
Total Floor Area 6,912㎡
Structure: RC + Steel
Number of Floors: 6 Stories above the ground

Purpose and Composition

Purpose: Administrative duties
Composition:
- ▫Taxation Bureau
- ▫Legal Affairs Bureau
- ▫Labor Standards Supervision Office

Energy Used

▫Electricity ▫Gas ▫City Water

Standard for the Environmental Preservation Performance of Government Building Facilities

(Ministry of Land, Infrastructure and Transport Government of Japan)

Performance Factors related to Greening

- **Long Life**
- **Appropriate Use and Disposal**
- **Eco Materials**
- **Conservation of Energy and Resources**
  (Reduction Heat Land/ Use of Ntural Forms of Energy/ Effective Use of Energy & Resources)
- **Local Environment Conservation**
  (Local Ecosystem Conservation/ Consideration of Local Influence)

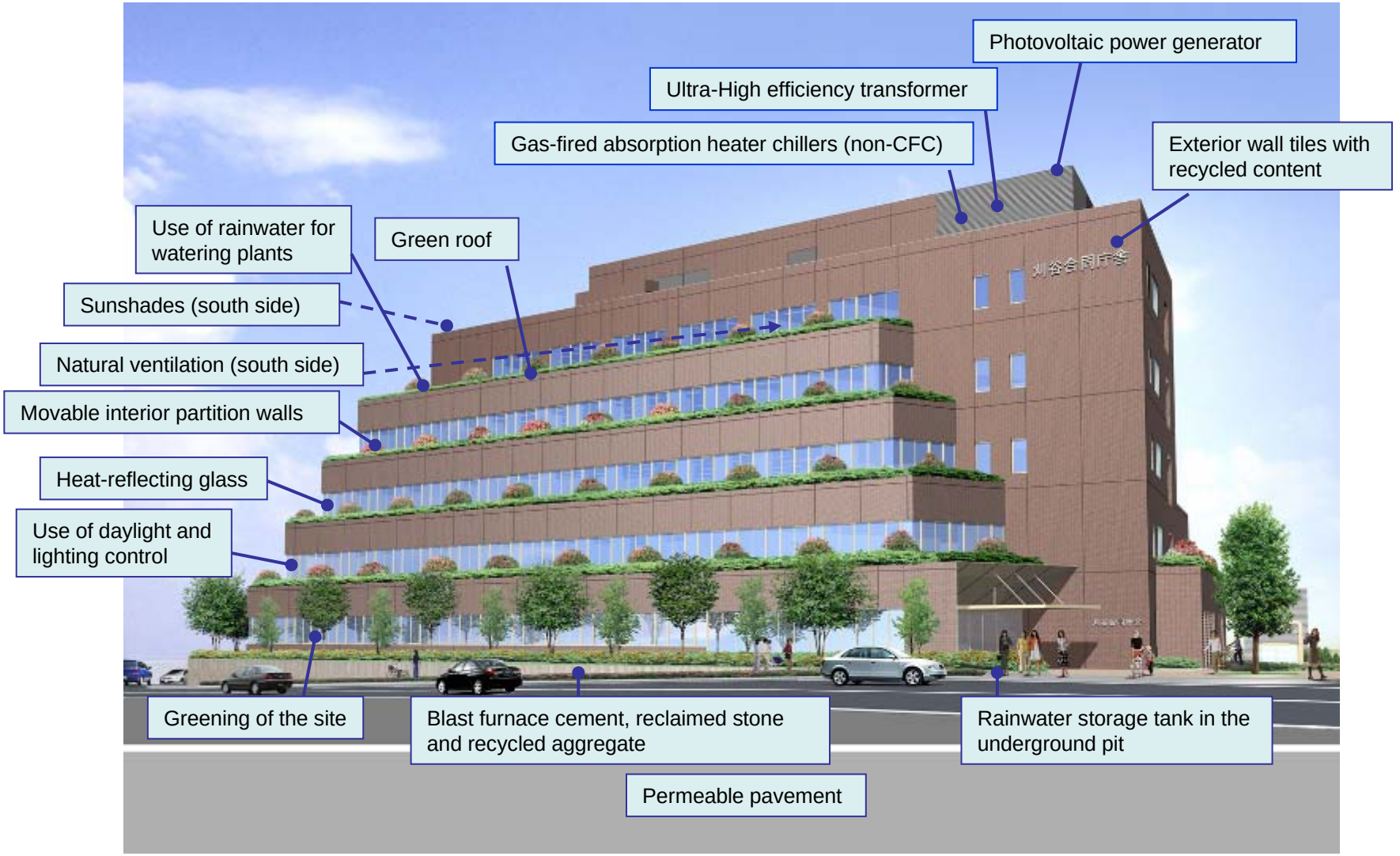
Evaluation and Verification of Greening

(Principal numerical indices of environmental load)

LCA

(LCCO2 (life cycle carbon dioxide emission)
(LCW (life cycle waste disposal)
(LCR (life cycle resources input)

Kariya Regional Government Office Building



North face of the building

Major Green Technologies

(Categorized by the Japanese government)

Local Environment Conservation

- Greening of the site/green roof
- Countermeasures for Light Pollution/Air Pollution

Conservation of Energy and Resources

- Sun shade eave
- Natural lighting
- Photovoltaic power generation equipment
- Rainwater harvesting equipment (watering)
- Heat reflecting glass
- High-efficiency lighting fixture + lighting control
- Hybrid (solar & wind) outdoor light
- VAV & VWV
- Ultra high efficiency transformer
- Low-flow plumbing fixtures

Long Life

- Compact air-handling unit
- Elevators without machine rooms
- Extra space to appropriately meet future changes
- Access floors
- Variability of interior partitions

Eco Materials

- Exterior wall tiles with recycled content
- EM cables
- Stainless steel pipes and tanks

Appropriate Use and Disposal

- HCFCs
- Non-CFC heat source (Absorption heater chillers)

Assessment of Individual Greening Technologies (Quantitative Verification)

A. Photovoltaic Power Generator

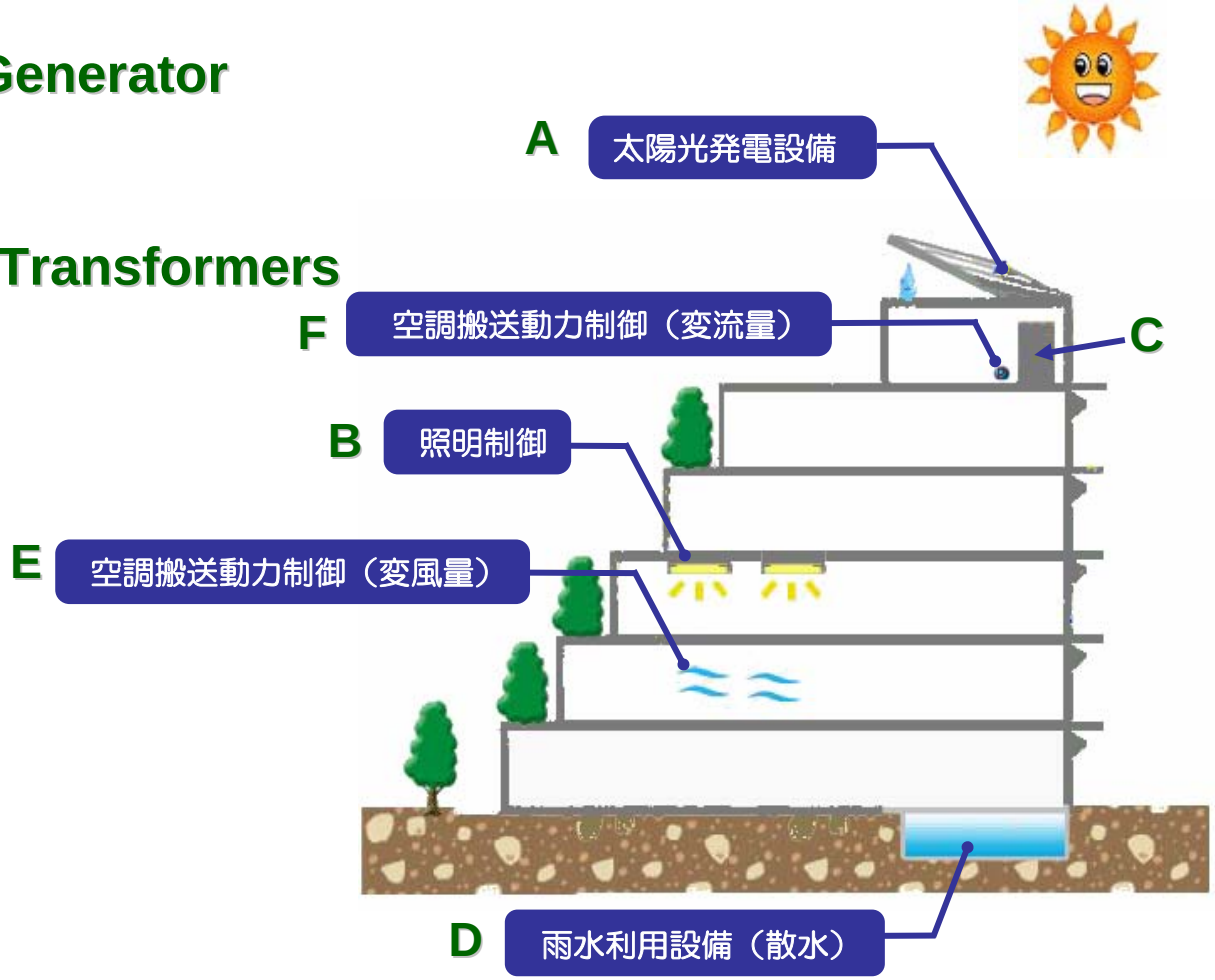
B. Lighting Control

C. Ultra-High Efficiency Transformers

D. Harvested Rainwater

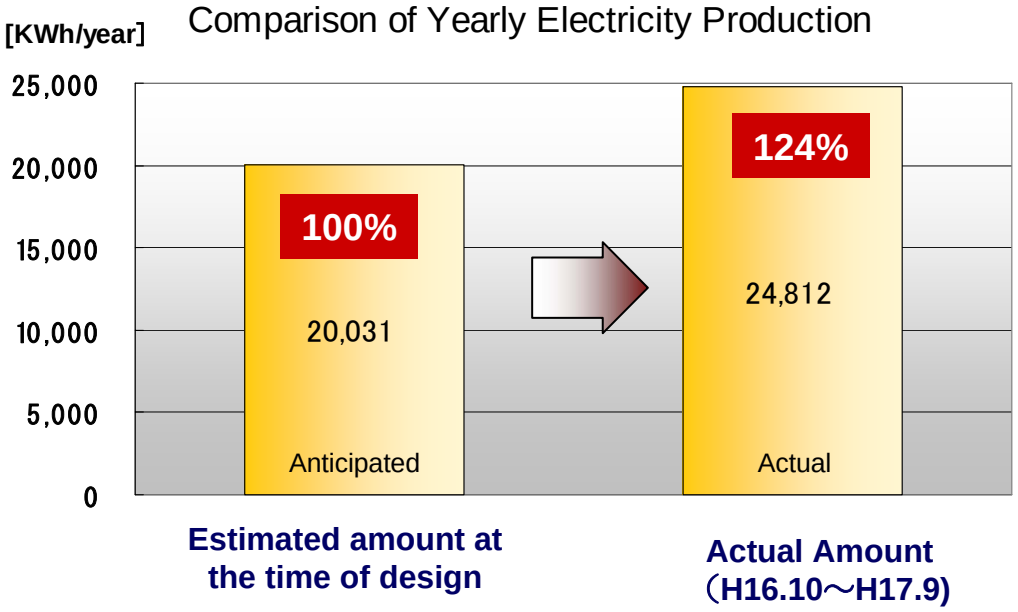
E. VAV Control

F. VWV Control



Assessment of Greening Technologies: Photovoltaic Power Generator

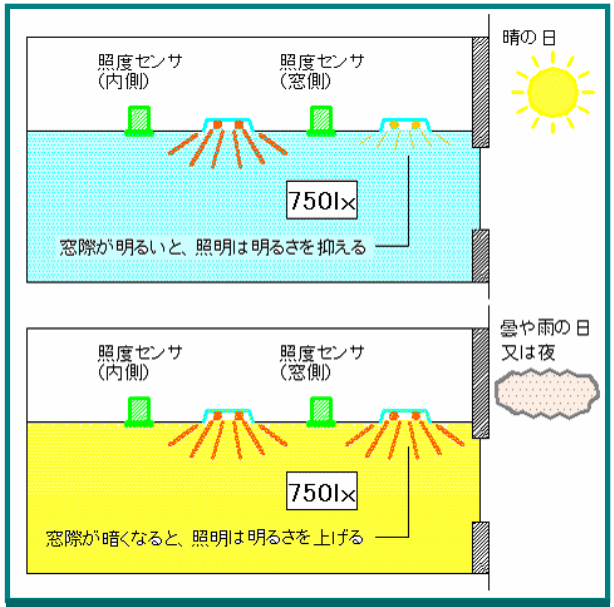
20kW Photovoltaic generator is installed on the roof and connected to the parallel system.



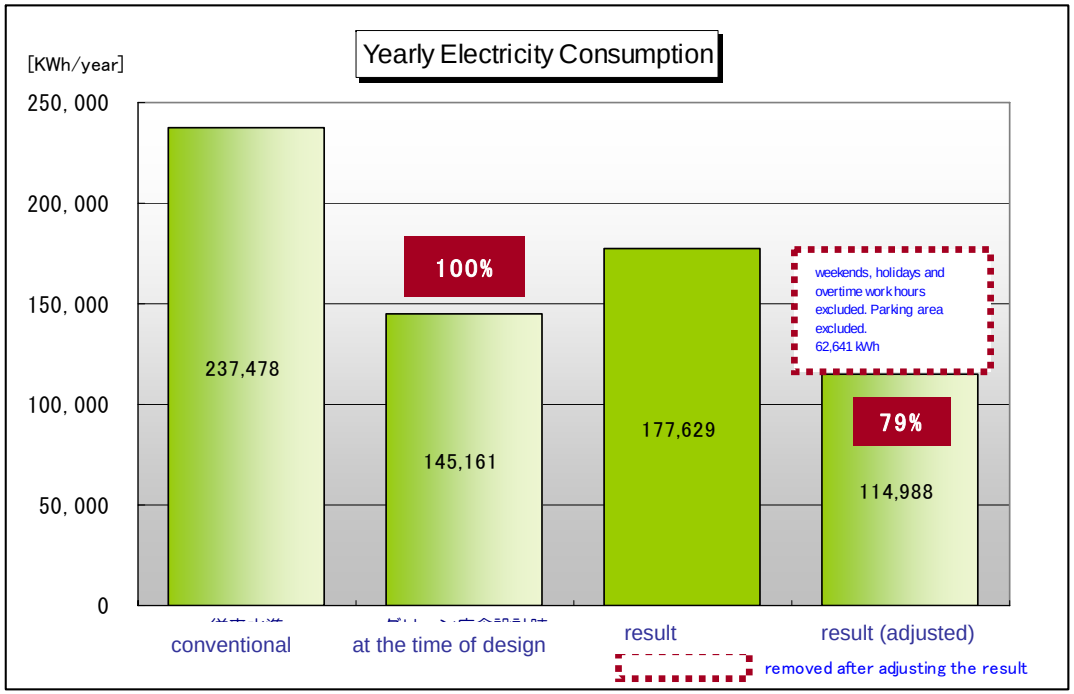
PV Power generated about 7% of the overall annual electricity consumption

Contribute to emission reduction of about 12 t-CO_2/year (The conversion is based on the basic units used by the government)

Assessment of Greening Technologies: Lighting Control



High efficiency lighting fixtures are used in office room areas.
Occupancy sensors are used in the bathrooms, hallways and stairs.



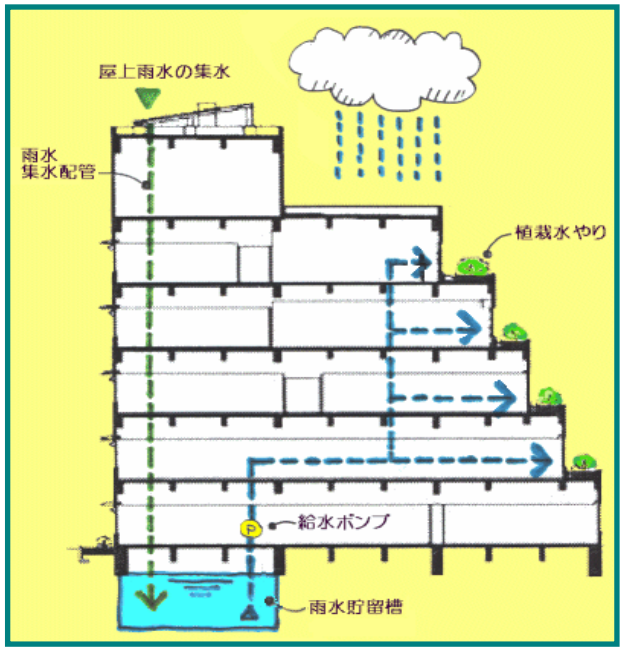
Reduction of Electricity Consumption

- **Yearly Reduction: 122,490kWh/year**

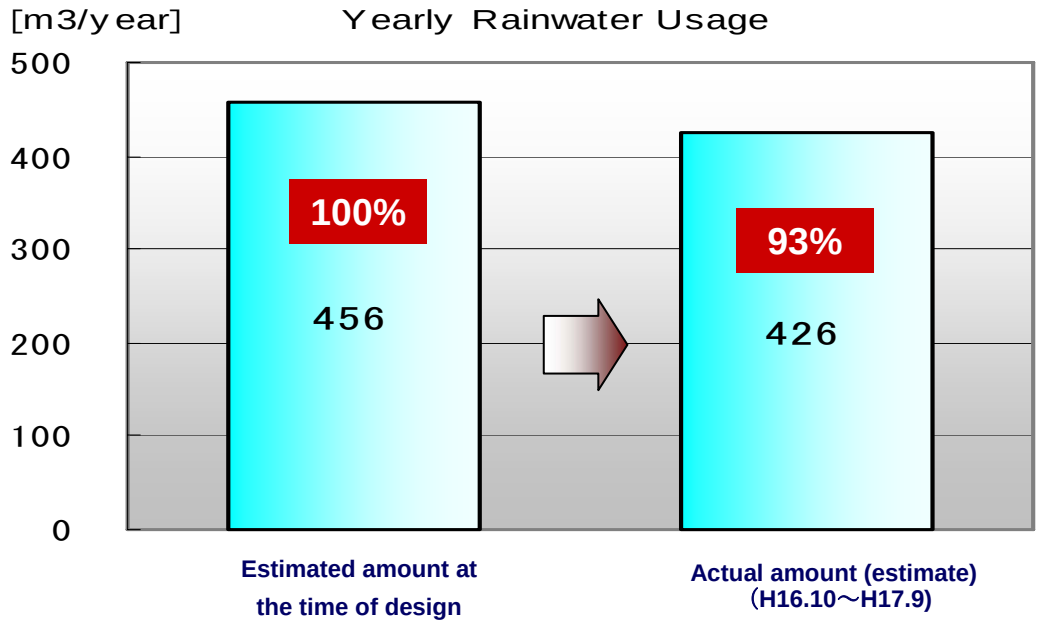
(52% reduction compared to conventional approach)

Contribute to emission reduction of about 62 t-CO2/year

Assessment of Greening Technologies: Rainwater Harvesting Equipment



Rainwater is stored in the underground pit and used for watering roof gardens.



Reduction of City Water Consumption

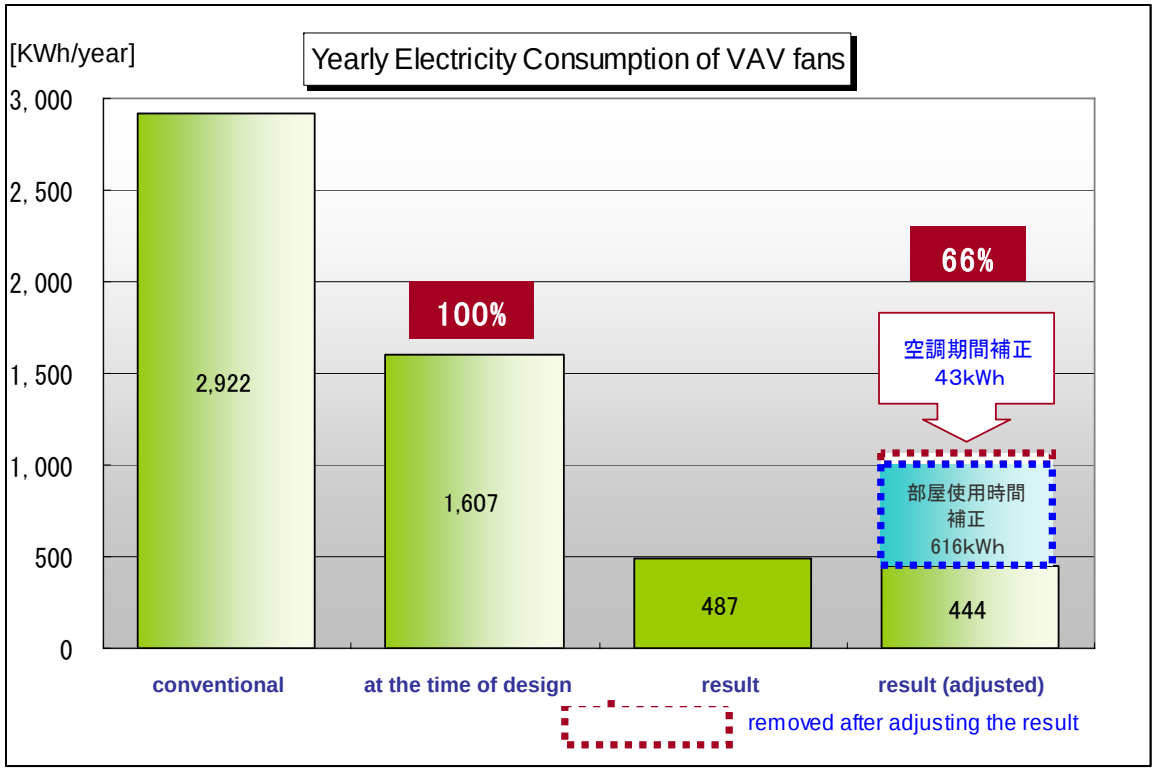
- Overall water consumption: 4,566 m3/year
- Reduction in city water consumption: about 9 %

Contribute to emission reduction of about 0.9 t-CO2/year

Assessment of Greening Technologies: VAV Control

The capacity of air-handling system is determined based on the maximum building load, but not on the partial load which is dependent on the season, time and operational conditions.

The volume of air supply is controlled to adjust to the variation in the amount of load (VAV control) .



Reduction of Electricity Consumption

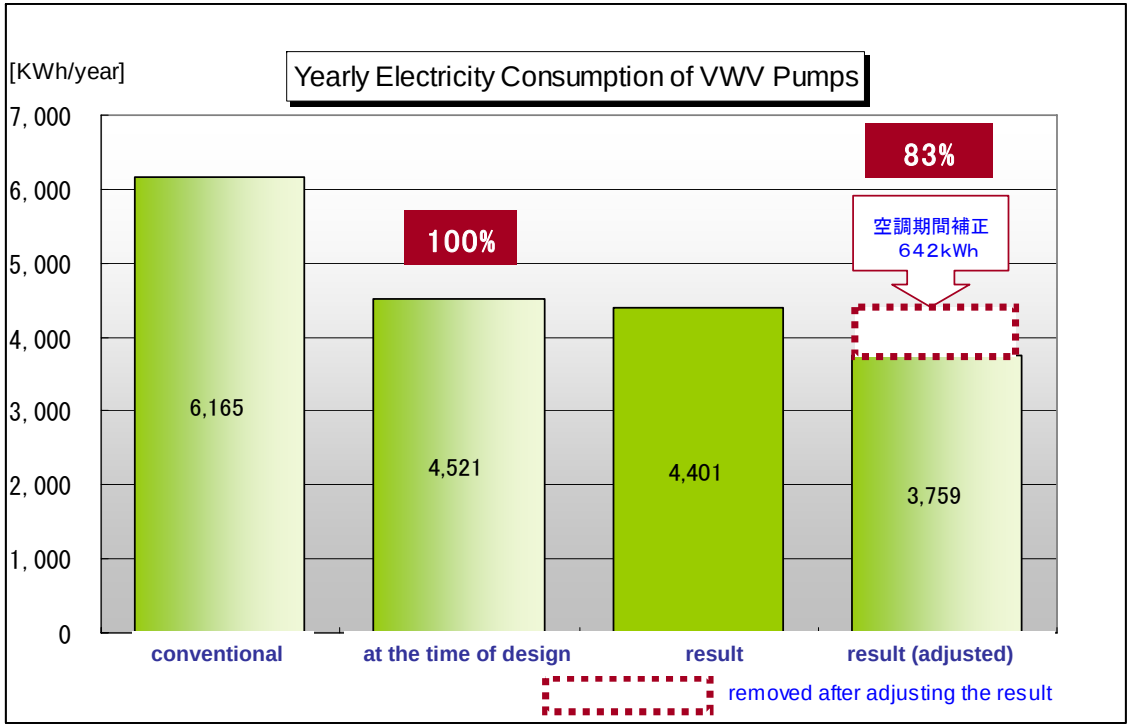
- Yearly Reduction: 1,862 kWh/year
  (54% reduction compared to conventional approach)

Contribute to emission reduction of about 0.9 t-CO2/year

Assessment of Greening Technologies: VWV Control

The capacity of air-conditioning system is determined based on the maximum building load, but not on the partial load which is dependent on the season, time and operational conditions.

The volume of water supply is controlled to adjust to the variation in the amount of load (VWV control) .



Reduction of Electricity Consumption

- **Yearly Reduction: 2,406 kWh/year**
  (54% reduction compared to conventional approach)

Contribute to emission reduction of about 0.9 t-CO2/year

Local Environment Conservation

- Green roof, countermeasures for light and air pollution

Green Roof

Outdoor lighting Fixtures

Gas-fired absorption heater chiller

Thermal Protection

- Sunshades, well-insulated walls and double glazed glass

Lessen heat gain by sunshades, well-insulated wall materials and heat-reflecting glass.

The width of the sunshades is 450mm.

Water conservation

- Low-flow Plumbing Fixtures

Urinal Sensor
Flush Valve

Flush toilet

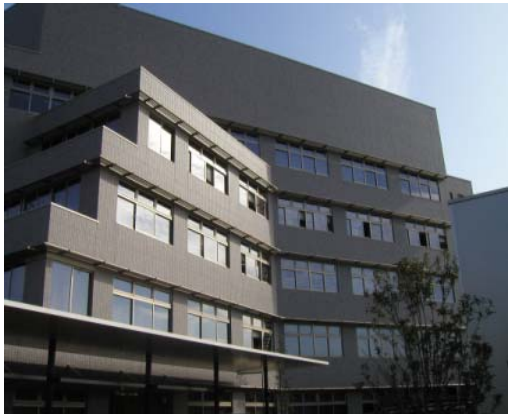
Automatic faucet

Japanese style
flush toilet

Eco Materials

- recycled, easy to recycle, non-toxic, natural material and long life

- Exterior wall tiles with recycled content
  Porcelain tiles with more than 20% recycled content
- Certified cables (as eco material)
- Stainless steel tanks and pipes
- Blast furnace cement
- Pre-cast concrete (East and North walls)
- Green roof



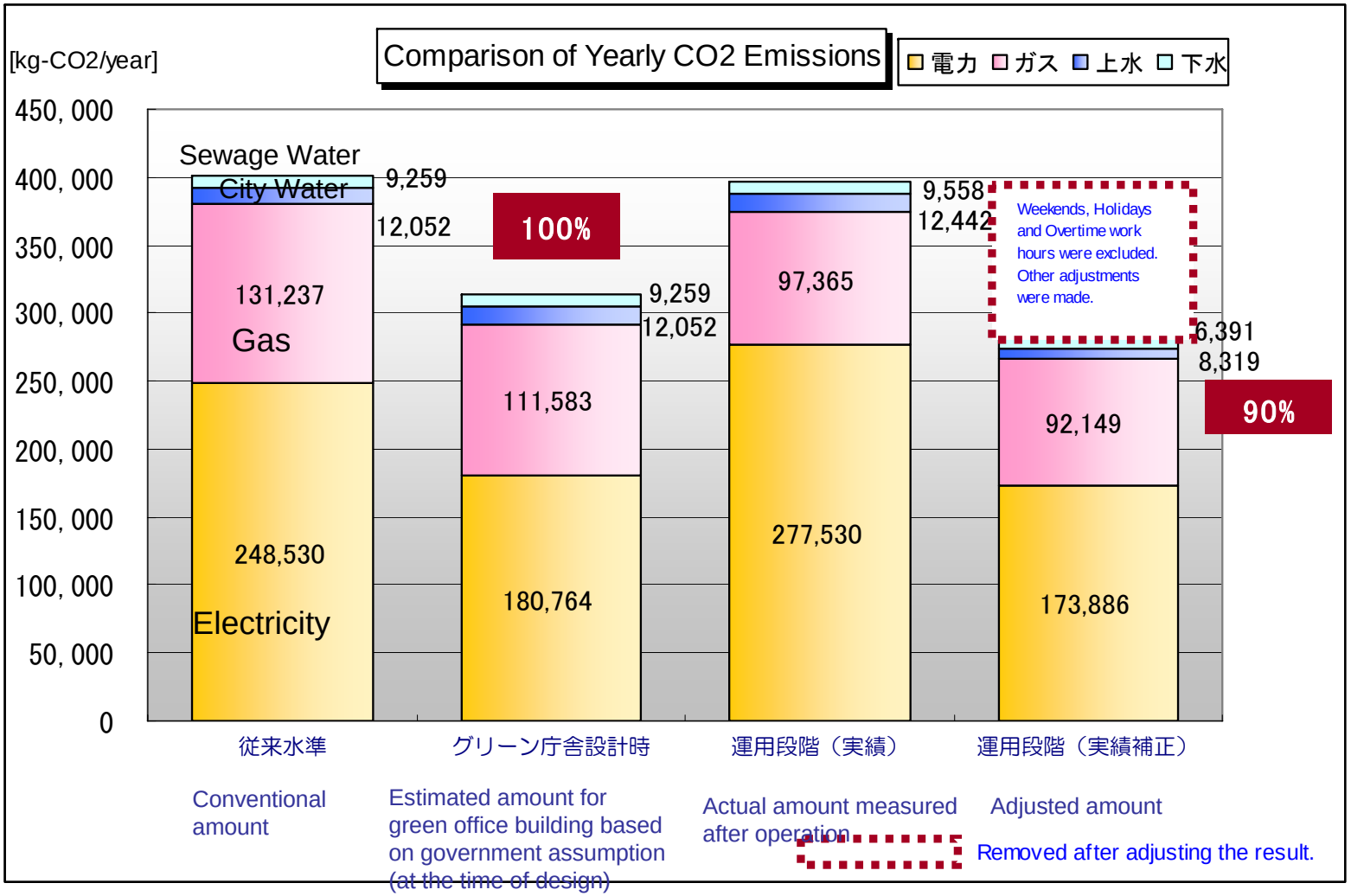
Wall tiles with recycled content

Pre-cast concrete walls

① Kariya Regional Government Office Building

Comparison of Yearly CO2 Emissions

Yearly CO2 Emission Reduction＝120,334 kg-CO2/year
（Compared to conventional amount）



CASBEE

(**C**omprehensive **A**ssessment **S**ystem for **B**uilding **E**nvironmental **E**fficiency)

(Japan Sustainable Building Consortium)

Assessment Items

Q1: Indoor Environment
Q2: Quality of Services
Q3: Outdoor Environment on Site

→ **Q**

L1: Energy
L2: Resources & Materials
L3: Off-site Environment

→ **L**

$$\text{BEE (Building Environmental Efficiency)} = \frac{Q \text{ (Building Environmental Quality \& Performance))}}{L \text{ (Building Environmental Loadings)}}$$